

The present book endeavours to integrate different sub-divisions of Rachana Sharira (anatomy) to enable students of anatomy to learn all the relevant aspects of a topic like Marma Shariram, Kala Shariram, Kostha Shariram and Garbha Shariram.

Knowledge of gross anatomy is one of the pillars of a sound medical curriculum. In the present textbook, enough anatomical knowledge has been included so that essential information is retained. Anatomy should be taught with clinical emphasis, as it is fundamental to clinical practice. It also makes anatomy interesting, easy to understand and remember.

Salient features:

- This book is illustrated with 24 colour diagrams in 1st part and 48 colour diagrams in IInd part which serve as readers delight.
- In each part of the book, there are 400 multiple questions.
- Information is provided in an easy, concise, relevant and compact manner.
- For easy remembrance mnemonics are given.
- Most useful for Ayurveda medical students to answer basic questions in Rachana Sharira of the human body.
- This book also caters to the exam-oriented needs of the students.
- Applied anatomy or clinical applications are also given for easy understanding.
- Anatomy of the human body described with relevant comparison with modern medicine as and when necessary.

I do hope that because of its good colour photographs, correlation with modern anatomy, emphasis on applied anatomy and multiple questions of Rachana Sharira this book will be useful to students of B.A.M.S.



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Dr. P. K. Moharana has presented papers in four international and fourteen national seminars. He has dissected 27 cadavers till now. He is having sound knowledge in both Ayurveda as well as modern medicine.

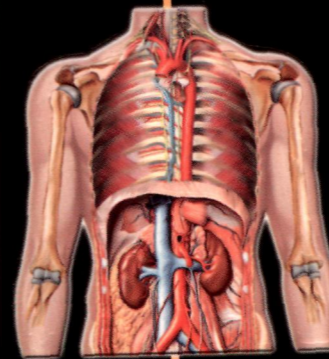
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DELHI - 110007**

I
Dr. P. K. Moharana

A Text Book of Anatomy



A Text Book of Anatomy (Rachana Sharira)



Dr. P. K. Moharana



Lord Dhanwantarayeh Namah

**A TEXT BOOK OF
ANATOMY**

THE
CHAUKHAMBA AYURVIJNANA STUDIES
91

A TEXT BOOK OF ANATOMY

(According to the Syllabus of CCIM, New Delhi)

Volume One

By
Dr. Pradeep Kumar Moharana

M.D. (Ay).



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**DEDICATED TO MY BELOVED PARENTS AND
STUDENTS**

PREFACE

Over the years, while teaching the students of rachana shareera, myself, along with many of my colleagues, shared the views of an absolute dearth of a single comprehensive text book of rachana shareera worth mentioning to prescribe to the students.

Being constantly insisted and hard pressed by my beloved students, I ultimately decided to write a compact, comprehensive syllabus wise and practically oriented text book of rachana shareera. It is an attempt to supply the students a comparatively easy technique to remember rachana shareera along with some multiple questions, which will be useful for the examination and for the higher study. The aim being to emphasize the simplicities rather than complexities. The book is written in a clear and concise language and in author's own style, which holds the reader's interest. Extensive illustrations, flow charts (schemes) and diagrams have been used as and where needed to add lucidity and clarity to the subject and to emphasize the practical nature of the book.

Although the book has been written primarily for the undergraduates, it should also prove to be useful to the students of other system of medicine, those aspiring for getting the sound knowledge of AYURVEDA. I, however, do not consider this book to be an ideal one but a humble attempt has been made to remove the bottlenecks, as far as possible, of the books available to the students at present.

Very little of what is worthwhile in this book could have been brought to publication without the generous co-operation, advice and assistance of many of my colleagues, seniors, juniors, and students.

The author wishes to acknowledge with gratitude Dr. K.T.Jayakrishnan, Principal for his sincere help.

I am thankful to Dr. B.C. Jana, J.B.Roy state, Ayurveda College Kolkata – 4 reader, dept of rachana sharira for sincere advice.

I wish to thank Dr. B. N. Mishra, Dr. S. K Brahma, for their sincere advice and co-operation.

I express my sincere thanks to Dr. S. Rout, Dr .C. R. Das, Dr.S.K Meher, Dr.Panda, Dr.Vasu, Dr. Rajasekar, Dr.Sai prasad, Dr.V.Reddy, Dr.N.Reddy, Dr.Ramdas, Dr.Prameela, Dr.Sudir, Dr.Geetha kumar, Dr.Maya Devi, Dr.Savitri, Dr.Veugopal, Dr.P.R.Swaminathan, Dr.S.Swaminathan, Dr.Karunakaran , Dr.B.Reddy, Dr.S.Kutty, Mrs. E.M Balamani, Smt. G. Gayathri, Smt. S. Usha, Sri. M. G. Sudhakar for their sincere co-operation and valuable suggestion.

I have much pleasure in expressing my cordial appreciation to the students of sir Jayendra Saraswathi Ayurveda College.

In preparing a textbook like this I have utilized the knowledge of a number of stalwarts in my profession and consulted many books and publications. I wish to express my appreciation and gratitude to all of them including the related authors and publishers.

I have much pleasure in expressing my grateful thanks to Dr.I.P.Badapanda, Dr.L.N.Maity, Dr.B.P.Shaw, Dr.P.C.Tripathi, not only for their valuable suggestions to built my carrier and for their constructive criticism as and when sought for.

I express my sincere gratitude to Dr. Mohan Alva, Chairman, Dr. S. Negalaguli, Principal, Dr. L. Upadhyaya, Asst Professor of Alva's Ayurveda Medical College.

I express my heartfelt thanks to Dr. N. Jaysankaran, Vice Chancellor, Dr. Krishnamurthy, Dean, Dr. Bhaskaran, Registrar, Dr.Nagalakshmi COE of Sri Chandrasekharendra Saraswathi Vishwa Mahavidyalaya, and Deemed University.

I wish to thank Sridar.G, Santhosh Kumari, H.Meera, L.Sakthi Balan, Paritosh Bhatt, A.Abhishek, V.H.Prathyusha, and V.Sathya for the preparation of the text and the photographs depicted in this book.

To my wife Suneeta and daughter Prateeksha without whose love, support and encouragement, I could ever been able to complete this book.

Place: - Chennai -
Date: - 14.11.2005

Dr. Pradeep Kumar Moharana



Jagadguru Sri Chandrasekharendra Saraswathi Swamikal



Jagadguru Sri Jayendra Saraswathi Swamikal



Sri Sankara Vijayendra Saraswathi Swamikal

FOREWORD

Study of anatomy in the curriculum of B.A.M.S has always been a controversial point of discussion. The Western method of analysing the structure is very well established in the form of anatomy and it is accepted all over the world.

This methodology of studying the body in the physical plane may not always find parallel in the ayurvedic system. It results in giving a lot of contradictions for the sincere students who are eager to know the exact structure of the body.

Here is an attempt by Dr.P.K.Moharana to clarify the areas to be stressed from ayurvedic point of view as well as from western point of view.

It is also written according to the prescribed syllabus of Rachana Shareera, so that, it will help the students to prepare themselves for examination and also it will be helpful for better understanding of physical structures from different angles of observations.

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Author's Request.

It is an attempt made by me to correlate the Shareera Rachana with the modern anatomy.

Certain chapters are added from modern texts for better understanding and to get a sound knowledge of ayurveda and modern science.

Some mistakes may appear in the manuscript, it may be due to ignorance during typing and printing. I had tried to correct the mistakes as far as possible. Inconvenience is regretted.

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INTRODUCTION TO THE HUMAN BODY

The human body is one of the most sophisticated of all creations. There are various parts that together, make up the body, as a whole. Each of these components performs a specific function. In spite of being made up of such diverse parts, the body operates as a single entity. All the structures of the body are interdependent and they co-ordinate and correspond with each other in order to maintain a condition of normalcy in the body. For example, any stimulus perceived by the sensory organs reaches the brain through the corresponding axons and neurons and similarly the brain responds to the stimulus, sending the necessary impulse to the organ that has perceived the stimulus. Accordingly the organ functions and responds to the external stimulus. This communication is possible through the nervous system. Similarly in the cardiovascular system also blood, lymph etc. serve as means of communication within different parts of the body. This kind of integrity is the base for existence. Once this co-ordination is lost, the internal atmosphere of the body also gets disturbed and this leads to the condition of "dis-ease". Similarly, even to make the slightest movement, the bones, muscles, nerve fibers, tendons etc. of that particular part must function properly in an integrated manner. Otherwise, movement becomes quite difficult in that part of the body. Hence the proper functioning of the body depends upon the proper co-ordination between the structures that constitute the body. This is why, generally, the normalcy of any structure is inferred from its normal functioning. Any condition wherein there is damage to the structure is always accompanied by a loss of function of that particular part and vice versa. Hence, the condition of the body is always presented in terms of its functions. When a condition of disease sets in, the normal functioning of the body gets impaired, which is suggestive of structural derangement at some level in the body. Thus structure has an inseparable relation with its function and forms a base or substratum for its function to exist in it. To understand the body in its totality, both these aspects of structure and function must be analyzed thoroughly.

Hence, life science has been divided into two main branches namely Anatomy and Physiology. These branches deal with the structure and its function respectively.

These two provide the foundation for understanding the body parts and functions. Anatomy (anatomē = to cut up) is the study of the structure and relationships among the structures. Although anatomy was first studied by dissection of cadavers, many other techniques now contribute for the advancement of the anatomical knowledge.

While anatomy deals with structures of the body, physiology deals with the functions of the body parts, that is, how they work.

Definition Of Shareera

1. शरीर्यते अनेन इति शरीरम् । (Ch.Su.1 Chakrpani Com.)

The transformation process proceeds towards disintegration.

2. तत्र शरीरं नाम चेतनाधिष्ठानभूतं पञ्चमहाभूतविकारसमुदायात्मकं समयोगवाहि ।

(Ch.Sha.6/4)

The body, which is maintained in a state of equilibrium, represents the conglomeration of factors derived from the five mahabhutas and this is the seat of the chetana (soul).

3. शुक्रशोणितं गर्भाशयस्थमात्मप्रकृतिविकारसंमूर्च्छितं गर्भ इत्युच्यते । तं चेतनावस्थितं वायुविभजति, तेज एनं पचति, आपः क्लेदयन्ति, पृथिवी संहन्ति, आकाशं विवर्धयति, एवं विवर्धितः स यदा हस्तपादजिह्वाघ्राणकर्णनितम्बादिभिरङ्गैरुपेतस्तदा शरीरं इति संज्ञा लभते । तच्च षडङ्गं- शाखाश्चतस्रो, मध्यं पञ्चमं, षष्ठं शिर इति । (Su.Sha.5/3)

It is the coalescence of the male and female seeds in the uterus where the soul combines with them intimately along with eight prakruthis (elementary principles) and sixteen formations of prakruthi (vikaras). The eight prakruthis are Avyaktha, Mahan, Ahankara, and the five tanmatras. The sixteen vikaras are the five mahabhuta and eleven indriyas. When garbha is actively energetic, vayu forms further segmentation, tejas form the digestive processes, ap (water) moisten the whole, the prithvi strengthens it and akasa (space) develops the same.

The embryo is a styled body (shareera) only when it is developed with hands, feet, tongue, nose, ears, buttocks and other organs.

Shaareera:

शरीरम् अधिकृत्य कृतम् तन्त्रम् शारीरम् ।

The study of the shareera (physical structure) is called as shaareera.

Shareeri:

पञ्चमहाभूत शरिरि समवायः पुरुषः स एषः कर्मपुरुषः चिकित्साधिकृत्य ।

The purusha or the metaphysical body is constituted by the combination of five mahabhutas and soul. This is also called as *Karma Purusha* (persons acting and subjected to act), who is eligible for treatment that is responsible for all the activities and is one to be treated when digressions from the normal supervene.

Importance Of Anatomy:

1. Because of this immense ramifications of interests and the blending of structural approach with other disciplines the proper territory of anatomy is at present hard to define clearly, for the clinical purposes it must concern itself primarily with human topographic anatomy, that is, the clear and sufficiently detailed analysis of the body to serve the needs of the surgeons, physicians and the various medical specialties.
2. Anatomy is a time honoured title encompassing a great range of endeavors, embracing all areas of knowledge relevant to the structural organization of the human body, and like other branches of science, it is constantly changing as new research data transform our image of the body's dynamic organization.
3. Computer controlled imaging techniques are increasingly widening our appreciation of three- dimensional, living structure and may in the future be expected to play a major role in anatomical data acquisition, storage and communication as well as clinical diagnosis.
4. The students require an anatomical vocabulary. It must be adequate to define precisely the relevant positions of these structures and they should have an elementary knowledge of the kinds of structures they will encounter.
5. Anatomy is a part of the continuum of human knowledge. As in all areas of experience, it is possible to see human anatomy from what is essentially a reductionist viewpoint, to limit oneself to smaller and smaller areas of analysis and of course, without such an approach all the science drifts into meaningless generalization.

SHARIRASYA SHADANGATWAM:

For the better understanding of the human body, Susrutha has divided the human body into 6 parts.

तत्र षडङ्गं- शाखाश्चतस्रो, मध्यं पञ्चमं, षष्ठं शिर इति । (Su.Sha.5/3)

शिरो अन्तराधि द्वौ बाहु, द्वौ सक्थिनि च समासतः षडङ्गं प्रत्यङ्गम् तस्याक्षि हृदयादिकम् ।

(A.H. Sha 3)

According to Charaka,

द्वौ बाहु, द्वे सक्थिनी, शिरोग्रीवम्, अन्तराधिः इति षडङ्गम् । (Ch.Sha.7)

(1 - 4) – shakha (2 upper limbs, 2 lower limbs)

5 – Madhya sharira (trunk)

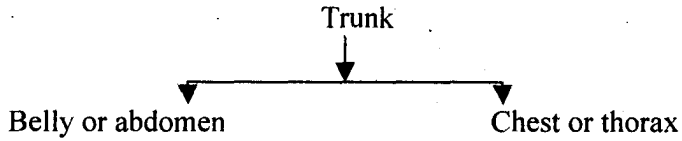
6 – shira (head & neck)

2 upper limbs, 2 lower limbs, head and neck, trunk.

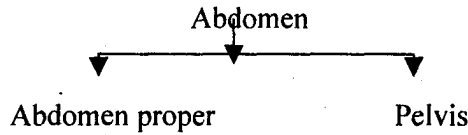
According to cunningghum anatomy, for descriptive purposes the human body is divided into

- Head
- Neck
- Trunk
- Limbs

Again the trunk is sub divided into



The abdomen is further divided into



Sharira sastra vibhagah:

These are the following divisions of shareera

- | | |
|---------------------------------|-------------------------|
| 1. अभिनिवृत्ति शारीरम् | 2. गर्भ शारीरम् |
| 3. संख्या शारीरम् | 4. प्रमाण शारीरम् |
| 5. अस्थि शारीरम् | 6. सन्धि शारीरम् |
| 7. पेशी शारीरम् | 8. कोष्ठ शारीरम् |
| 9. कला शारीरम् | 10. त्वक् शारीरम् |
| 11. सिरा, धमनी, स्रोतस् शारीरम् | 12. उत्तमाङ्गिय शारीरम् |
| 13. इन्द्रिय शारीरम् | 14. मर्म शारीरम् |

The Major System Of The Human Body Mnemonics– MR. LI . CRUSEND

- M – muscular system
- R – respiratory system
- L – lymphatic system & immune system
- I – integumentary system
- C – cardio-vascular system
- R – reproductive system
- U – uro genital system
- S – skeletal system
- E – endocrine system
- N – nervous system
- D – digestive system.

Sub Divisions Of Anatomy:

1. *Cytology* – microscopic study of the structure of cell.
2. *Developmental anatomy* – study of development from fertilized egg to adult form.
3. *Embryology* – study of development from the fertilized egg through the eighth week in utero.
4. *Gross or Macroscopic anatomy* – study of the structures that can be examined without the use of microscope.
5. *Histology* – microscopic study of the structure of tissues.
6. *Pathological anatomy* – study of structural changes associated with disease.
7. *Regional anatomy* – study of a specific region of the body such as head or chest.
8. *Radiographic anatomy* – study of the structure of the body that includes by the use of x- rays.
9. *Systemic anatomy* – study of specific systems such as Digestive system or nervous system.
10. *Surface anatomy* – study of the morphology and markings of the body.
11. *Comparitive anatomy* – study of the structures of the human body by comparing with the similar structure of different animals.
12. *Applied anatomy* – application of anatomical knowledge to diagnose a disease and its fate.

CAVITIES OF THE BODY:

There are four cavities that contain the main organs, they are (CAPT)

- | | |
|-------------------|---------------------|
| 1. Cranial cavity | 2. Abdominal cavity |
| 3. Pelvic cavity | 4. Thoracic cavity |

Body cavities are confined spaces within the body that contain internal organs. The cavities help to protect, separate and support the organs.

The body cavities may be separated from each other by structures such as muscles, bones or ligaments.

The Cranial Cavity:

It is formed by the cranial (skull) bones and contains the brain and vertebral (spinal) canal, which is formed by the vertebra of the backbone and contains spinal chord and beginning of spinal nerves.

The Abdominal Cavity:

The serous membrane that lines the abdominal cavity and covers the organs within it called as peritoneum. The abdominal cavity contains the stomach, spleen, liver, gall bladder, pancreas, small intestine and most of the large intestine.

The Pelvic Cavity:

It contains the urinary bladder, portions of the large intestine and internal organs of reproduction.

The Thoracic Cavity:

It includes the plural cavities, the mediastinum and one pericardial cavity. Each of the two plural (pleura = ribs or sides) cavities surrounds a lung. Each plural cavity is a small, fluid filled space between the parts of the serous membrane that covers the lung and the part that lines the wall of the thoracic cavity. Among the structures in the mediastinum are the heart, the oesophagus, the trachea, thymus gland and many large blood and lymphatic vessels. Within the mediastinum is the pericardial cavity. It is the fluid filled space between the parts of the serous membrane that covers the heart and the part that lines the thoracic cavity. The serous membrane associated with the heart is called as the pericardium.

ANATOMICAL TERMS

The body or any detached part of it usually lies horizontally on a table during dissection, but the dissector must remember that terms descriptive of position are always used as though the body were standing upright with the upper limbs hanging by the side and the palms of the hands directed forwards. This is the anatomical position. In the anatomical position, the subject stands erect (upright position) facing the observer, with feet flat on the floor, arms placed at the sides and palms turned forward.

Once the body is in the anatomical position, it is easier to visualize and understand how it is organized into various regions.

DIRECTIONAL TERMS:

<u>TERM</u>	<u>DEFINITIONS</u>	<u>EXAMPLE</u>
Superior (Cephalic or cranial)	Towards the head or the upper part of a structure.	The right lung is superior to liver.
Inferior (Caudal)	Away from the head or nearer the feet or towards the lower part of a structure.	Stomach is inferior to the heart.
Anterior (Ventral)	Nearer to or at the front of the body. In the supine position, the body position is anterior side up.	The sternum (breast bone) is anterior to the heart.
Posterior (Dorsal)	Near the back.	The oesophagus is posterior to the trachea.
Superficial	Towards or on the surface of the body.	The muscles of the thoracic wall are superficial to the organs in thoracic cavity.
Deep	Away from the surface of the body.	The ribs are deep to skin of chest.
Proximal	Nearer to the attachment of a limb to the trunk nearer to the point of origin.	The humerus is proximal to the radius.
Distal	Farther from the attachment of a limb to the trunk; farther from the point of origin.	The phalanges are distal to the carpals.
Medial	Nearer to the mid line of the body or structure. The midline is an imaginary vertical line that divides the body into equal left and right halves.	The ulna is on the medial side of fore arm.
Lateral	Further from the mid line of the body or a structure	The radius is on the lateral side of the forearm.
Intermediate	Between 2 structures	The index finger is intermediate between the thumb and middle finger.
Ipsilateral	On the same side of the body.	The gall bladder and ascending colon of the large intestine are ipsilateral.
Contra lateral	On the opposite side of the body.	The ascending and descending colons of the large intestine is contra lateral.

PRESERVATION OF DEAD BODY:

तस्मान्निःसंशयं ज्ञानं हर्त्रां शल्यस्य वाञ्छता ॥

शोधयित्वा मृतं सम्यग्द्रष्टव्यो अङ्गविनिश्चयः ॥४७॥

प्रत्यक्षतो हि यद्दृष्टं शास्त्रदृष्टं च यद्भवेत् ॥

समासतस्तदुभयं भूयो ज्ञानविवर्धनम् ॥४८॥ (Su.Sha.5/47-48)

One who intends to acquire definite knowledge of surgery should study the anatomy practically by dissecting the dead body properly;

Whatever is actually seen and observed during dissection and also theoretically learnt from books on anatomy, should supplement each other. Both methods tend to the growth of true knowledge.

Knowledge acquired from the study of Sastras can make a man perfect only if sided by personal observations, whether the subject of study is anatomy or any other. The art of Medicine should be practiced after solving personal difficulties, both in theory and practice.

तस्मात् समस्तगात्रमविषोपहतमदीर्घव्याधिपीडितमवर्षशतिकं निःसृष्टान्त्रपुरीषं पुरुषमावहन्त्यामापगायां निबद्धं पञ्जरस्थं मुञ्जवल्कलकुशशणादीनामन्यतमेनावेष्टिताङ्गमप्रकाशे देशे कोथयेत्, सम्यकप्रकृथितं चोद्धृत्य, ततो देहं सप्तरात्रादुशीरबालवेणुबल्वजकूर्चानामन्यतमेन शनैः शनैरवघर्षयंस्त्वगादीन् सर्वानेव बाह्याभ्यन्तरानङ्गप्रत्यङ्गविशेषान् यथोक्तान् लक्षयेच्चक्षुषा ॥

(Su.Sha.5/49)

Selection of human body is based on the certain criteria.

1. Where all the limbs are intact.
2. Where the death was not due to poison.
3. Where the illness was not of long duration.
4. Where the person's age should not exceed 100 years.

Embalming Procedure:

It involves initial washing of the cadaver in a disinfectant fluid and shaving of the body of hair, before cannulae were inserted into either femoral or common carotid artery.

A total volume of between 18-30lits of embalming fluid is introduced by using a mechanical pump. The use of supplementary local injections of fluid may be required to effect maximal preservation, since often blockage of blood vessels by clots prevents from reaching all parts of the body. After embalming the body is wrapped in polythene sheet and stored for at least 6 week at 10°C.

Methods Of Embalming:

Embalming consists of mainly two processes.

1. Arterial embalming.
2. Cavity embalming.

Arterial Embalming:

In this process the arterial fluid is injected into the selected artery. Blood is drained simultaneously from the suitable vein to make room for preservative solution. The preservative fluid is distributed from the arch of the aorta and does not flow through the chambers of the heart as blood does in the living. Eventually the embalming solution passes through the capillaries and enters the tissue spaces. Here it comes in contact with the body cells and changes the proteins colloidal nature by establishing many cross linkages.

Cavity Embalming:

In this process the organs in the abdominal and thoracic cavities are treated with preservative solution. The contents of the hollow organs and any liquids or gases that may have accumulated in the body cavities are removed by aspiration. A very strong preservative solution is injected by a trocar or long needle into the abdominal and thoracic cavities through the same openings.

Need Of Embalming:

Embalming is the scientific treatment of dead human body ensuring that it is free from possible infection to the living. The demand for embalming bodies for transportation or for preservation when there is delay in performing the funeral ceremony is increasing in this country.

- To prevent transmission of certain deadly diseases like HIV infection and Hepatitis-B.
- To arrest process of decomposition and putrefaction.
- To allow transportation and delayed funeral service.
- To achieve pre-mortem appearance.

Embalming Chemicals And Fluids:

Embalming chemicals and fluids should have the following fundamental properties it should.

1. Ensure that there is no risk or fear of infection on contact with the body.
2. Produce without mutilation, a natural colour and effect on the body, so that a life like appearances is produced.
3. Prevent contamination with insects and maggots.
4. Ensure preservation of the body and the preservation often result in odious purging and discharge from the various orifices of the body.

The embalming fluid consists of the following groups of chemical and their ingredients.

1. Preservatives-Formaldehyde, methanol, phenol.
2. Germicides- Phenol, Zephiran chloride and glutaraldehyde.
3. Buffers- Borax, Sodium bicarbonate, Magnesium carbonate, Sodium carbonate.
4. Wetting agents-Glycerin, Sorbitol.
 - i) Anticoagulants-Sodium citrate and Sodium oxalate.
 - ii) Dyes-Eosin, Ponceau.
 - iii) Vehicles-Glycerine, Sorbitol, alcohols in addition to water.
 - iv) Perfumes- Cinnamon oil, Menthol, Oil of winter green (methyl salicylate).
 - v) Muscle Relaxants-Magnesium chloride.

Embalming Fluids:

All the chemicals in the embalming fluid are designed to preserve and sanitize the body. The factors considered in selection and preparation of an embalming fluids are- age, sex, status of the body, weather conditions and type of embalming.

The following fluids are normally prepared in the practice of embalming.

1. Arterial fluid.
2. Cavity fluid.
3. Pre injection fluid.

Arterial Fluid:

It is injected into the vascular system of the body. It is composed of

- a. Formalin-10%
- b. Methanol-55%
- c. Sodium borate-15 gm.
- d. Sodium citrate-15 gm.
- e. Glycerine-15%.
- f. Phenol-5%
- g. Water-15%.
- h. 1% eosin-5 ml.
- i. Oil of winter green-10 ml.

Cavity Fluid:

The cavity fluid is injected into the body cavities i.e., thoracic, abdominal and pelvic cavity. For an average body approximately two liters of cavity fluid is injected with a trocar over the viscera of the thoracic, abdominal and pelvic cavities.

It is composed of

- | | |
|-------------------------|-----------------|
| a. Formalin- 60% | b. Methanol-25% |
| c. Glycerine-2.5% | d. Phenol-10% |
| e. Mercuric chloride-1% | f. Lavender-1%. |

LIFE PROCESS

All living forms have certain characteristics that distinguish them from non-living things. Following are several of the more important life processes of humans.

1. Metabolism- It is the sum of all the chemical processes that occur in the body. One phase of metabolism, called **catabolism**, provides us with energy needed to sustain life. The other phase, called **anabolism**, uses the energy from catabolism to make various substances that form the body's structural and functional components.

Some other processes contributing to metabolism are

- a. *Ingestion*-The taking in of food.
- b. *Digestion*-The breaking down of foods into simpler forms that can be used by cells.
- c. *Absorption*-The uptake of substances by cells.
- d. *Assimilation*-The build up of absorbed substances into different materials required by cells.
- e. *Respiration*-The generation of energy, usually in the presence of oxygen with the release of Carbon dioxide.
- f. *Secretion*-The production and release of useful substances by cells.
- g. *Excretion*-The elimination of wastes produced as a result of metabolism.

2. Excitability-It is our ability to sense changes within and around us. We do this by continually responding to stimuli. Such as light, pressure, heat, noises, chemicals and pain to make adjustments that maintain health.

3. Conductivity-It refers to the ability of cells to carry the effect of stimulus from one part of a cell to another. This characteristic is highly developed in nerve cells and is developed to a great extent in muscle fibers (cells).

4. Contractility-It is the capacity of cells or part of cells to actively generate force to undergo shortening and change form for purposeful movements.

5. Growth-It refers to an increase in size. It involves an increase in the number of cells or an increase in the size of existing cells or the substance surrounding cells as internal components increase in size or an increase in the size of the substance surrounding cells.

6. Differentiation-It is the process where by unspecialized cells change to specialized cells.

Specialized cells have structural and functional characteristics that differ from cells from which they originated through differentiation, a fertilized egg normally develops into an embryo, foetus, infant, child and adult, each of which consists of a variety of diversified cells.

7.Reproduction-It refers to either the formation of new cells for growth, repair or replacement or the production of a new individual. Through reproduction, life transmitted from one generation to the next.

Levels of Structural Organization

The human body consists of several levels of structural organization that are associated with one another in various ways.

The lowest level of organization, the **Chemical level**; includes all chemical substances essential for maintaining life. All these chemicals are made up of atoms joined together in various ways. The chemicals, in turn are put together to form the next higher level of organization the cellular level.

Cells are basic structural and functional units of an organism.many kinds of cells are present in the human body e.g. muscle cells, nerve cells and blood cells and each performs a different function.

The next higher level of structural organization is the **tissue level**. Tissues are groups of similar cells that together with their intercellular material (substance between cells) usually have a similar embryological origin and perform special functions.

In many places in the body, different kinds of tissues are joined together to form an even higher level of organization: **The organ level**. Organs are structures that are composed of two or more different tissues, have specific functions and usually have recognizable shapes. Examples of organ are heart, liver, lungs, brain and stomach.

The next higher level of structural organization in the body is the **system level**. A system consists of an association of organs that have a common function. The digestive system, which functions in the breakdown and absorption of food, is composed of the mouth, saliva producing glands called salivary glands, pharynx, oesophagus, stomach, small intestine, large intestine, rectum, liver, gall bladder and pancreas.

The highest level is the **organismic level**. All the parts of the body functioning with one another constitute the total organism-One living individual.

अभिनिवृत्ति शारीरम्

पुरुष :

पुरिशेते, पुरौ शते, पुर्याम् शेते, इति पुरुषः ।

Which is living in the physical body is called as purusha. There are 2 types of purusha i.e Shuddha purusha and Karma purusha.

एक धात्वात्मक पुरुषः -

चेतनाधातुरप्येकः स्मृतः पुरुष संज्ञकः ।

The body is composed of the Atma alone.

द्वि धात्वात्मक पुरुषः -

Which is composed of Kshetra and kshetrajna (sharira and atma) .

It is also composed of Agni and Soma.

त्रि धात्वात्मक पुरुषः -

सत्त्वमात्मा शरीरं च त्रयमेतत् त्रिदंडवत् ।(Ch.Su.1/44)

The body is composed of Mind, Soul and the Body.

दोषधातुमलं मूलं हि शरीरं । (Su. Su 15/2)

The body is said to be composed of doshas, dhatus and malas.

सत्वरजस्तमश्चेति त्रयो प्रोक्ता महागुणाः ।

The body is said to be composed of Satwa rajas and tamas

पंच धात्वात्मक पुरुषः

The body is composed of pancha maha bhuthas (Akasha, Vayu, Agni, Jala and Prithvi)

षड् धात्वात्मक पुरुषः -

पञ्चमहाभूत शरीरि समवायः पुरुषः । (Su.Su.1/22)

The body constitutes of pancha mahabhoothas and the atma.

खाद्यश्चेतना षष्ठाः धातवः परुष संज्ञकाः ।

The pancha maha bhootha beginning with Akasha along with the other mahabhuthas and atma is said to be the body. It is also other wise known as karma purusha, adhi karana purusha or chikitsa purusha

सप्त धात्वात्मक पुरुषः

रसासृङ्मांसमेदो अस्थि मज्जा शुक्राणिधातवः । (A. H. Su.1/13)

The body is composed of the seven dhatus i.e rasa, raktha, mamsa, medas, asthi, majja and sukra.

द्वादश धात्वात्मक पुरुष :

आत्मेन्द्रियमनो अर्थानां यो अयं पुरुषसंज्ञकः । (Ch.Su.25/3)

The Atma, 5 sense organs and their respective objects and the mind constitutes the body.

आत्मेन्द्रियमनो अर्थानां राशिरेव पुरुषः ।

The Atma, 5 sense organs and their respective objects and the mind is said to be the Raasi purusha.

त्रयोदश धात्वात्मक पुरुष : :

दोषधातुमलं मूलं हि शरीरं । (Su.Sha.15/2)

The body is said to be formed from doshas, dhatus, and malas.

सप्तदश धात्वात्मक पुरुषः

आत्मेन्द्रियमनो अर्थानां यो अयं पुरुषसंज्ञकः । (Ch.Su.25/3)

तत्र चक्षुः श्रोत्रं घ्राणं रसनं स्पर्शनं इति पञ्चेन्द्रियाणि । (Ch.Su.8/8)

The body is composed of panchamahabhuta, manas, atma, panchagyanendriyarthas.(shabda, sparsha, rupa, rasa and gandha) and pancha gyanendriya.

चतुर्विंशति तत्त्वात्मक पुरुष :

पुनश्च धातुभेदेन चतुर्विंशतिकः स्मृतः मनो दशन्द्रियाण्यर्थाः प्रकृतिश्चाष्टधातुकी (Ch.Sha .1/17)

The body is composed of 24 elements i.e. ekadasha indriya (panchagyanendriya, panchakarmandriya and manas), pancha indriyarthas and asta prakriti (avyakta, ahankar, buddhi and panchatanmatra). It is also other wise known as rasi purusha

पंचविंशति तत्त्वात्मक पुरुष :

शुक्र शोणितं गर्भाशयस्थं आत्म प्रकृति विकारसंमूर्छितं गर्भं इत्युच्यते । (Su.Sha.5/3)

The combined semen and ovum in womb, mixed with the 8 prakritis and 16 vikaras and ridden in by the Atma is called as foetus.

GARBHASHAREERAM

The reproductive system has an important role to play in the propagation of species. It is through this that the specific traits of any species are maintained and transferred from generation to generation. Thus, reproduction is the process by which the continuity of life is maintained. गर्भशरीरम् Includes the study of processes like fertilization, development of the embryo, growth of the foetus, parturition etc.

According to Indian sciences, the जीवात्मा or the individual soul descends into a human body and attains a particular form. This is termed as “गर्भ”. Hence; this science aims at preparing for this manifestation. This process of preparing the parents commences with रसायन, वाजीकरण etc. This is done in order to obtain a healthy offspring, which forms the base for a healthy society.

Definition Of गर्भः -

(1) शुक्रशोणितजीवसंयोगे तु खलुकुक्षिगते गर्भसंज्ञाभवति ।।(Ch.Sha.4/5)

(2) शुक्रशोणितं गर्भाशयस्थमात्मप्रकृतिविकारसंमूर्च्छितं गर्भ इत्युच्यते ।।(Su.Sha.5/3)

The term “ गर्भ ” is given to the product of fertilization (ie) the union of शुक्र and आर्तव(spermatozoan and ovum). It is called गर्भ when the आत्मा, प्रकृतिand विकार also manifest following the union शुक्र and आर्तव. This गर्भ is present in the कुक्षि (uterus).

Definition Of गर्भः -

(1)शुक्रशोणितं गर्भाशयस्थमात्मप्रकृतिविकारसंमूर्च्छितं गर्भ इत्युच्यते । तं चेतनावस्थितं वायुर्विभजति, तेज एनं पचति, आपः क्लेदयन्ति, पृथिवी संहन्ति, आकाशं विवर्धयति, एवं विवर्धितः स यदा हस्तपादजिह्वाघ्राणकर्णनितम्बादिभिरङ्गैरुपेतस्तदा शरीरं इति संज्ञा लभते । तच्च षडङ्गं- शाखाश्चतस्रो, मध्यं पञ्चमं, षष्ठं शिर इति ।। (Su.Sha.5/3)

(2) तत्र शरीरं नाम चेतनाधिष्ठानभूतं पञ्चमहाभूतविकारसमुदायात्मकं समयोगवाहि । (Ch.Sha.6/4)

(3) शीर्यते अनेन इति शरीरम् । (Ch.Su.1 Chakrapani Com.)

A गर्भ that gets thus manifested in the कुक्षि, gradually becomes differentiated into different parts like हस्त (hand), पाद (foot), जिह्वा (tongue), घ्राण (nose), कर्ण (ear), नितम्ब (buttocks) etc due to the action of the Panchamahabhutas, and attains a definite form. This is termed as the “शरीरम् “ or body. The शरीरम् lodges in it the चेतना धातु and is basically made up of the Panchamahabhutas.

According to Ayurveda and other Indian sciences, the microcosm is the representation of the macrocosm. Hence, it is logically understood that, as the

universe is made up of Panchamahabhutas, the human body, which is but a part of the universe, should be composed of the same constituents as that of the universe. Further it is obvious that there is a continuous process of transformation taking place in the body. This finally proceeds towards its disintegration. The term "शीर्यते" indicates this process in specific.

The human body exists in different levels. The Darshanas view the body as स्थूल or भूत शरीरम्, सूक्ष्मशरीरं and कारण शरीरम्. Whatever is seen materially as the human body is called the physical self or स्थूल शरीरम्. The others exist on a subtle plane. The formation of this स्थूलशरीरम् is brought about by the action of the Panchamahabhutas.

तत्र खात् खानि देहे अस्मिन् श्रोत्रं शब्दोविक्कता ।

वातातस्पर्शतवगुच्छ्वासा वह्नेग्रूपक्तयः ।।

आप्या ज्विहारसक्केदा घ्रणगन्ध्यास्थि पार्थिवम् । (Ast.Hru.Sha.3/3)

The Panchamahabhutas contribute to the formation of the body thus: -

- 1 आकाश - खानि (channels), श्रोत्र (ears), शब्द (sounds of the body), विक्कता (hollow spaces).
2. वायु - स्पर्श (touch), त्वक् (skin), उच्छ्वास (respiration).
3. वह्नि - दृक् (eyes), रूपम् (form of vision), पक्ति (digestion).
4. आप - जिह्वा (tongue), रस (taste), क्लेद (moisture).
5. पृथ्वि - घ्राण (nose), गन्ध (smell), अस्थि (bones).

Thus the five sense organs manifest along with their objects and functions.

Factors Essential For Conception:

ध्रुवं चतुर्णासन्निध्यात्तार्भः स्यात् विधिपूर्वकम्

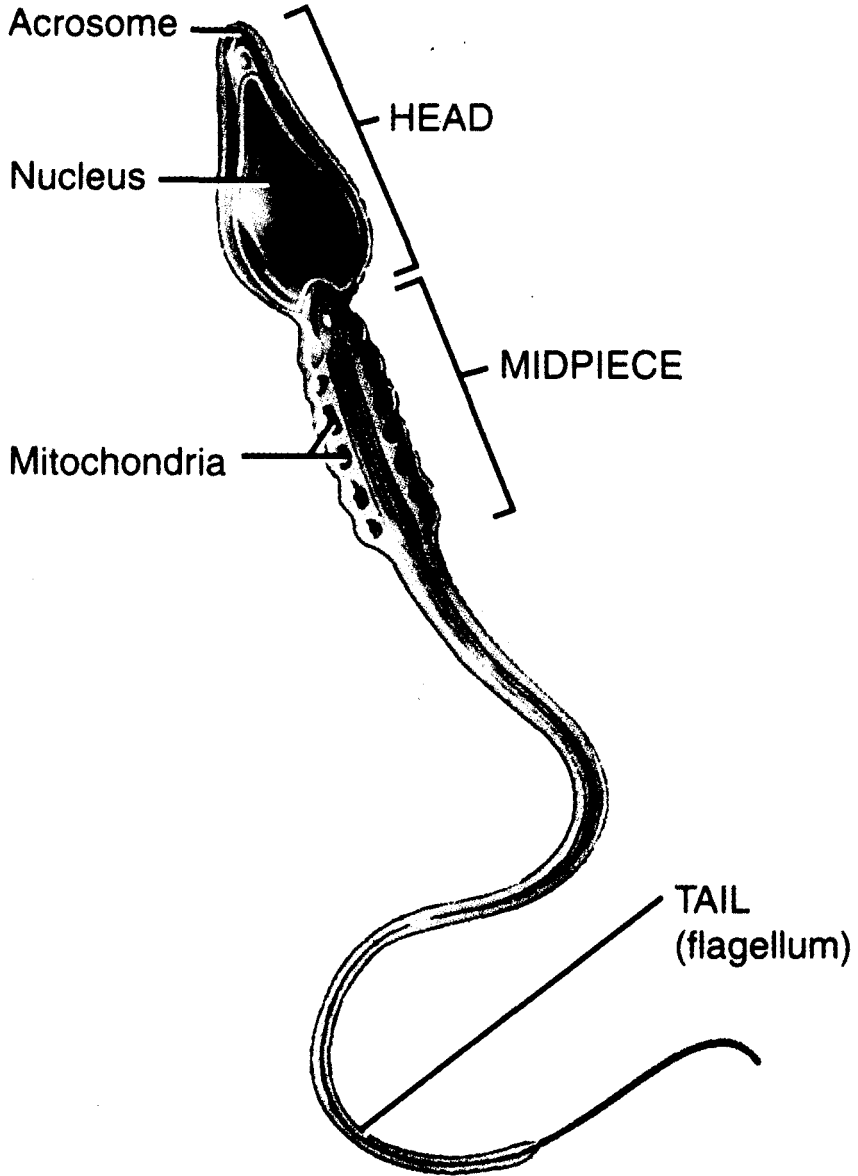
ऋतुक्षेत्राम्बुबीजानाम् सामग्र्याद् अंकुरो यथा ।। (Su.Sha.2/33)

Just as how a healthy condition is important for the growth of a plant, a healthy condition is a prerequisite for conception. This involves four factors namely,

1. ऋतु (Ovulation period)
2. क्षेत्रम् (Female reproductive system)
3. अम्बु (that nourishes)
4. बीजः (Sperm and Ovum)

When these four are properly maintained, the growth and development of the foetus formed as a result of conception, happens normally.

Sperm Cell



Parts of a sperm cell

There are also other conditions for conception such as-
पुर्णषोडशवर्षास्त्री पुर्णविंशेन संगता ।

शुद्धे गर्भाशये मार्गे रक्ते शुक्रे अनिले हुदि ।।

विर्यवन्तं सुतं सुते ततो न्युनाब्दयोःपुनः ।

रोग्यल्यायुरधन्यो वा गर्भो भवति नैव वा ।। (Ast.Hru.Sha.1/8,9)

1.The age of the woman should not be less than 16 years.

2.The man should have completed 20 years of age.

3.There must be purity of the गर्भाशय (uterus), मार्ग or स्रोतस (channels of the body), शुक्र, आर्तव and वायु

4.The mental condition should also be pure before conception.

When these conditions are satisfied, the result of conception may be a healthy offspring. While on the contrary, it may lead to misconception or even if produced, the foetus will be affected by diseases and may have a very short life.

This is why the संस्कार like बीजशुद्धीकरण etc are done before the couple go in for conception, to attain purity of the शुक्र and आर्तव

शुद्ध शुक्र लक्षणं :-

स्फटिकाभं द्रवं स्निग्धं मधुरं मधुगन्धि च

शुक्रमिच्छन्ति, केचित्तु तैलक्षौद्रनिभं तथा (Su.Sha.2/11)

A healthy शुक्र is like स्फटिक ,crystal like, स्निग्ध , मधुर and has the smell of मधु (honey). Some opine that pure शुक्र resembles तैलम् , while others consider that it appears like क्षौद्रम्(honey). Only such a शुक्र possessing the above-mentioned qualities is capable of producing a healthy गर्भ. Hence to attain these qualities, शुद्धीकरण is done prior to conception.

Semen – It is a mixture of sperm and secretion of the seminal vesicles, prostate gland and bulbo urethral glands. In an ejaculation the average volume of the semen is 2.5 – 5 ml with 50 – 150 millions sperm/ml. When the number of spermatozoa falls below 20-million/ ml, the male is likely to be infertile. pH of the Semen is 7.2 – 7.6. The milky appearance is due to the presence of prostatic secretion and mucoid consistency is due to the secretion of bulbo – urethral gland and seminal vesicle. It provides the transportation medium and nutrients to the sperm. Due to the alkaline nature, it neutralizes the acidic environment of the male urethra and female vagina. It also contains enzymes, which activate the sperm after ejaculation. It contains seminal plasmin, which acts as an antibiotic, and it has ability to destroy certain bacteria. It is helpful to ensure fertilization. Once the semen is ejaculated into the vagina, it coagulates rapidly, because the clotting enzymes from the prostate gland act on the fibrinogen produced by the seminal vesicle. The clot liquefies after about 5 – 20 minutes because of fibrinolysin. 50 – 60 % of spermatozoa have normal morphology. It contains fructose.

MENARCHE AND MENOPAUSE

1. रसादेव स्त्रीयारक्त रजःसज्ञ प्रवर्तते ।

तद्वर्षाद् द्वादशाहर्ष्वयाति पञ्चाशत् क्षयम् ।। (Su.Su.14/6)

2. तद्वर्षाद् द्वादशात्काले वर्तमानमसृक पुनः ।

जरापक्वशरीराणांयाति पञ्चाशतःक्षयम् । (Su.Sha.3/1)

Artava is a product of rasadhātu, which comes out of the female genitalia every month between 12th and 50th year of age. The first appearance of menstruation is known as menarche to become rajaswala and permanent cessation of menstruation at the age of fifty, when the body is fully in grip of senility.

आर्तवम्: - ऋतौ भवं तदारतवम् । (A.H. Su. 1/8)

The term “ आर्तवम् ” has been given to that which is produced every month during the ऋतुकाल or the ovulation period. It is otherwise called as स्त्रीशुक्रम् . It is an essential factor for reproduction.

Artava Pravriti Karana:

1. मासेनोपचितकाले धमनिभ्यां तदारतवम् ।

ईषत्कृष्णं विवर्णं च वायुर्येनिमुख नयेत् ।। (Su.Su.3/10)

2. मासेनोपचितं रक्तं धमनिभ्यामृतो पुनः ।

ईषत्कृष्णं विगन्धं च वायुर्येनिमुखा व्रुदेत् । (A.H.Sha.1/22)

3. एव मासेन रसःशुक्रं स्त्रीणां चार्तवं भवति । (Su.Su.14/14.)

Usually in a month rasadhātu becomes semen in male and menses in women. That blood accumulated inside the uterus during the month, which is slightly black and of unusual smell, brought in to the dhamanis (arteries) during the rutu (menstrual period) is expelled out by apana vayu through the orifice of yoni.

ऋतुकाल:-

ऋतुश्च निषिक्तस्यबीजस्य फलप्रसवानुगुमः काल (Ast.San.Sha.1/10)(Indu commentary)

ऋतुकाल is the period during which the sperms (बीज) that are deposited, are likely to bear fruit and result in the formation of a गर्भं conception occur only during this period as the योनि of the woman gets constricted after ऋतुकाल . This does not permit the entry of sperms (बीज) into the uterus.

तथा रक्तमेव च स्त्रीणाम् मासे . मासे गर्भकोष्टमनुप्राप्य त्र्यहं प्रवर्तमानमार्तवमित्याहुः ।

(Ast.San.Sha.1/10)

Vagbhatta opines that the blood (रक्त) that reaches the गर्भकोष्ट during the ऋतुकाल (every month) and flows out for three days, is called the आर्तवम्

1. रतुस्तु दृष्टार्तव द्वादशरात्रं भवति। षोडोषरात्रमित्यन्ते।।

शुद्धयोनिगर्भाशयार्तवा मसमपि केचित्।

तद्वददृष्टार्तवोअप्यस्तित्यपरे।। (As.H .Sha.1/19-20)

2. रतुस्तु द्वादशरात्रं भवति दृष्टार्तवः अदृष्टार्तवाअप्यस्तित्येके भाषन्ते।। (Su.Sha.3/6)

Rutu denote (both the menstrual period & ovulation period) the period during which menstrual flow is visible, is of twelve days duration (from the day of appearance of menstrual flow). Some say it is of sixteen days, still other opine that the entire month is period in those who has purity of vaginal tract, uterus and menstrual flow, some authorities opine that there is also a period of invisible menstrual flow.

From the above it is concludes of four opinions.

- (a) It is of twelve days after menstruation.
- (b) It is of sixteen days after menstruation.
- (c) It is of the whole month.
- (d) It is present even in the absence of menstruation.

RUTUMATI LAKSHANA (Psychological state in this stage): -

पीनसप्रसन्नवदना प्रक्लिन्नात्ममुखाद्वजाम्।

नरकामांप्रियकथांस्त्रस्तकुक्ष्याक्षिमुर्धजाम्।।

स्फुरद् भुजकुच श्रोणिनाभ्युरुजघनस्फिचाम।

हर्षात्सुक्यपरां चापि वद्यात् रतुमतिमिति।। (Su.Sha.3/7-8).

The women whose face is corpulent, run down (slightly emaciated) and pleasant or cheerful, body, mouth and gums excessively moistened, who has longing for man, likes talk (wants company), abdomen slightly dropping down, eye and hair loosened, develops twitching in arm, pelvis, breast, umbilicus, thighs and buttocks and has excessive desire for sexual intercourse should be known as rutumati.

नियतं दिवसेअतिते संकुचत्यम्बुजंयता।

रुतौव्यतिते नार्यास्तु योनिःसंन्रियते तथा।। (Su.Sha. 3/9)

Thus the rutavyatitakala is present for the fourteen days starting at the end of Rutukala and ending at the beginning of rajakala. In this period regressive changes take place in yoni. Just as the lotus closes at the end of the day so also the yoni (uterus, vaginal tract)(os) contracts after the period of conception is over. The coitus is also prohibited in this period.

आर्तव हि चतुरंजली प्रमाणम्। (Su.Sha.3)

According to Susruta the amount is 4 anjali.

शुद्धार्तव लक्षणं :

1. शशासृकप्रतिमं यत्तु यद्वा लाक्षारसोपमम् ।
तदार्तवं प्रशंसन्ति यद्वासो न विरञ्जयेत् ॥ (Su.Sha.2/17)

2. गुन्जाफलसवर्णं च पद्मालक्तकसन्निभम्
इन्द्रगोपसम्काशम् आर्तवमशुद्धमेव तत् ॥ (Ch.Chi.30/226)

Pure आर्तव resembles the blood of a rabbit. It has a colour similar to that of लाक्षारस गुन्जाफलम् पद्मपुष्पम् and इन्द्रगोप . It possesses a specific quality of not staining a cloth after it is washed.

Bleeding Period

मासिमासि रजःस्त्रीणां रसजं स्रवतित्र्यहम् ॥ (A. H.Sha.1/7.)

Bleeding continues for three to seven days averagely five days and is neither excessive nor scanty, is to be considered as normal.

MENSTRUAL CYCLE

Introduction:

The term menstruation is derived from the Latin word “*mensis*” means lunar month because the bleeding occurs roughly at the interval of 28 days.

During the menstrual cycle, some major changes occur in the vagina, breast & other organs, side by side the maturation of follicle in the ovary continues.

Definition: -

Menstruation is monthly uterine bleeding for 4 – 5 days coming regularly every 28 days. From puberty till menopause in a woman's reproductive life. This is normal uterine function. Bleeding comes from Oestrogen and progesterone primed endometrium, out flows through vagina into vulva. Woman gets 13 menses in a year and around 400 menses in her reproductive life.

Usually it is made up of (a) 30-40ml of blood, (b) stripped of endometrium, (c) mucus, (d) leucocytes, (e) an unfertilized ovum. The menstrual blood that comes out from the uterus clots promptly due to rapid formation of fibrin. If the blood remains in the uterus for sometime fibrin is deposited on the endometrium and as a result there is partial clotting.

During each cycle the uterine mucosa gradually hypertrophies. The whole purpose is to prepare a suitable bed for reception and implantation of the fertilized ovum. If pregnancy takes place, proliferate mucosa becomes converted into placenta. If pregnancy does not take place, the hypertrophied mucosa breaks down and is discharged as menstruation. Therefore menstruation may be described as the funeral of

the unfertilized ovum or as the weeping of the uterus for the lost ovum. A menstrual cycle starts at the onset of menstrual bleeding on first day and completes the cycle on 28th day. On next day, subsequent menses bleeding starts.

For calculation of the onset of bleeding is taken as first day of menstrual cycle. In an average cycle, the bleeding stops on about 4th day. From the day of stopping of the bleeding till the day of ovulation (14th day), the endometrium continuously proliferates and hence this phase is called as the Proliferative phase. After the ovulation, for a period of another 14th days, the proliferation stops, but the glands of the endometrium become filled with secretion, so that this phase is called as secretory phase.

Therefore the menstrual cycle can be conveniently grouped in three phases viz.

1. Proliferative phase (5th to 14th days)-10 days. (Rutukala)
2. Secretory phase (15th to 28th days)-14 days. (Rutavyatita kala)
3. Menstrual phase /Bleeding phase (1st to 4th days). (Rajahkala)

The 2-3 days of secretory phase just before the onset of next bleeding are taken as menstrual phase.

Play of sex hormones from hypothalamus in brain, anterior pituitary gland and ovary causes menstrual bleeding from uterine endometrium. This is called 'Hypothalamus-pituitary-ovarian uterine axis'.

I. Proliferative Phase (Rutukala): -

Ranges from 5th to 14th days of the cycle and is so named as the endometrium continues to proliferate during this phase and attains 5mm thickness. At this stage an ovarian follicle, stimulated by FSH, is growing towards maturity & producing estrogen. This proliferate growth of endometrium is influenced and controlled by estrogen. The proliferation of endometrium prepares for the reception of fertilized ovum. The endometrium becomes thicker by rapid cell multiplication accompanied by an increase in the numbers of mucus secreting glands and blood capillaries. This phase ends when ovulation occurs & estrogen production stops.

The ovulation period is around 12th to 14th day of the cycle, but is subject to variations. It has been observed that variation in proliferate period, as secretory phase is always of 14th days duration. Thus day of ovulation always falls on 14 days previous to first day of bleeding phase. This phase can be compared with Rutukala mentioned by the different scholars of Ayurveda.

The process of ovulation is determined by following observations.

- Recording of basal body temperature during the cycle. At the time of ovulation there is slight increase in body temperature i.e., 0.4-0.6F (typically on 14th day) due to a small increase in progesterone.
- Inter menstrual pain usually develops 14 days before the period is due and is attributed to ovulation.

- Positive fern test with cervical mucus on 12-15 day of menstrual cycle is suggestive of presence of ovulation. Because it is regulated by estrogen and progesterone.
- The cervix also exhibits signs of ovulation. The external os dilates slightly, the cervix rises, and cervix becomes softer.
- Estimation of pregnandiol levels in urine gives an indication of ovulation. Estrogen levels in the blood and urine are maximum at ovulation period.
- There is an increase of LH just before ovulation.

2. Secretory Phase (Rutavyatita kala) :-

Progesterone causes secretory changes in endometrium (day 15 – 26) to receive fertilized ovum for embedding. Glycogen appears as sub nuclear vacuoles in endometrial gland followed by secretion of glycogen and mucus in the lumen of gland. Glands become 'Corkscrew'. Endometrial coiled vessels become coiled, stroma becomes vascular and oedematous. Endometrium thickens to 10 mm. Stage of regression occurs in secretory endometrium on day 27 to 28.

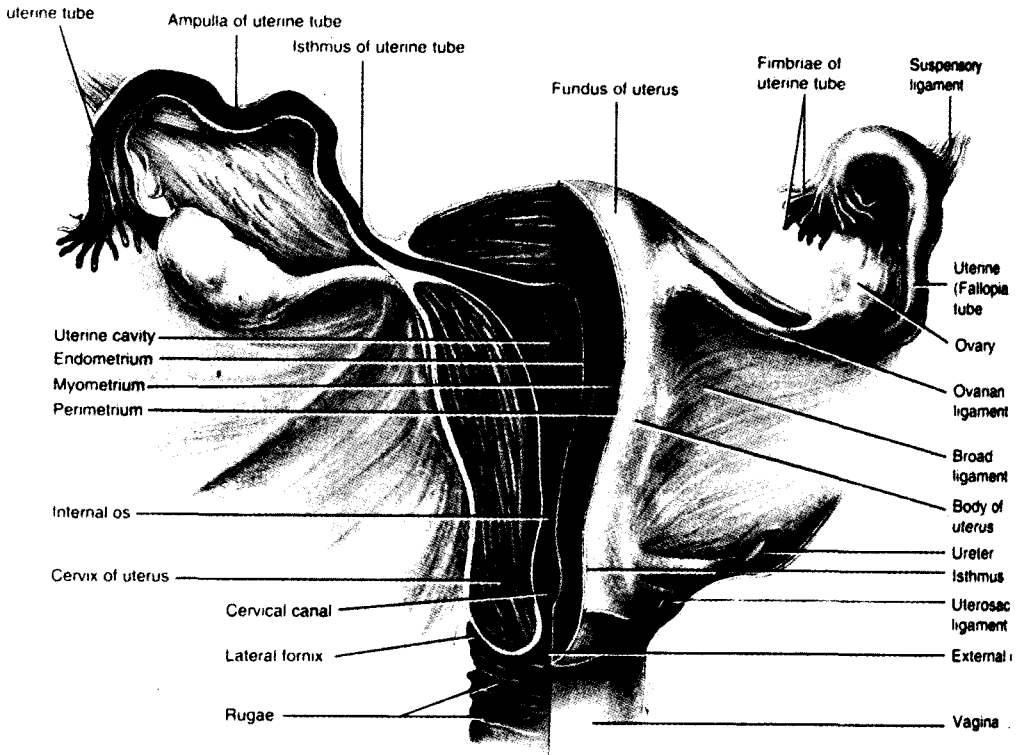
The second week of secretory phase is designated as premenstrual phase when secretory activity is maximum. The endometrium at this stage is 7-8mm in thickness and appears soft, edematous, vascular & velvety. If ovum fails to fertilize, the corpus luteum starts degenerating by 22nd day of the cycle resulting in decrease of progesterone levels. This leads to vasoconstriction of endometrial arteries in its inner 2/3 portion. The resulting ischaemia, necrosis, & desquamation of endometrium cause the onset of bleeding phase. This phase can be compared with rutavyatita kala mentioned by scholars of Ayurveda.

3. Bleeding Phase/ Menstrual Phase (Rajhkala): -

Just before onset of bleeding the endometrium is fully developed and highly vascular. If ovum is not fertilized, the level of progesterone in the blood inhibits the activity of the pituitary gland and the production of luteinising hormone is considerably reduced. The withdrawal of this hormone cause degeneration of the corpus luteum and thus progesterone production is decreased. About 14 days after ovulation basal 1/3rd part has straight arteries remain unaffected and inner 2/3rd of endometrial tissue and menstrual begins. The menstrual flow consists of extra secretion (leucocytes, mucus etc.) endometrial cells blood from the broken down capillaries and the unfertilized ovum. The bleeding is usually more on 2nd and 3rd day, the blood loss during this phase is 100-150ml. Due to fibrinolysis the blood doesn't clot in uterus, clotting may occur in case profuse bleeding. When the amount of progesterone in the blood falls to a critical level another ovarian follicle is stimulated by FSH and the next cycle begins.

If ovum is fertilized there is not broken down of the endometrium and no menstrual flow. The fertilized ovum (zygote) travels through the uterine tube to the uterus

Female Reproductive System



where it becomes embedded in the wall and produces the hormones chorion gonadotrophin which similar to anterior pituitary luteinising hormone. This hormone keeps the corpus luteum intact enabling it to continue to secrete progesterone for the first 3-4 months of the pregnancy, inhibiting the maturation of ovarian follicles. During that time the placenta develops and produces estrogen, progesterone and gonadotrophin. The placenta provides an indirect link between the circulation of the mother and that of the fetus. Through the placenta the fetus obtains nutritional materials, oxygen and antibodies and gets rid of carbon dioxide and other waste products. This phase can be compared with Rajahkala mentioned by the different scholars of Ayurveda.

गर्भोत्पत्ति (Formation Of The गर्भ) :

शुद्धेशुक्रात्वे सत्वः स्वकर्मक्लेशचोदितः

गर्भः सम्पद्यते युक्तिवसादग्निरिवारणौ। (Ast.Hru.Sha.1/1)

Fertilization is the process of union of the male gamete, the spermatozoa with the female gamete or the ovum. The single celled fertilized ovum present after this process is called as the zygote or the embryo. This further undergoes different processes of growth and differentiation and becomes the foetus in advanced stages of pregnancy.

According to Ayurveda, the process of formation of गर्भ takes place by the संयोग (union) of शुद्ध शुक्र and शुद्ध आर्तव , just as how fire is produced by the संयोग (contact or friction) of two pieces of wood. When this संयोग of शुक्र and आर्तव takes place, the सत्व or the आत्मा (soul) also, enters and corporeal, setting in, according to the past actions performed by it.

Gametogenesis: - the process involved in the maturation of the two highly specialized cells, spermatozoon in the male and ovum in female before they unite to form zygote is called spermatogenesis.

Oogenesis: - The process involved in the development of a mature ovum is called oogenesis.

The primary oocyte undergoes first meiotic division giving rise to secondary oocyte and one polar body. The two are unequal size; the secondary oocyte contains haploid number of chromosomes (23,X), but nearly all the cytoplasm and one pair of sex chromosomes, named 'XX'. The first stage of maturation occurs with full maturation and ovarian follicle just prior to ovulation but the final maturation occurs only after fertilization.

The primary oocyte undergoes first meiotic division giving to secondary oocyte contains haploid number of chromosomes (23,X), but nearly all the cytoplasm and the small polar body also contains half of the chromosomes (23,X). Ovulation occurs soon after the formation of secondary oocyte.

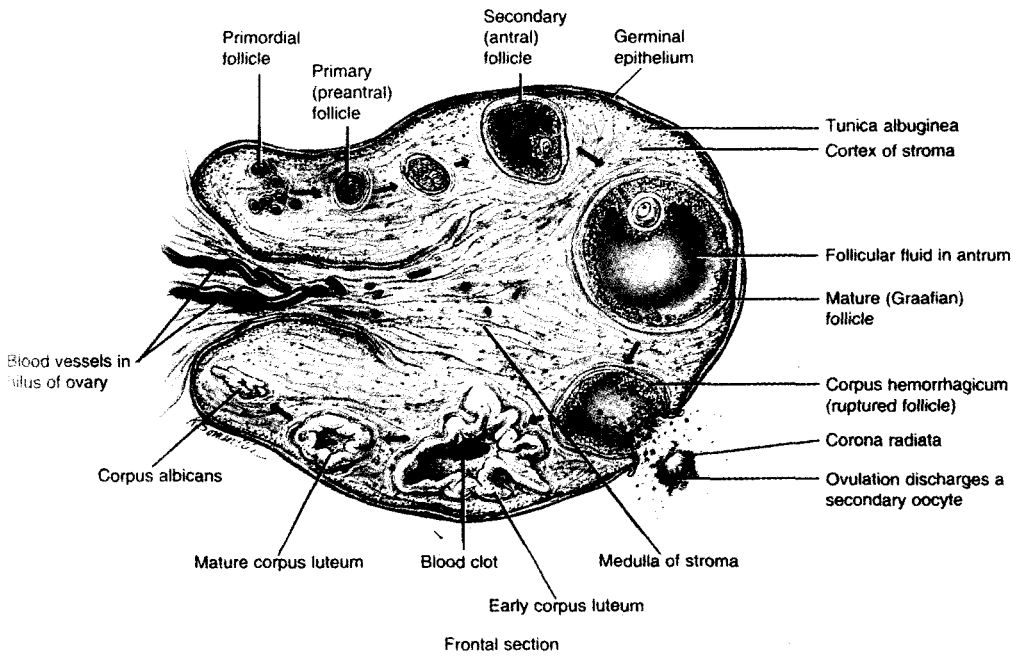
The secondary oocyte completes the second meiotic division (homotypical) only after fertilization by the sperm in the fallopian tube and results in the formation of two unequal daughter cells, each possessing 23 chromosomes (23,X) the larger one is called the mature ovum and the smaller one is the second polar body containing the same number of chromosomes. The first polar body may also undergo the second meiotic division. In the absence of fertilization, the secondary oocyte does not complete the second meiotic division and degenerates as such.

Structure Of A Mature Ovum: -

A fully mature ovum is the largest cell in the body and is about 130 microns in diameter. It consists of cytoplasm and a nucleus with its nucleolus, which is eccentric in position and contains 23 chromosomes (23,X). During fertilization, the nucleus is converted into a female pronucleus. The ovum is surrounded by a cell membrane called **vitelline membrane**.

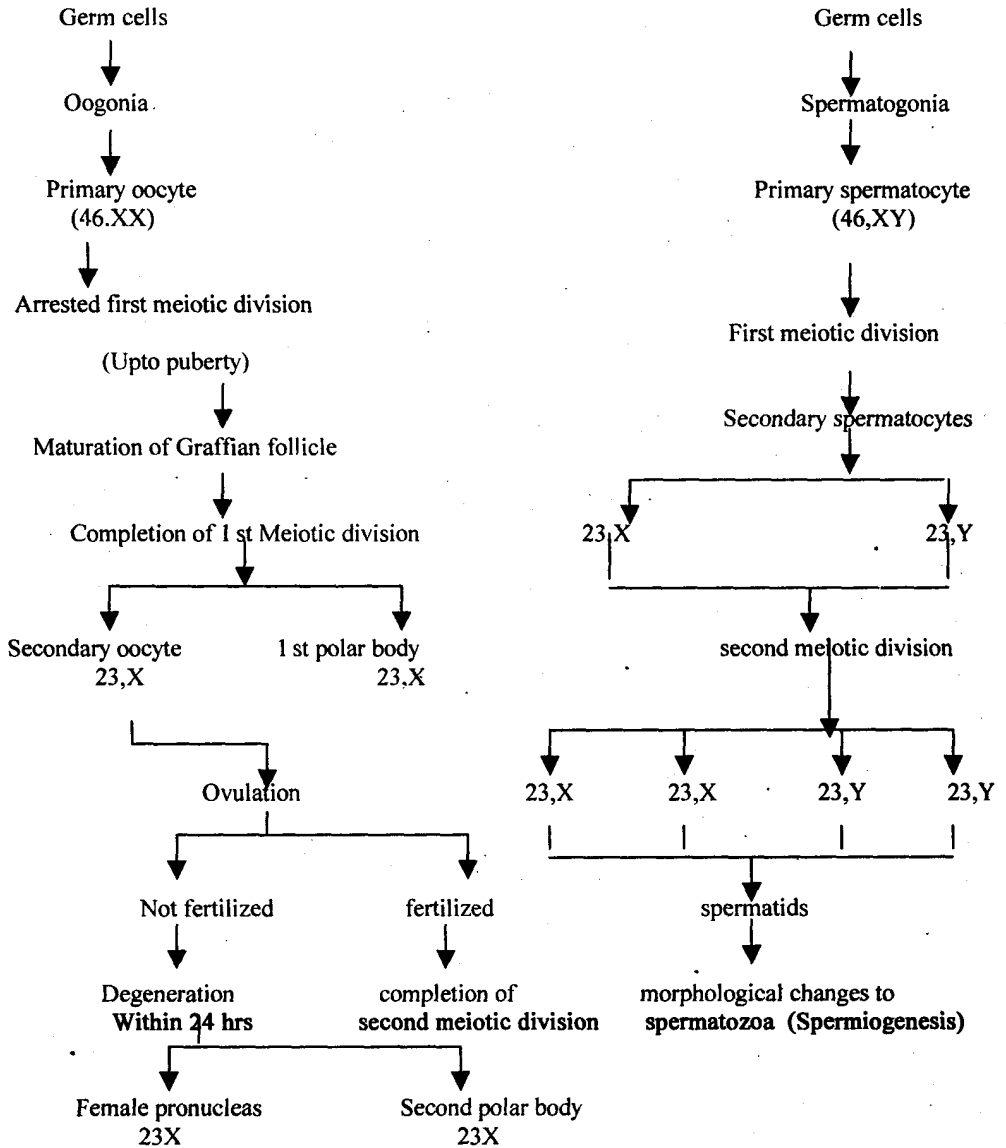
There is a transparent mucoprotein envelope, the zona pellucida. The pellucida is penetrated by tiny channels, which are thought to be important for the transport of the materials from the granulosa cells to the oocyte. In between the vitelline membrane and the Zona pellucida, there is a narrow space called perivitelline space, which accommodates the polar bodies. The human oocyte after its escape from the follicle retains a covering of granulosa cells known as the corona radiata derived from the cumulus oophorus.

Uterus



Scheme Showing Gametogenesis

OOGENESIS SPERMATOGENESIS



Spermatogenesis: -

The process involved in the development of spermatids from the primordial male germ cells and their differentiation into spermatozoa is called spermatogenesis.

Shortly before puberty, the primordial germ cells develop into spermatogonia in turn differentiate into primary spermatocytes, which remain in the stage of prophase of the first meiotic division for a long time (about 16 days). Each spermatocyte contains 22 pairs of autosomes and one pair of sex chromosomes, named "XY". With the completion of the first meiotic division, two secondary spermatocytes are formed having equal share of cytoplasm and haploid number of chromosomes either 23 X or 23Y. Immediately follows the second meiotic division (homotypical) with the formation of four spermatids, each containing haploid number of chromosomes, two with 23, X and two with 23, Y. Immediately after their formation, extensive morphological differentiation of the spermatids occurs without further cell division to convert them into spermatozoa. The process is called spermatogenesis. In man, the time required for a spermatogonium to develop into a mature spermatozoan is about 61 days.

Ovulation: -

Ovulation is a process whereby a secondary oocyte is released from the ovary following rupture of a mature Graafian follicle and becomes available for conception. Only one secondary oocyte is likely to rupture in each ovarian cycle, which starts at puberty and ends in menopause. However, menstruation can occur without ovulation and ovulation remains suspended during pregnancy and lactation.

Causes of ovulation:-

1. **LH surge:-** Sustained peak level of oestrogen for 24-36 hours in the late follicular phase leads to LH surge from anterior pituitary. It stimulates completion of reduction division of the oocyte and initiates luteinisation of the granulosa cells, synthesis of progesterone and prostaglandins.

2. **FSH rise:-** Preovulatory rise of progesterone facilitates the positive feedback action of oestrogen to induce FSH surge which cause increase in plasminogen activator, then plasminogen convert into plasmin which helps lysis of the wall of the follicle.

Thus the combined LH/FSH midcycle surge is responsible for the final stage of maturation, rupture of the follicle and expulsion of the wall of the follicle.

Following ovulation, the follicle is changed into corpus luteum.

GHARBADHANAM (Fertilization):-

Fertilization is the process of fusion of the spermatozoon with the mature ovum. It begins with sperm egg collision and ends with production of a mono nucleated single cell called as zygote. Its objectives are:

1. To initiate the embryonic development of the egg.
2. To restore the chromosome number of species.

• Almost always the fertilization occurs in the ampullary part of the uterine tube.

Approximation Of The Gametes:

The ovum immediately following ovulation is picked up by the tubal fimbriae which partly envelope the ovary, especially at the time of ovulation. The pick up action might be muscular or by a kind of suction or by ciliary action or by a positive chemotaxis exerted by the tubal secretion. The ovum is rapidly transported to the ampullary part.

Out of hundred's of millions of sperms deposited in the vagina at single ejaculation, only thousands capacitated spermatozoa enter the uterine tube, while only 300 – 500 reach the ovum. The tubal transport is facilitated by muscular contraction and aspiration action of the uterine tube. It takes about 1 hour for the sperms to reach the site.

Contact And Fusion Of The Gametes:

Complete dissolution of the cells of the corona radiata occurs probably by the chemical action of the hyaluronidase liberated from the acrosomal cap of the hundreds of sperms present at the site or by the action of muscular enzyme

- Penetration of the zona pellucida is probably facilitated by the release of hyaluronidase from the acrosomal cap. More than one sperm may penetrate the zona pellucida.
- Out of many sperms, one touches the vitelline membrane. Soon, penetration of the other sperms is prevented and immobilisation of the sperms present inside the zona pellucida occurs by zonal reaction and vitelline block.
- Completion of the second meiotic division of the oocyte immediately follows, each containing haploid number of chromosomes (23, X). The bigger one is called the female pro nucleus and the smaller is called the second polar body, which is pushed into the peri vitelline space.
- The sex of the child is determined by the pattern of the sex chromosome supplied by the spermatozoon.

IMPORTANT EVENTS FOLLOWING FERTILIZATION	
'0' hour	- fertilization
30 hours	- 2 cells stage (blstomeres)
40 – 50 hours	- 4 cells stage
72 hours	- 12 cells stage
96 hours	- 16 cells stage, Morula enters the uterine cavity
5 th day	- Blastocyst
6 – 7 th day	- zona pellucida disappears, interstitial implantation occurs
9 th day	- lacunar period. Endometrial vessel - tapped
10 – 11 th day	- implantation completed
13 th day	- primary villi
16 th day	- second villi
21 st day	- tertiary villi
21 st – 22 nd day	- fetal heart. Feto – placental circulations.

गर्भावक्रान्तिः :-

(1) गर्भस्य उपगमनम् अवतरणम् इति यावत् गर्भावक्रान्तिः (Dalhana comm.)

(2) तेजो यथा अर्करश्मीनाम् स्फटिकेन तिरस्कृत्।

नेन्धनं दृश्यते गच्छत्सत्त्वो गर्भाशयं तथा ॥ (Ast.Hru.Sha.1/3)

The process of “ गर्भावक्रान्ति “ actually means “The descent of the self”. Only after this, the गर्भ can be said to be alive. This is not visible to the human eye. This process can be only inferred.

When the rays of the sun are focused on a crystal (such as स्फटिक माणि OR सूर्यकान्ता Stone) that is held above some fuel (like a piece of wood or paper), the rays travel through the crystal and enter the fuel that is placed below. One cannot observe the process where the rays reach the fuel; but one can clearly understand that the rays of the sun have been conveyed to the fuel, when he observes fire in the fuel. Similarly, the exact process of गर्भावक्रान्ति cannot be perceived directly. The entry of the आत्मा into the body can be understood when the गर्भ shows signs of life.

(3) गते पुरणे रजसि नवे अवस्थिते शुद्धे गर्भस्याशये मार्गे च

बीजात्मा शक्रमविकृतमविकृतेन वायुना प्रेरितमन्यैश्च

महाबूतैरनुगतमार्तवेनाभिमूर्च्छितमन्वक्षमेव रागादिक्लेशवशानुवर्तिना

स्वकर्मचोदितन जीवेनाभिसंसृष्टं गर्भाशयमुपयाति ॥ (Ast.San.Sha.2/2)

The normal functioning of वात plays an important role in the process of union of शुक्र and आर्तव. This वात, that exists in a normal state causes the complete elimination of पुराण रजस् (previous menstrual blood) that remains accumulated in the गर्भाशय after each cycle of menstruation gets completed. Thus, the गर्भाशय मार्ग (channels and passages) get purified and become prepared to receive the शुक्र.

Similarly शुक्र that has been purified by processes like बीजशुद्धीकरण, वाजिकरण etc enters the योनि. This शुद्ध शुक्र is carried by the normal वात, towards the शुद्ध आर्तव and their union takes place in the गर्भाशय (uterus). At the same time, the Panchamahabhutas and Jiva also get united with the शुक्र and आर्तव.

The Panchamahabhutas are present in the पुंबीज and स्त्रीबीज in a very minute form. These are responsible for the differentiation and growth of the गर्भा.

The जीव or आत्मा carries along वासन and संस्कार of the previous जन्म. These are also mentioned as क्लेश (miseries). They are five in number viz, राग, द्वेष, अविद्या, अस्मिता and अभिनिवेश. These exist as a result of past actions. One cannot get rid of these क्लेश (miseries) within a single lifetime. Hence, the cycle of birth and death repeats itself until one attains freedom from these miseris. These वासन or क्लेश get transferred from one जन्म to the next one along with the जीव or आत्मा. Thus when the आत्मा leaves a body after death, it carries along with it the वासन of that जन्म and reaches the human body that is to be born in the next जन्म. While it does so, the आत्मा travels with the speed of the mind.

The endocrinological, physiological and anatomical alterations that accompany pregnancy give rise to symptoms and signs that provide evidence that pregnancy exists. These symptoms and signs are classified into three groups: presumptive evidence, probasle signs and positive signs of pregnancy.

Presumptive Evidence Of Pregnancy:-

Presumptive evidence of pregnancy is based largely on subjective symptoms that include

1. Nausea with or without vomiting
2. Disturbance in urination
3. Fatigue
4. The perception of foetal movement.

Presumptive signs include:-

1. Cessation of menses
2. Changes in the breasts
3. Discolouration of the vaginal mucosa
4. Increased skin pigmentation and the development of abdominal striae
5. Especially important, does the woman believe that she is pregnant.

Probable Evidence Of Pregnancy: -

The Probable signs of pregnancy include: -

1. Enlargement of the abdomen
2. Changes in the shape, size and consistency of the uterus
3. Anatomical changes in the cervix
4. Braxton Hicks contraction
5. Ballottement
6. Physical outlining of uterus
7. Presence of chorionic gonadotropin in urine or serum.

Positive Signs Of Pregnancy:

The three positive signs of pregnancy are,

1. Identification of foetal heart action separately and distinctly from that of the pregnant woman.
2. Perception of active foetal movements by the examiner.
3. Recognition of the embryo and foetus any time in pregnancy by sonographic techniques or of the more mature foetus radiographically in the latter half of pregnancy.

गर्भकरभावाः -

Apart from the Panchamahabhutas that are responsible for the growth of the गर्भ, there are few more factors that influence the growth of the गर्भ.

मातृतः पतृत आत्मतः सात्म्यतो रसतः सत्वतः इत्येतेभ्यो

भावेभ्यः समुदितेभ्यो गर्भः सम्भवति ॥ (Cha.Sha.4/4)

The मातृज, पितृज, आत्मज, सात्म्यज, रसज and सत्वज have an influence on the formation of various parts of the body of the गर्भ.

1. मातृज भावाः -

मांसशोणितमेदोमज्जहृत्नाभियकृत्प्लीहान्त्रगुदप्रभृतीनि मृदूनि मातृजानि ॥ (Su.Sha.3/32)

The following parts are formed and derived from the mother. They are मांस, रक्त, मेद, मज्जा, हृदय, नाभी, यकृत, प्लीह, अन्त्र, गुद and all other soft parts of the body.

2. पितृज भावाः :-

गर्भस्य केशश्मश्रुलोमास्थिनखदन्तसिरास्त्रायुधमनीरेतःप्रभृतीनि स्थिराणि पितृजानि ॥

(Su.Sha.3/32)

The केश, श्मश्रु, लोम, अस्थि, नख, दन्त, सिरा, स्त्रायु, धमनी, शुक्र and other hard parts are derived from the father.

3. आत्मज भावा :-

इन्द्रियाणि ज्ञानं विज्ञानमायुः सुखदुःखादिकं चात्मजानि ॥ (Su.Sha.3/32)

The इन्द्रिया (sense organs), knowledge, wisdom and prudence, longevity (आयु) सुख and दुःख of the individual are derived from the आत्मा or self.

4. सात्यजभाव :-

वीर्यमारोग्यं बलवर्णौ मेधा च सात्यजनि ॥ (Su.Sha.3/32)

वीर्य (vigour & strength), health, complexion and lustre, intelligence etc are produced by सात्यज factors.

5. रसजभावा :-

शरीरोपचयो बलं वर्णः स्थितिर्हानिश्च रसजानि ॥ (Su.Sha.3/32)

The built, strength, luster, sustenance and disintegration of different parts of the body are derived from the रस.

6. सत्वज भावा :-

सात्त्विं शौचमास्तिव्यं शुक्रधर्मरुचिर्मतिः ।

राजसं बहुभाषित्वं मानक्रुद्धम्भमत्सरम् ॥

तामसं भयमज्ञानं निद्रालस्यं विषादिताः । ॥ (Ast.Hru.Sha.3/7)

कायिक, वाचिक and मानसिक शुचि (ie) cleanliness of the body, speech and mind, belief in god, righteousness, possession of pure virtues are derived from सत्वगुण.

Talkativeness, pride, anger, greed and jealousy are derived from रजोगुण.

Fear, ignorance, sleepy nature, lethargy and grief are derived from तमोगुण.

गर्भप्राणाः -

अग्नीः सोमो वायुः सत्त्वं रजस्तमः पञ्चेन्द्रियाणि भूतात्मेति प्राणाः (Su.Sha.4/2)

The growth of the factors involves the participation of these factors collectively called as गर्भप्राणाः

They are अग्नि (the element of heat in the body that is represented by पित्तम्), सोम or the element of cold that is represented by कफ , वायु , that maintains a balance th त्रिगुण 's namely सत्त्व , रजस् and तमस् , the पञ्चेन्द्रिया or sense organs and the भूतात्मा or the self. These factors form the life (प्राण) of the गर्भ.

जरायोरुत्पत्ति (Formation Of Placenta-अपरा):-

गृहीतगर्भणामार्तववहानां स्रोतसां वर्तमान्यवरुध्यन्ते गर्भेण, तस्माद् गृहीतगर्भणामार्तवं न दृश्यते, ततस्तदधः प्रतिहतमूर्ध्वमागतमपरं चोपचीयमानमपरेत्यभिधीयते, शेषं चोर्ध्वतरमागतं पयोधरावभिप्रतिपद्यते, तस्माद् गर्भिण्यः पीनोन्नतपयोधरा भवन्ति ॥ (Su.Sha.4/24)

The आर्तववहा स्रोतस् of a pregnant woman becomes occluded by the presence of the गर्भ. This is the reason why there is no menstruation during pregnancy. Thus, because of this, the menstrual fluid (आर्तव) that has become incapable of moving downwards begins to move upwards. A part of it gets accumulated and contributes to the formation of अपरा (placenta), while the rest of it moves further upwards to reach the स्तन (breasts) and contributes to form स्तन्य (breast milk). Hence the breasts of pregnant women appear full and plumpy.

तस्याश्च रजोवहीनां स्रोतसां वर्तमान्युपरुध्यन्ते गर्भेण ।

तस्मात्ततः परमार्तवम् न दृश्यते ।

ततस्तदधः प्रतिहतमपरमपरं चोपचीयानमपरेत्याहुः जरायुरित्यन्ये ।

स्थिते रक्ते रोमराजिः प्रादुर्भवति । (Su.Sha.4/24)

Some call the accumulated part of the आर्तव that moves upwards as अपरा while others term it जरायु.

गर्भो रुणाद्धि स्रोतांसि रसरक्तवहानि वै ।

रक्ताज्जरायुर्भवति नाडि चैव रसात्मिका ॥ (Su.Sha.4/24) Dalhana Commentry

Dalhana opines that the जरायु or अपरा is derived from the रक्त, while the गर्भ नाडि or the umbilical cord of the गर्भ is formed from the रस of the mother. Indu, the commentator of ashtanga samgraha opines that, besides the accumulation of आर्तव, the diet and regimen of the pregnant lady also plays a role in the formation of the placenta.

गर्भस्य पोषणः -

(1) मातुस्तु खलु रसवहायां नाड्यां गर्भनाभिनाडी प्रतिबद्धा, सा अस्य मातुराहाररसवीर्यमभिवहति । असंजाताङ्गप्रत्यङ्गप्रविभागमानिषेकात् प्रभृति सर्वशरीरावयवानुसारिणीनां रसवहानां तिर्यग्गतानां धमनीनामुपस्त्रेहो जीवयति ॥ (Su.Sha.3/31)

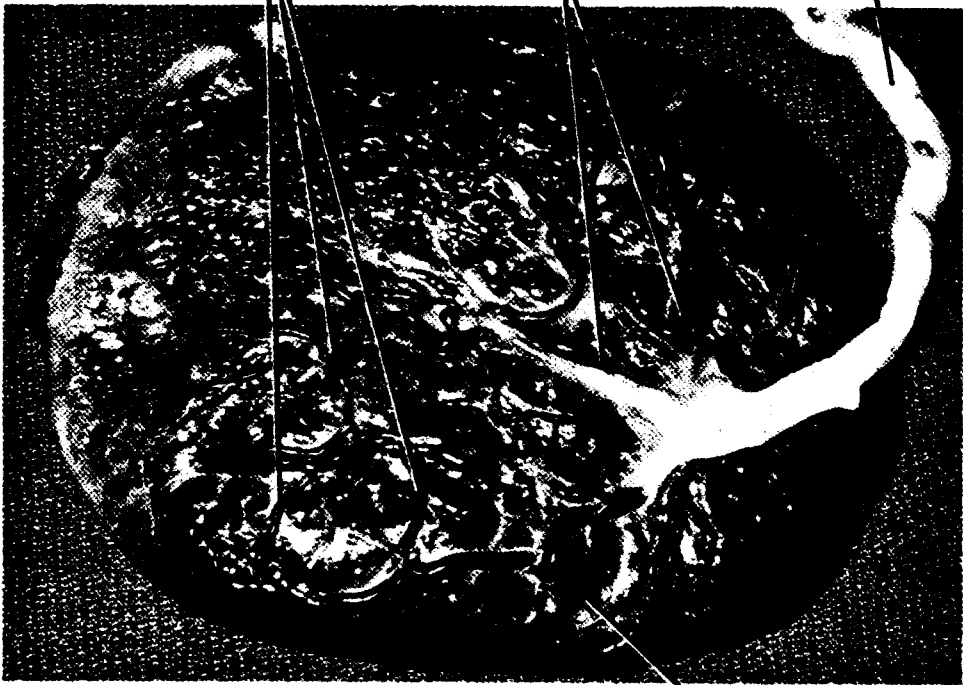
The गर्भ is completely dependant on its mother for its sustenance. The nutrition necessary for the development of the गर्भ is provided by the रस of the mother. The अपरा is connected (by the धमनी) to the mother's हृदय, which is the रसस्थानं.

Placenta

Umbilical arteries

Umbilical veins

Umbilical cord



Amnion covering fetal surface of placenta

The अपरा conveys the mother's रस to the गर्भ through the गर्भनाडि (umbilical cord). The गर्भनाडि is attached to the नाभि of the गर्भ. Thus the आहार रस reaches the body of the foetus. This आहार रस is digested by the गर्भ 's own अग्नि i.e., (स्वकायाग्नि) and the सार is utilized for the further development of Dhatus and for the proper nourishment of the foetus.

Foetal Circulation-

The foetal circulation which is known as circulatory system of the foetus differs from the postnatal (after birth) circulation because the lungs, kidneys, and gastro-intestinal organs begin to function at birth. In foetal life the placenta serves as the organ of respiration. The fetus obtains its O₂ and nutrients by diffusion from the maternal blood and eliminates its CO₂ and wastes by a process of diffusion through the placental barrier.

The exchange of materials between fetal and maternal circulation occurs through a structure called the placenta. It is attached to the umbilicus (navel) of the fetus by the umbilical cord.

Blood passes from the fetus to the placenta via two umbilical arteries. These branches of the Internal iliac (hypogastric) arteries are within the umbilical cord. At placenta, fetal blood picks up O₂ and nutrients and eliminates CO₂ and wastes. The oxygenated blood returns from the placenta via a single umbilical vein. The umbilical vein ascends to the liver of the fetus where it divides into two branches. Some blood flows through the branch that joins the hepatic portal vein and enters the liver. Most of the blood by passes the liver via the ductus venosus and drains into the Inferior Vena Cava directly or through the left hepatic vein.

Some amount of blood undergoes a portal circulation through the hepatic sinusoids and then flows into the venacava. This accounts for enlargement of the liver in foetal life and in the new born.

The Inferior vena cava receives a mixture of oxygenated and deoxygenated blood- the oxygenated blood being derived from the ductus-venosus, and the deoxygenated blood from the caudal parts of the embryo.

At the same time deoxygenated blood returning from the superior regions of the fetus enters the superior venacava and passes into the right atrium.

Most of the fetal blood does not pass from the right ventricle to the lungs, as it does in post-natal circulation because an opening called the foramen ovale exists in the septum between the right and left atria. About 1/3rd of the blood passes through the foramen ovale directly in to the systemic circulation. The blood that does pass into the right ventricle is pumped into the pulmonary trunk, but little of this blood reaches the non-functioning fetal lungs. Most is sent through the ductus arteriosus. This vessel connects the pulmonary trunk with the aorta is carried to all parts of the fetus through the systemic circulation.

When the common iliac arteries branch into the external and internal iliacs then it goes to the umbilical arteries and back to the placenta for another exchange of materials. The only fetal vessel that carries fully oxygenated blood is the umbilical vein. At birth, when pulmonary, renal and liver functions begin.

Sex Determination: -

Sex differentiation is seen not only in advanced forms but also in primitive forms of life. In highly advanced forms such as human beings, male and female individuals differ morphologically, anatomically and physiologically. Such organisms are said to be different sexual forms and the phenomenon is known as sexual dimorphism.

Sex determination of a foetus can be made by many methods such as chromosomes, environment, hormones etc. The chromosomal theory is the most common method of sex determination.

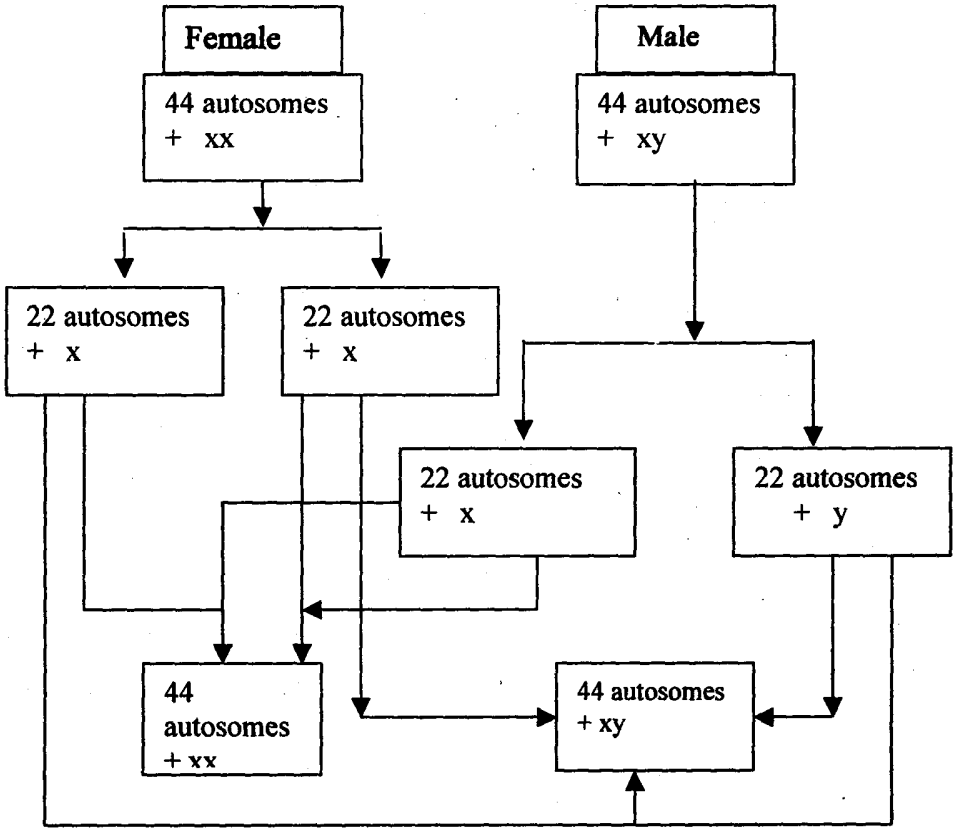
All the diploid body cells of human beings have 46 chromosomes. They exist as 23 homologous pairs. These chromosomes are responsible for the transmission of inherited characters or traits from generation to generation. This phenomenon is also called as heredity. Heredity is maintained by minute factors called genes, present in the chromosomes. Genetics is the branch of science that deals with the study of the underlying principles of heredity to explore the secrets of the blueprint of life.

Out of the 23 pairs of chromosomes, 22 pairs are called autosomes. These determine the body characters. The 23rd pair of chromosome is called as the sex chromosome. This determines the sex of the individual.

Thus, the human diploid cell is made up of 44 autosomes+2 sex chromosomes.

Sex chromosomes of human beings are of two types namely X and Y. The female sex chromosome is XX and the male bears XY chromosomes.

During the formation of gametes in this XX-XY mechanism of sex determination, the females (XX) produce a single type of gametes (ie) all has the same chromosome composition (22A+X). These females are called homogametic since all gametes are the same. The male produces two different types of gametes- one type containing X chromosomes+ one set of auto somes (22 A+X) and another type containing Y chromosomes (22A+Y). These males are also called heterogametic because two different kinds of gametes. The fertilization of the egg cell with 'X' bearing sperm results in the development of a female child and with that of a 'Y' bearing sperm results in the formation of a male child.



Male (xy)

Female (xx)

(1) रक्तेन कन्यामधिकेन पुत्रं शुक्रेण । (Ch. Sha 2/12)

(2) तत्र शुक्रबाहुल्यात् पुमान्, आर्तवबाहुल्यात् स्त्र, साम्यादुभयोर्नपुंसकमिति (Su.Sha.3/5)

The sex of the foetus is determined based on the relative predominance of the शुक्र OR आर्तव, during the process of fertilization. A male child is formed as a result of predominance of शुक्र, while a female is formed due to the predominance of आर्तव over शुक्र. Here the term “ बाहुल्य ” indicates more of qualitative rather than the quantitative aspect. It has been explained as the “कार्यशक्तिसामर्थ्यम्”.

Thus, when the पुरितः or semen is more powerful compared to the स्त्रीरजः

It results in the formation of a पुंगर्भ. Whereas, if the स्त्रीरजः is more powerful, it becomes dominant, suppressing the influence of the पुरितः on the गर्भ. The foetus thus formed by a powerful स्त्रीरजः will be a female.

When the शुक्र and आर्तव are equal, it results in the formation of a eunuch (नपुंसक).

आधिक्यो रजसः कन्या पुत्रः शुक्राधिके भवेत् ।

नपुंसकं समत्वेन यथेच्छा परमेश्वरी ॥ (sharangadhara Samhita prathama khanda 6/2)

One can thus, determine the sex of the foetus only to some extent. The entire thing depends on the will of god and one can never say for sure, that one can always predict the sex.

The pregnant lady shows certain signs during pregnancy. These signs are also helpful to determine the sex of the foetus. These are described in the 2nd chapter of the शारीरस्थान of चरकसंहिता. On observing the habits and behaviour of the pregnant woman, one can determine the sex of the child. For example, when the woman possesses feminine habits and behaves more like a female, becomes interested in articles bearing feminine names, or when the left side of the body of the woman is more active than the right & when the स्तन्य appears first on the left स्तन, it indicates the presence of a female garbha. The woman having opposite characters is said to have conceived a male child. A mixture of these characters indicates that the foetus is a नपुंसक.

मासानुमासिकी गर्भवृद्धिः - Monthwise Development Of The Foetus: -

(1)(a) तत्र प्रथमे मासि कललं जायते ॥ (Su.Sha.3/18)

(b) स सर्वगुणवान् गर्भत्वमापन्नः प्रथमे मासि समुच्छितः सर्वधातुकलुषीकृतः खेटभृतो भवत्यव्यक्तविग्रहः सदसद्भुताङ्गावयवः ॥ (Ch.Sha.4/9) ॥

In the first month, कलल or an indistinct mass is formed. According to Charaka, the shape is *avyakta* and the गर्भ looks like श्लेष्म । There is no distinct body part .At this stage; the Dhatus are also present only in this सूक्ष्म (minutest) form. The आत्म । is present in this gelatinous mass.

(2)(a) द्वितीये शीतोष्मानिलैरभिप्रपच्यमानानां महाभूतानां संघातो घनः संजायते, यदि

पिण्डः पुमान्, स्त्री चेत् पेशी, नपुंसकं चेदर्बुदमिति ॥ (Su.Sha.3/18)

(b) द्वितीये मासि घनः संपद्यते पिण्डः पेश्यर्बुदं वा । तत्रघनः पुरुषः, पेशि स्त्री, अर्बुदं नपुंसकम् ॥ (Ch.Sha.4/10)

In the second month the गर्भ becomes a घन or पिण्ड like form. If this solid mass is oval shaped, it is a male, if it is elongated (पेशी) in shape, it is a female, and if the mass is rounded (अर्बुद like); then it is a hermaphrodite. At this stage, the Mahabhutas, acted upon by शीत (कफ), ऊष्म (पित्त) and अनिल (वायु), start the process of differentiation and form this solid mass, called घन .

(3) (a) तृतीये हस्तपादशिरसां पञ्च पिण्डका निर्वर्तन्ते अङ्गप्रतङ्गविभागश्च सूक्ष्मो भवति ॥

(Su.Sha.3/18)

(b) तृतीयेमासि सर्वेन्द्रियणि सर्वाङ्गवयवाश्च यौगपधेनाभिनिर्वर्तन्ते ॥११॥ (Ch.Sha.4/11)

In the third month, there is a formation of five पिण्डका s that develop into the hands, feet and the head .At this, the अङ्गप्रतङ्गविभाग commences and proceeds further. The five पिण्डका s are present in the form of small bud-like structures, at this stage.

(4) (a) चतुर्थे सर्वाङ्गप्रत्यङ्गविभागः प्रव्यक्तो भवति, गर्भहृदयप्रव्यक्तीभावाञ्चतनाधातुरभिव्यक्तो भवति ॥ (Su.Sha.3/18)

(b) चतुर्थे मासिस्थिरत्वमापध्यते गर्भः तस्मात्तदा गर्भिणी गुरुगात्रत्वमधिकमापध्यते विशेषेण ॥ (Ch.Sha.4/20)

The parts of the body become more distinct. As the हृदय, the seat of consciousness (चेतनास्थानम्) also becomes well developed at this stage, the foetus becomes conscious during the fourth month and expresses its desires and feelings through its mother. At this stage, the lady is called as an दौहदिनी as she bears the foetus whose हृदय is active. The pregnant woman expresses the feelings of the foetus as her own desires and longings. These must be fulfilled.

(5) (a) पञ्चमे मनः प्रतिबुद्धतरं भवति ॥ (Su.Sha.3/18)

(b) पञ्चमे मासि गर्भस्य मांसशोणितोपचयो भवत्यधिकमन्येभ्यो मासेभ्यः तस्मात्तदा गर्भिणी कार्श्यं मापध्यते विशेषेण ॥ (Ch.Sha.4/21)

In the fifth month, the मनः or mind of the foetus begins to function. Thus the foetus becomes livelier, waking from a sub-conscious state.

(6) (a) षष्ठे बुद्धिः ॥ (Su.Sha.3/30)

(b) षष्ठे मासि गर्भस्य बलवर्णोपचयो भवत्यधिकमन्येभ्यो मासेभ्यः तस्मात्तदा गर्भिणी बलवर्णहानि मापध्यते विशेषेण ॥ (Ch.Sha.4/22)

The बुद्धिः manifests in the sixth month of development. Charaka opines that the foetus becomes endowed with more energy and complexion at this stage.

(7) (a) सप्तमे सर्वाङ्गपरतङ्गविभागः प्रव्यक्तरः ॥ (Su.Sha.3/30)

(b) सप्तमे मासि गर्भः सर्वैर्भावैराप्याध्यते तस्मात्तदा गर्भिणी सर्वाकरैः क्लान्ततमा भवति ॥ (Ch.Sha.4/23)

In the seventh month the body parts get differentiated rapidly and become even more conspicuous and all the other Dhatus grow & develop rapidly.

(8) (a) अष्टमे अस्थिरीभवत्योजः, तत्र जातश्चेन्न जीवेन्निरोजस्त्वान्नैऋतभागत्वाच्च, ततो बलिं मासौदनमस्मै दापयेत् ॥ (Su.Sha.3/30)

(b) अष्टमे मासि गर्भश्च मातृतो गर्भतश्च माता रसहारिणीभिः संवाहिनीभिर्मुहुर्मुहुरोजः परस्परतआददाते गर्भस्यासंपुर्णत्वात्। तस्मात्तदा गर्भिणी मुहुर्मुहुर्मुदा युक्ता भवति मुहुर्मुहुश्च म्लाना, तथा गर्भः, तस्मात्तदा गर्भस्य जन्म व्यापत्तिमद्भवत्योजसो अनवस्थितत्वात्। तं चैवार्थमभिसमिक्ष्याष्टमं मासमगण्यमित्याचक्षते कुशलाः ॥ (Ch.Sha.4/24)

In the eighth month, the ओजस् becomes unstable, shifting from the mother's side to the foetus and vice versa. Hence a child born in the eighth month does not survive after birth due to the absence of ओजस्.

Hence, to avoid premature birth of the child, special offerings are made during the 8th month of pregnancy.

(9)(a) नवमदशमैकादशद्वादशानामन्यतमस्मञ्जायते, अतो अन्यथा विकारी भवति ॥

(Su.Sha.3/30)

(b) तस्मिन्नेकदिवसात्क्रान्तेपि नवमं मासमुपदाय प्रसवकालमित्याहुरा दशमान्मासात्।

एतावान् प्रसवकालः, वैकारिकमतः परं कुक्षाववस्थानं गर्भस्य ॥ (Ch.Sha.4/25)

After this, parturition should take place within the 9th and 12th month of conception. If it is prolonged, it must be understood that the foetus has some kind of विकार or abnormality, and immediate treatment should be given to remove the foetus out of the uterus.

PRAMANA SHAREERAM

Measurements Of The Various Parts Of The Body:

The height of the man:

स्वं स्वं हस्तत्रयं सार्धं वपुः पात्रं सुखायुषोः । (As.Hr.sha.3)

For a happy life, one should have the height of the body three and half "hastas" taking one's own hand as the measurement.

पुरुषायामः -सर्विंशमङ्गुलशतं पुरुषायम इति ॥ (Su.Su.35/ 12)

अथ पुनरायुषो विज्ञानार्थमङ्गुलप्रमाणसारान् उपदेक्ष्यामः । तत्राङ्गुलि -
अन्तराधिसक्थिबाहुशिरांसि, तदवयवाः प्रत्क्षणीति । तत्र स्वैरङ्गुलैः पादाङ्गुलप्रदेशिन्यौ द्वयङ्गुलायते
। प्रदेशिन्यास्तु मध्यमानामिकाकनिष्ठिका यथोत्तरं पञ्चमभागहीनाः । चतुरङ्गुलायते
पञ्चाङ्गुलविस्तृते प्रपदपादतले । पञ्चचतुरङ्गुलायतविस्तृता पाणिः । चतुर्दशाङ्गुलायतः पादः ।
चतुर्दशाङ्गुलपरिणाहानि पादगुल्फजङ्घाजानुमध्यानि । अष्टादशाङ्गुला जङ्घा, जानूपरिष्ठाञ्च
द्वात्रिंशदङ्गुलमेवं पञ्चाशत् । जङ्घायामासमावूरू ॥ (Su.su.35/ 12)

"The average height of an human body is 120 *Angula*." for knowing the life of the humans, "sum and substance" of the measurements of primary and subsidiary parts of the body is very necessary.

The primary parts – the trunk, the superior and the inferior extremities and the head; the sub division of these are called as subsidiary parts.

In each individual one's own "Anguli" is to be taken as the measure. Each of the toe and the second finger of the foot is two angulas in length. The third, fourth and fifth finger of the foot is 1/5 less in length than its successor.

The forefoot or the portion next to the finger (prapada) and the arch of the foot is 4 angulas long and 5 angulas broad. The heel is five angulas long and four angulas broad; the foot is fourteen angulas long. The circumference of the foot, the ankle, the calf and the knee each of them is 14 angulas in their centers. The length of the calf is 18 angulas. Above the knee (upto hip joint) the length is 22 angulies, and thus together they are 50 angulas. The length of the thigh is equal to the length of the leg.

The structures that are 2 angulas are; the testis, the chin, the teeth, each side of the nose, the root of the era, the inner portion of the eyes or the distance in between the two eyes.

Similarly the structures having 4 angulas are; the penis (in relaxed state); the mouth (wide- opened completely); the length of the nose, the height of the ear, the neck, the, the breath of the forehead, the distance between the two pupils.

The following structures that are 12 angulas are; - the length of the perineum (from the tip of the coccyx to the symphysis pubis); the distance between (1) the penis and the umbilicus. (2) Umbilicus and the heart. (3) The heart and the root of the neck, (4) in between the breasts: the length of the face (from the tip of the chin to the upper border of the forehead); the circumference of the wrist and the elbow.

The circumference (in the center of the calf) of "indrabasti" and the length between the top of the shoulder and the elbow are of each 16 angulas.

The "Hasta" is 24 angulas (it is the length from the elbow to the tip of the, middle finger), the distance between the tip of the two shoulders is 32 angulas; the circumference of (the upper part of) the thigh is 32 angulas; measurement between the wrist and the elbow is 16 angulas, the palm of the hand is 6 angulas long and 4 angulas broad.

The following having 5 angulas are;

- (1). The distance between the root of the thumb and the index finger;
- (2) The distance between the ear and the lateral angle of the eye.
- (3) Each of the two middle fingers.

The index finger and the fourth finger are each $4\frac{1}{2}$ angulas.

The little finger and the thumb are each $3\frac{1}{2}$ angulas.

The mouth is 4 angulas broad and the circumference of the neck is 20 angulas. The nare of the nose is $1\frac{1}{3}$ Angula broad; the circumference of the cornea is $\frac{1}{3}$ that of the eye.

The circumference of the pupil is $\frac{1}{9}$ that of the cornea. The hair border is 11 angulas distant from the center of the top of the head. The distance of the hair border and the distant of the center of the top of the head from the occipital protuberance is each of 10 angulas [i.e., the center of the top of the head is 10 angulas distant from the hair limit].

The distance between the two mastoid tuberosities from behind is 14 angulas.

Woman's buttock or the pelvic region is in proportion to the chest of the man. The chest of the woman is 18 angulas broad and the same measurement is for the male pelvic region.

Thus the 120 angulas of the human body are described. Similarly the measurement of one's own angulas; a woman or a man whoever possesses these normal measurement, will get long life and plenty of wealth. Those who possess less or still lesser than the above mentioned will get its fruit less or lesser respectively.

The Quantities Of Fluids In The Body

तदुदकं दशाजजलिप्रमाणम्, नवाञ्जलयः पूर्वस्याहारपरिणामधातोः यं रसइत्याचक्षते । अष्टौ शोणितस्य, सप्तपूरीषस्य, षट्श्लेष्मायाः, पञ्चपित्तस्य, चत्वारोमूत्रस्य, त्रयोवसायाः, दौमेदसः, एकोमज्जयाः, मस्तिष्कस्यार्धाञ्जलिः, शुक्रस्यतावदेवप्रमाणमोजसः इति एतच्छरीरतत्त्वमुक्तम् ।।

(Ch.sha.7/15.)

We will mention these quantities in the measure of “*Anjali*”. The quantities mentioned here should be taken as ideal ones; and it should be understood that even in normal body these quantities are increasing or decreasing according to the environment. The quantities are - the water in the body is 10 anjalis. [The word ‘*Anjali*’ applied here is the name of a measure; it is also called ‘kutava’.

The water, which when in increased quantity mixes with the faeces passing out also with the urine, blood and other tissues in the body; by which the external skin layer is sustained and nourished, that which existing in the skin receives the name as “lymph” when exudes from a wound; that which accompanying with heat exudes from the hair roots as ‘sweat’; all this water in the body is 10 anjalis. “Rasa” formed by the conversion of our diet which is previously digested, is 9 anjalis. The blood is 8 anjalis; the faecal matter is 7 anjalis; The “sleshma” is 6 anjalis; pitta is 5 anjalis; the urine is 4 anjalis; “vasa” is three anjalis; “meda” is 2 anjalis; majja is 1 Anjali; the brain substance is ½ anjali; the same is the measure of “sukra” and “ojas”. It is the true state of the human body.

PRAMANA SARIRA

S.NO	Name of dhatu	Charaka	Vaghbata	Adhamalla
1.	Jala/Ambu	10 anjalis	10 anjalis	-
2.	Rasa	9 anjalis	9 anjalis	9 anjalis
3.	Rakta	8 anjalis	8 anjalis	8 anjalis
4.	Pureesha	7 anjalis	7 anjalis	7 anjalis
5.	Sleshma	6 anjalis	6 anjalis	6 anjalis
6.	Pitta	5 anjalis	5 anjalis	5 anjalis
7.	Mutra	4 anjalis	4 anjalis	4 anjalis
8.	Artava (Prakrita)		4 anjalis	4 anjalis
9.	Vasa	3 anjalis	3 anjalis	3 anjalis
10.	Medas	2 anjalis	2 anjalis	2 anjalis
11.	Artava (Prasutaya)	-	2 anjalis	-
12.	Sthanya	-	1 anjali	1 anjali
13.	Majja	1 anjalis	1 anjali	1 anjalis
14.	Sukra	½ anjalis	Anjali	1 prasrita / ½ anjali
15.	Mastiska	½ anjalis	½ anjali	1 prasrita / ½ anjali
16.	Ojus (Apara)	½ anjalis	½ anjali	1 prasrita / ½ anjali
17.	Ojus (para)	8 bindu	-	-

OSTEOLOGY (अस्थि शारीरम्)

Introduction: -

अस्थि is one of the basic and most important structures of the human body. It helps in the maintenance of proper body frame, owing to its hard nature.

The term अस्थि” can be explained as follows: -

“अस्यतेक्षिप्यते इति अस्थि”

This suggests that अस्थि is a substance that is not generally decomposed as fast as other associated parts of the body like muscles etc. It remains in the same state even after a long period of time after death. Hence the term अस्थि has been designated for bones. According to the Amarakosha, अस्थि has synonyms like किकसम्, कुल्यम् etc. The number of bones and their classification and descriptions are also available in the Atharva Veda.

In the Charaka samhita, अस्थि is said to be formed from मेदोधातु. अस्थि is considered as a गम्भीर धातु and it occurs as the fifth Dhatu in the sequence of the Sapta dhatus.

According to क्षीरदधिन्याय, by the action of धात्वाग्नि, medas is transformed to अस्थि. Regarding this process, a question of how a hard substance such as अस्थि could be formed from substances like मेदस् occurred in the disciples mind: -

“स्लेक्षणाभ्यां मांसमेदोभ्यां खरत्वं कथमास्तिषु।।”

To this the acharya answered that:-

“पृथिव्यग्नि अनिलादीनां संघातःस्लेष्मणाकृतः।

खरत्वंप्रकरोतस्य जायते अस्थि ततो नृणाम्।।”

By the action of धात्वाग्नि on medodhatu predominant of पृथिवी,अग्नि,वायु महाभुत is formed, it is naturally firm and strong. This is termed as अस्थि. It performs the function of धारण (support) of the body due to its firmness. अस्थि is predominant of पृथिवी, अग्नि,वायु and also आकाशमहाभुत .

अस्थि gains much importance as it is also considered as a आश्रय of वात, by आश्रयआश्रयी भाव. But the relation between अस्थि and वायु differs in one aspect from others. In the case of रक्त and स्वेद, पित्त is the आश्रयी and कफ is the आश्रयी for others fluids of the body. While increase of रक्त leads to the increase of पित्त also, in the case of अस्थि and वात it is not found to be so. When वात undergoes वृद्धि, instead of वृद्धि, there is क्षय of theअस्थि धातु and vice versa. Hence this aspect is considered important for treatment.

Similarly, as explained above, अस्थि धातु does the nourishment of its succeeding Dhatu (ie) मज्जा धातु. Like any other Dhatu of the body अस्थि धातु also has a स्थायी and अस्थायी part. While the स्थायी portion remains as अस्थि, the अस्थायी portion of अस्थि धातु nourishes or does the पोषण of its succeeding Dhatu (ie) मज्जा, there by maintaining constancy in Dhatu parinama.

Importance Of Asthi: -

Acharya Susruta as mentions the importance of अस्थि: -

आभ्यन्तरैगतैः सारैर्यथा तिष्ठन्ति भूरूहाः ।
 अस्थिसारैस्तथादेहा घ्नियन्ते देहिनां ध्रुवम् ॥
 तस्मान्छिरविनष्टेषु त्वङ्मांसेषु शरीरिणाम् ।
 अस्थिनी न विनश्यन्ति साराण्येतानि देहिनाम् ॥
 मांसान्यत्र निबद्धानि सिराभिः स्नायुभिस्तथा ।

अस्थि न्यालम्बनं कृत्वा न शिर्यन्ते पतन्ति वा ॥ (Su. Sh. 5/21-23)

अस्थि is support of the human body just as how trees are supported by the middle core सार present inside the trunk. Major structures like सिराs, स्नायुs, मांसs etc are held in their proper position as they are attached to the bones. Hence none of these structures fall off. The body is also maintained in a proper and erect posture because of bones.

Bones provide protection to the underlying soft tissues and organs.

Hence even when all the other accompanying structures that are attached to the bones shrivel and degenerate, bones remain unchanged owing to their firmness.

त्रीणि सषष्टान्यस्थिशतानि वेदवादिनो भाषन्ते शल्यतन्त्रेषु तु त्रीण्येव शतानि (Su.Sha.5/18)

Expert of Vedas opines that –there are three hundred and sixty bones; nevertheless, in Shalyatantra they are only three hundred.

1.No. Of. Bones present according to Sadanga Shareera:

तेषां सविंशमस्थिशतं शाखासु, सप्तदशोत्तरं शतं श्रोणिपार्श्वपृष्ठोरःसु, ग्रीवां प्रत्यूर्ध्वं त्रिषष्टिः, एवमस्थां त्रीणि शतानि पूर्यन्ते ॥ (Su.Sha.5/18)

The 300 bones are divided under this following heading.

1. शाखा (Four limbs)- 30x 4 = 120
2. श्रोणिपार्श्वपृष्ठोर (Trunk) = 117
3. ग्रीवां (Head and neck) = 63

300.

एकैकस्यां तु पादाङ्गुल्यां त्रीणि त्रीणि तानि पञ्चदश, तलकूर्चगुल्फसंश्रितानि दश, पाण्यामेकं, जङ्घायां द्वे, जानुन्येकम्, एकमूराविति त्रिंशदेवमेकस्मिन् सक्थि भवन्ति, एतेनेतरसक्थि बाहू च व्याख्यातौ, श्रोण्या पञ्च, तेषां गुदभगनितम्बेषु चत्वारि, त्रिकसंश्रितमेकं, पार्श्वे षट् त्रिंशदेकस्मिन्, द्वितीये अप्येवं, पृष्ठे त्रिंशत्, अष्टावुरसि, द्वे अंसफलके, ग्रीवायां नव, कण्ठनाड्यां चत्वारि, द्वे हन्वोः, दन्ता द्वात्रिंशत्, नासायां त्रीणि, एकं तालुनि, गण्डकर्णशङ्खुष्वेकैकं, षट् शिरसीति ॥(Su.Sha.5/19)॥

Modern:

The adult human skeleton consists of 206 bones grouped in the Principal divisions.

1. Axial skeleton
2. Appendicular skeleton.

Axial Skeleton:

The longitudinal axis or center of the human body is a straight line that runs through the body's center of gravity. This imaginary line extends through the head and down to the space between the feet. The axial skeleton consists of the bones that lie around the axis; skull bones, hyoid bone, ribs, sternum and vertebrae. Although the auditory ossicles are not considered as a part of the axial or appendicular skeleton but rather as a separate group of bones, they are placed with the axial skeleton for convenience.

Appendicular Skeleton:

The appendicular skeleton contains the bones of the upper and lower limbs (extremities), plus the bones called girdles whose function is to connect the limbs to the axial skeleton.

As per the standard grouping 80 bones are included under axial skeleton and 126 bones are in appendicular skeleton.

Types Of अस्थि s (Bones):

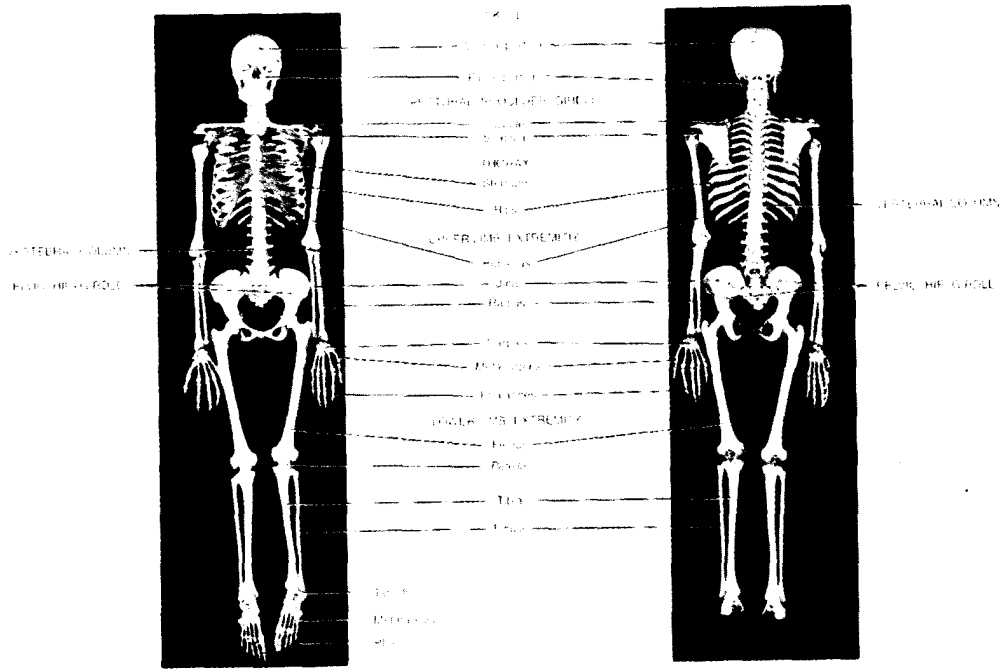
एतान् पञ्चविधानि भवन्ति, तद्यथा - कपालरुचकतरुणवलयनलकसंज्ञानि । तेषां जानुनितम्बांसगण्डतालुशङ्खुशिरःसु कपालानि, दशनास्तु रुचकानि घ्राणकर्णग्रीवाक्षिकोषेषु तरुणानि, पार्श्वपृष्ठोरःसु वलयानि, शेषाणि नलकसंज्ञानि ॥(Su.Sha.5/20)

The अस्थि are of five types.

1. कपाल (flat)- जानु (patella), नितम्ब (hip bone), अंस (scapula), शंख (temporal), शिर (skull).
2. रुचक -Teeth.
3. तरुण (Cartilage)- Nasal concha, Ear ossicles orbit
4. वलय -Ribs and costal cartilages.
5. नलक-Long bones.

Human Skeleton

Anterior and Posterior view



All the bones of the body can be classified into 6 types based on the shape and location.

1. Long bones
2. Short bones.
3. Flat bones.
4. Irregular bones.
5. Sesamoid bones.
6. Sutural bones.

Long Bones:

It has greater length than width. Long bones are typical of limbs, with length reflecting both speed and power in movement. It consists of multiple centers of ossification, variable number of extremities (ends) and a shaft. They are usually somewhat curved for strength. Long bones consist mostly of compact bone tissue in their diaphyses but they also contain considerable amounts of spongy bone tissue in their epiphyses.

Example- Femur, tibia and fibula in lower limbs

Humerus, radius and ulna in upper limbs.

Metacarpals, Metatarsals and phalanges are the smaller examples of long bone, having a proportionately greater shaft diameter and only a single epiphysis.

Short Bone:

These are equal in length and width. These bones have a thin layer of compact bone tissue. These are generally subject to compression more than other bones. They are somewhat cube-shaped.

Examples- All the carpal bones (except pisiform bone which is a sesamoid bone) and ankle or tarsal bones (except for the calcaneus which is an irregular bone).

Flat Bone:

Flat bones are generally thin and composed of two nearly parallel plates of compact bone tissue enclosing a layer of spongy bone tissue. Flat bones afford considerable protection and provide extensive areas for muscle attachment. Flat bones include the cranial bones, which protect the brain.

The breast bone (sternum) and ribs, which protect organs in the thorax and shoulder blades (scapula).

Irregular Bones:

These bones include any elements not easily assigned to the foregoing groups. These have complex shapes and vary in the amount of spongy and compact bone present.

Examples - Vertebra of the backbone and some facial bones.

Sesamoid Bones:

It resembles a sesame seed. These develop in certain tendons where there are considerable friction, tension and physical stress such as palms and soles. These are not always completely ossified. These bones protect tendons from excessive wear and tear and they often change the direction of pull of a tendon, which improves the mechanical advantage at a joint.

Example- Two patellas (knee caps).

Sutural Bones:

It is included under this heading by means of location. Sutural bones are small bones located within joints, called sutures between certain cranial bones.

This time-honoured classification however has no great merit. Bones must be studied individually and considered in relation to the functional demand placed upon them.

.तेषां सविंशमस्थिशतं शाखासु, समदशोत्तरं शतं श्रोणिपार्श्वपृष्ठोरःसु, ग्रीवां प्रत्यूर्ध्वं त्रिषष्टिः,
एवमस्थां त्रीणि शतानि पूर्यन्ते । (Su.Sha.5/18)

Number of bones according to six major parts- extremities contain 120 bones, the trunk (pelvis, thorax and back) contains 117; in the neck and above there are 63. The total is thus 300.

Function Of Bone And Skeletal System:

Bone tissue and skeletal system performs several basic functions.

1. *Support*- the skeleton serves as the structural framework of the body by supporting tissues and providing attachment points for the tendons and skeletal muscles.
2. *Protection*- skeleton protects many internal organs from injury. For example cranial bones protect the brain, vertebra protects spinal cord, rib cage protects the heart.
3. *Locomotion*- because skeletal muscles attach to bones, when muscles contract, they pull on bones. Together, bones and muscles produce movement.
4. *Storage of minerals*- bone tissue stores several minerals especially calcium and phosphorus. On demand, bone releases minerals to the blood and maintain a balance.
5. *Production of blood cells*- within certain bones, a connective tissue called red bone marrow produces red blood cells, white blood cells and platelets, a process called haemopoiesis.
6. *Storage of Triglycerides*- triglycerides stored in the adipose cells of yellow bone marrow are an important chemical energy reserve with increasing age, much of the bone marrow changes from red to yellow.

Structure Of Bone:

The structure of a bone may be analysed by considering the parts of a long bone, for instance the humerus.

A typical long bone consists of the following parts.

1. *Diaphysis*- long, cylindrical, main portion of the bone and it is the bone's shaft or body.
2. *Epiphysis*- The distal and proximal ends of the bone.
3. *Metaphysis*- these are the regions in a mature bone where diaphysis joins with the epiphysis.
4. *Articular cartilage*- it is a thin layer of hyaline cartilage covering the epiphysis where the bone forms a joint with another bone it reduces friction and absorbs shock at freely movable joints.
5. *Periosteum*- it is a tough sheath of dense irregular connective tissue that surrounds the bone surface wherever it is not covered by articular cartilage. The periosteum contains bone-forming cells that enable bone to grow in diameter or thickness, but not in length. It also protects the bone, assists in fracture repair, helps nourish bone tissue and serves as an attachment point for ligaments and tendons.
6. *Medullary cavity*- it is also known as marrow cavity is the space within the diaphysis that contains fatty yellow bone marrow in adults.
7. *Endosteum*- it is a thin membrane that lines the medullary cavity. It contains a single layer of bone-forming cells and a small amount of connective tissue.

Histology Of Bone Tissue:

Like other connective tissues, bone or osseous tissues contain an abundant matrix of intercellular materials that surround widely separated cells. The matrix is about 25% water, 25% collagen fibers and 50% crystallized mineral salts. The abundant inorganic mineral salts are mainly hydroxyapatite (calcium phosphate and calcium carbonate). In addition, bone matrix includes small amounts of magnesium hydroxide, fluoride and sulphate. As these mineral salts are deposited in the framework formed by the collagen fibers of the matrix, they crystallize and the tissue hardens. This process of calcification is initiated by osteoblasts, the bone-building cells.

Four types of cells are present in bone tissue

1. Osteogenic cells
2. Osteoblasts
3. Osteocytes
4. Osteoclasts.

Osteogenic cells-They is unspecialized stem cells derived mesenchyme, the tissue from which all connective tissues are formed. Osteogenic cells are found along the inner portion of the periosteum in the endosteum, and in the canals within bone that contain blood vessels.

Osteoblasts- these are bone-building cells. They synthesize and secrete collagen fibres and other organic components needed to build the matrix of bone tissue and they initiate calcification.

Osteocytes- Mature bone cells are the main cells in bone tissue and maintain its daily metabolism, such as the exchange of nutrients and wastes with the blood like osteoblasts, osteocytes do not undergo cell division.

Osteoclasts- it develops from circulating monocytes (one type of WBC) they are found around the surface of bone and function in bone resorption. This is important in the development, growth, maintenance and repair of bone.

LOWER LIMB BONES

Tarsals, Metatarsals and phalanges.

The skeleton of the foot has three regions

1. Proximal tarsus
2. The intermediate metatarsus
3. The distal phalanges.

TARSUS (गुल्फ कुर्चास्थि)

The tarsus is a collective term for the seven tarsal bones. They are arranged in two rows. In the proximal row there are three bones.

1. Talus – above.
2. Calcaneous – below.
3. Navicular – it is present between talus and the three cuneiform bones or it is present between proximal and distal rows.

In the distal row there are four tarsal bones lying side by side.

From medial to lateral side. These are

1. Medial cuneiform.
2. Intermediate cuneiform.
3. Lateral cuneiform.
4. Cuboid.

The tarsal bones are much larger and stronger than the carpal bones because they have to support and distribute the body weight.

PATELLA (जान्वस्थि)

The patella or kneecap is a small, triangular bone located anterior to the knee joint. It is the largest sesamoid bone in the body, developed in the tendon of the Quadriceps femoris. It is situated in front of the lower end of the femur about 1cm above the knee joint.

Side Determination:

1. The patella is triangular in shape with its apex directed downwards. The apex is non articular posteriorly.
2. The anterior surface is rough and non-articular. The upper three fourth of the posterior surface are smooth and articular.
3. The posterior articular surfaces divide by a vertical ridge into a larger lateral area and a smaller medial area. The bone laid on a table rests on the broad lateral area.

Features:

The patella has an apex, a base, three borders (superior, lateral and medial) and two surfaces (anterior and posterior).

The apex is directed downwards, and lies about 1cm above the knee joint. The pointed inferior end is the apex.

The broad superior end of the patella is called the base.

The anterior surface is convex, rough. It is covered by an expansion from the tendon of the Rectus femoris and is separated from the skin by the pre patellar bursa.

The posterior surface contains two articular facets, one for the medial condyle and the other for the lateral condyle of the femur. The patellar ligament attaches the patella to the tibial tuberosity. The patellofemoral joint, between the posterior surface of the patella and the patellar surface of the femur, is the intermediate component of the tibiofemoral (knee) joint.

Attachments On The Patella:

Superior border – the base provides insertion to the rectus femoris in front and to the vastus intermedius behind.

Lateral border – it provides insertion to the vastus lateralis in its upper one third or half.

Medial border – it provides insertion to the vastus medialis in its upper two thirds or more.

The nonarticular area on the posterior surfaces provides attachment to the ligamentum patellae below, and is related to the infra patellar pad of fat above.

Applied Anatomy

1. Fracture of the patella should be differentiated from a bipartite or a tripartite patella.
2. The patella has a tendency to dislocate outwards because of the outward angulation between the long axes of the thigh and leg.

SCAPULA

Each scapula or shoulder bone is a large, triangular, flat bone situated in the posterior part of the thorax between the levels of the second and seventh ribs. The medial borders of the scapulae (plural) lie about 5cm(2inches) from the vertebral column. It has two surfaces, three borders, three angles and three processes.

The Surfaces:

- 1.Paralysis of serratus anterior causes winging of the scapula. The medial border of the bone The costal surface is concave and is directed medially and forwards. This part of the bone is almost rod like. It acts as a lever for the action of the serratus anterior in overhead abduction of the arm.
- 2.The dorsal surface gives attachment to the spine of the scapula, which divides the surface into a smaller supraspinous fossa and a larger infraspinous fossa. The spinoglenoid notch, situated lateral to the root of the spine, connects the two fossae.

The Borders:

- 1.The superior border is thin and short. Near the root of the coracoid process it presents suprascapular notch.
- 2.The lateral border is thick. At the upper end it presents the infraglenoid tubercle.
- 3.The medial border is thin. It extends from the superior angle to the inferior angle.

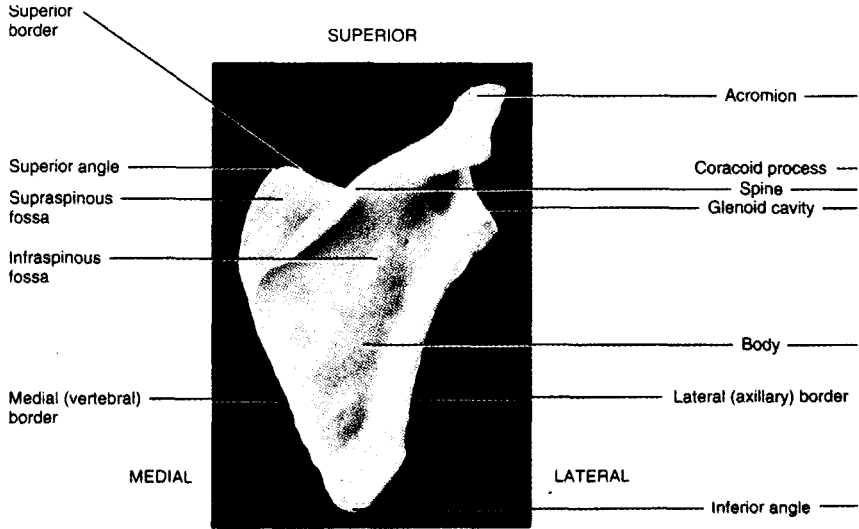
Three Angles:

- 1.The superior angle is covered by the trapezius.
- 2.the inferior angle is covered by latissimus dorsi.
- 3.the lateral (or glenoid) angle is broad and bears the glenoid cavity(or fossa) which is directed forwards, laterally and slightly upwards.

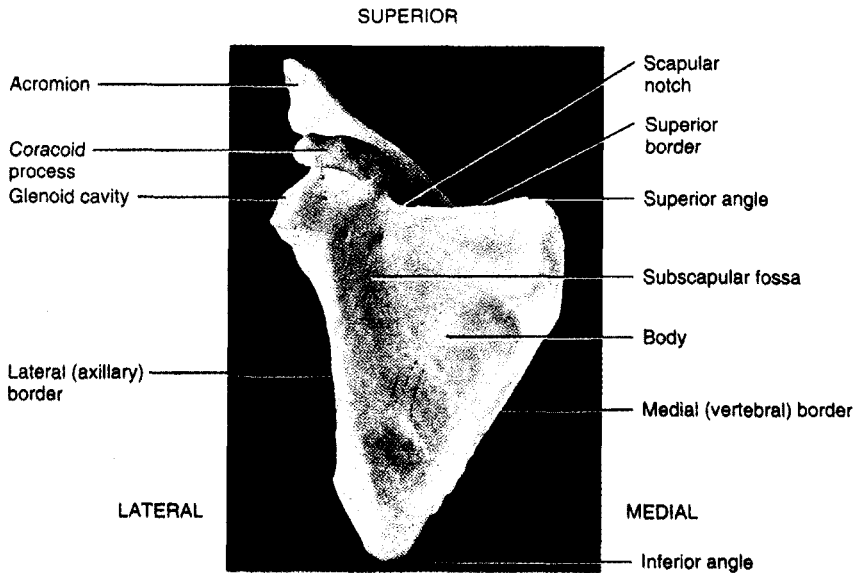
The Processes:

- 1.The spine (or spinous process) is a triangular plate of bone with three borders and 2 surfaces. It divides the dorsal surface of the scapula into the supraspinous and infraspinous fossae.
- 2.the acromion has two borders, medial and lateral; two surfaces superior and inferior, and a facet for the clavicle.
- 3.the coracoid process is directed forwards and slightly laterally.

Scapula



(b) Posterior view



(a) Anterior view

Determination Of The Side:

1. The lateral (glenoid) angle is large and bears the glenoid cavity.
2. The dorsal surface is convex and is divided by the triangular spine into the supraspinous and infraspinous fossae.
3. The lateral thickest border runs from the glenoid cavity above to the inferior angle below.

Attachments Of Scapula:

1. Subscapularis arises from the medial 2/3rd of the subscapular fossa.
2. Serratus anterior is inserted along the medial border of the costal surface.
3. Supraspinatus arises from the medial 2/3rds of the supraspinous fossa.
4. Infraspinatus arises from the medial 2/3rds of the infraspinous fossa.
5. The deltoid arises from the lower border of the crest of the spine from the lateral border of the acromion.
6. Trapezius is inserted into the upper border of the crest of spine into the medial border of the acromion.
7. Coracobrachialis arises from the medial part of the tip of the coracoid process.
8. Pectoralis minor is inserted into the medial border and superior surface of the coracoid process.
9. Rhomboideus minor is inserted into the medial border opposite the root of the spine.
10. Rhomboideus major is inserted into the medial border between the root of spine and inferior angle.

Applied anatomy-

1. become unduly prominent and the arm cannot be adducted.
2. In a developmental anomaly called scaphoid scapula, the medial border is concave.

CLAVICLE (जतुकास्थि)

It is otherwise known as collarbone. It is long, slender S-shaped bone with two curves, one convex and one concave. It supports the shoulder so that the arm can swing clearly away from the trunk. The clavicle transmits the weight of the limb to the sternum.

The bone has a cylindrical part called the shaft, two ends

1. Medial (sternal) end
2. Lateral (acromial) end.

Shaft:

The shaft is divisible into lateral one third and the medial two thirds. The lateral one third of the shaft is flattened from above downwards. It has two borders- Anterior.

-Posterior.

Anterior border is *concave* forwards.

Posterior border is *convex* backwards.

This part of the bone has two surfaces. The superior surface is subcutaneous. The inferior surface presents an elevation called the conoid tubercle and a ridge called the trapezoid ridge.

The medial two thirds of the shaft is rounded and is said to have four surfaces. The anterior surface is convex forwards. The posterior surface is smooth. The superior surface is rough in its medial part. The inferior surface has a rough oval impression at the middle end. A nutrient foramen lies at the lateral end of the groove.

Lateral End:

It is also known as acromial end. It is flattened from above downwards. It bears a facet that articulates with the acromion process of the scapula to form the acromioclavicular joint.

Medial End:

It is quadrangular and articulates with the clavicular notch of the manubrium sterni to form the sternoclavicular joint. The articular surface extends to the inferior aspect for articulation with the first costal cartilage.

The conoid tubercle on the inferior surface of the lateral end of the bone serves as a point of attachment for the conoid ligament. The costal tuberosity on the inferior surface of the medial end also serves as a point of attachment for the costoclavicular ligament.

Side Determination:

The side to which a clavicle belongs can be determined by the following characters.

1. The lateral end is flat and the medial end is large and quadrilateral.
2. The shaft is slightly curved, so that it is convex forwards in its medial 2/3, and concave forwards in its lateral 1/3.
3. The inferior surface is grooved longitudinally in its middle 1/3.

Attachments Of The Clavicle:

1.Lateral 1/3rd of shaft:

- a. Anterior border gives origin to deltoid.
- b. Posterior border provides insertion to trapezius.
- c. The conoid tubercle gives attachment to the conoid and trapezoid parts of the coraco-clavicular ligament.

2.Medial 2/3rd of shaft:

- d. The anterior surface gives origin to pectoralis major.
- e. The rough superior surface gives origin to the clavicular head of sternocleidomastoid.
- f. The subclavian groove gives insertion to subclavius muscle.
- g. The oval impression on the inferior surface at the medial end gives attachment to the costoclavicular ligament.

3.At the lateral end: - the margin of the articular surface for the acromioclavicular joint gives attachment to the joint capsule.

4.At the medial end: - the margin of articular surface gives attachment to the fibrous capsule and inter clavicular ligament.

Ossification: - the clavicle is the first bone in the body to ossify. It ossifies from the primary centers and one secondary center. The two primary centers appear in the shaft between the fifth and sixth weeks of intrauterine life and fuses about the 45th day. The secondary center for the medial end appears during 15-17 years and fuses with the shaft at the age of 21-22 years.

Sex Determination: -

1. In females the clavicle is shorter, lighter, thinner, smoother and less curved than in males.
2. In females, the lateral end of the clavicle is a little below the medial end, in males the lateral end is either at the same level or slightly higher than the medial end.

Peculiarities Of Clavicle: -

1. It is the only long bone that lies horizontally.
2. It is the first bone to start ossifying.
3. It is the only long bone, which has two primary centers of ossification.

Applied anatomy: -

1.The clavicle is commonly fractured by falling on the outstretched hand (indirect violence). The commonest site of fracture is the junction between two curvatures of the bone, which is the weakest point.

2.The clavicle may be congenitally absent or imperfectly absent (in a disease called cleido-cranial dysostosis).

MANDIBLE (हन्वस्थि)

The mandible (mandere=to chew) or lower jawbone is the largest, strongest facial bone. It is the only skull bone, which moves. (Other than auditory ossicles). It has a horse-shoe shaped body which lodges the teeth, and a pair of rami which project upwards from the posterior ends of the body and provide attachment of muscles. In the lateral view, the mandible consists of a curved, horizontal portion, the body, and two perpendicular portions, the rami. The angle of mandible is the area where each ramus meets the body.

The Body: -

Each half of the body has outer and inner surfaces and upper and lower borders. The outer surface presents the following features.

1. The symphysis menti – It is the line, where right and left halves of the bone meet each other. A faint ridge marks it.
2. The mental foramen is approximately inferior to second pre molar teeth. It is near this foramen that dentist reach the mental nerve when injecting anesthetics.

The inner surface presents the following features.

1. Mylohyoid line is a prominent ridge that runs obliquely down wards and forwards from below the third molar tooth to the median area below the genital tubercles.
2. Below the Mylohyoid line the surface is slightly hollowed out to form the sub mandibular fossa, which lodges the sub mandibular gland.
3. Above the Mylohyoid line there is a sub lingual fossa in which the sub lingual gland lies.

The upper border bears sockets for the teeth.

The lower border of the mandible is also called the base. Near the mid line the base shows an oval depression called the digastric fossa.

The Ramus: -

The ramus is quadrilateral in shape. It has 2 surfaces lateral and medial, 4 borders, upper, lower, anterior and posterior; and the coronoid and condyloid processes. The lateral surface is flat and bears a number of oblique ridges.

The medial surface presents the following;

1. The mandibular foramen lies little above the center of the ramus at the level of occlusal surfaces of the teeth. It leads into the mandibular canal, which descends into the body of the mandible and opens at the mental foramen.
2. The mylo-hyoid groove begins just below the mandibular foramen and runs downwards and forwards to be gradually lost over the sub-mandibular fossa.
3. The upper border of the ramus is thin and is curved downwards forming the mandibular notch.

4. The lower border is the backward continuation of the base of the mandible.
5. The anterior border is thin, while the posterior border is thick.
6. The coronoid process is a flattened triangular upward projection from the antero-superior part of the ramus.
7. The condyloid process is a strong upward projection from the postero-superior part of the ramus. Its upper end is expanded from side to side to form the head. The constriction below the head is the neck. Its anterior surface presents a depression called the pterygoid fovea.

Attachments and relations of the mandible: -

1. The oblique line (on the lateral side of the body) gives origin to the buccinator.
2. Mentalis is originated from the incisive fossa.
3. Mylo-hyoid muscle originated from mylo-hyoid line.
4. The superior constrictor muscle of the pharynx arises from the posterior end of the Mylo-hyoid line.
5. Genioglossus is originated from the lower part of the Geniohyoid.
6. The platysma is inserted into the lower border.
7. The medial pterygoid muscle is inserted on the medial surface of the ramus.
8. The lateral pterygoid muscle is inserted into the pterygoid fovea on the anterior aspect of the neck of the ramus.
9. The temporalis is inserted into the apex and medial surface of the coronoid process.

Age changes in the mandible: -

a) In Infants And Children: -

The two halves of the mandible fuse during the first year of life. At birth the mental foramen opens below the sockets for the two deciduous molar teeth near the lower border. The angle is obtuse because the head is in line with the body. The coronoid process is large and projects upwards above the level of the condyle.

b) In Adults: -

The mental foramen opens midway between the upper and lower borders because the alveolar parts of the bone are equally developed. The angle reduces to about 110 or 120 degrees because the ramus becomes almost vertical

c) In Old Age: -

Teeth fall out and the alveolar border is absorbed so that the height of the body is markedly reduced. The mental foramen and the mandibular canal are close to the alveolar border. The angle again becomes obtuse.

Relations To Nerves And Vessels: -

- 1.The mental foramen transmits the mental nerve and vessels.
- 2.The mylohyoid nerve and vessels lie in the mylohyoid groove.
- 3.The lingual nerve is related to the medial surface of the ramus.
- 4.The masseteric nerve and vessels pass through the mandibular notch.
- 5.The auriculo-temporal nerve is related to the medial side of the mandible.

Applied Anatomy: -

- 1.The mandible is commonly fractured at the canine socket where it is weak.
- 2.The next common fracture of the mandible occurs at the angle.

HYOID BONE

The hyoid bone is “U” shaped. It is situated in the anterior midline of the neck between the chin and the thyroid cartilage. At rest it lies at the level of the third cervical vertebra behind and the base of the mandible in front. It is kept suspended in position by muscles and ligaments. The hyoid bone provides attachment to the floor of the mouth and to the tongue above, to the larynx below and to the epiglottis and pharynx behind.

The bone consists of central part called the body and of two pairs of cornua, greater and lesser.

The body: -

It has two surfaces i.e anterior and posterior, two borders i.e upper and lower

The greater cornua: -

These are flattened from above downwards. Each cornu tapers posteriorly, but ends in tubercle. It has 2 borders i.e medial and lateral and 2 surfaces i.e upper and lower.

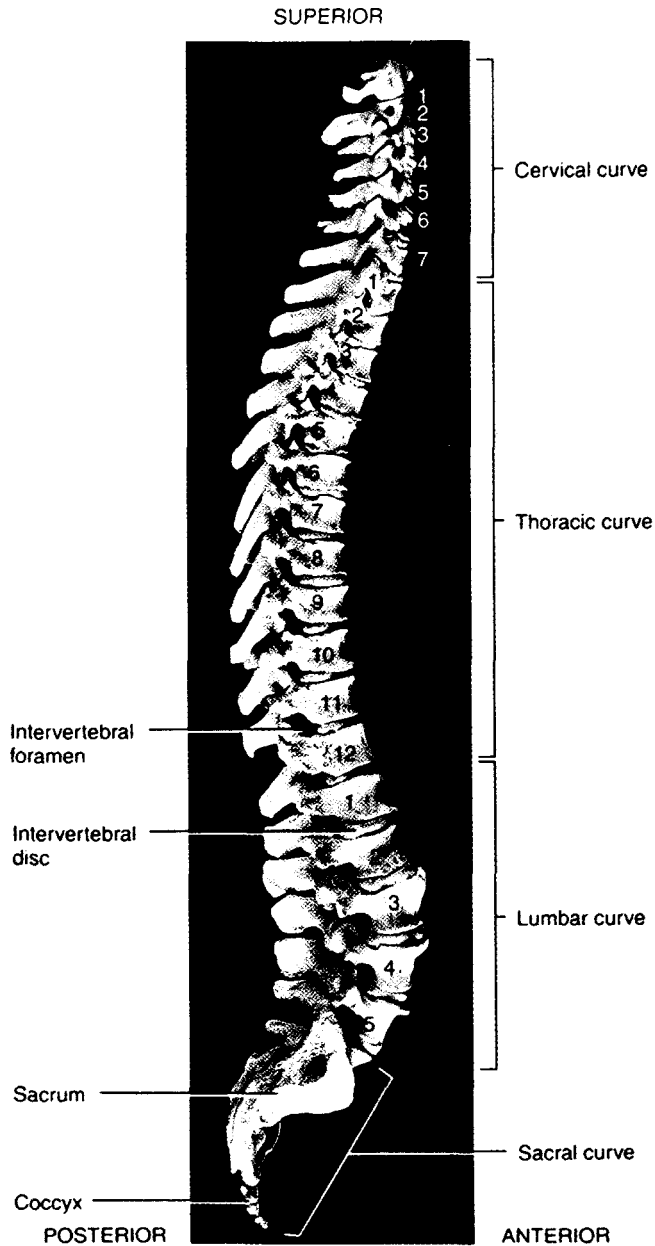
The Lesser Cornua: -

These are small conical pieces of bone, which project upwards from the junction of the body and greater cornua. The lesser cornua are connected to the body by fibrous tissue.

Attachments on the hyoid bone: -

- 1.The anterior surface of the body provides insertion to the geniohyoid and mylohyoid muscles and gives origin to a part of the hyoglossus.
- 2.The upper border of the body provides insertion to the lower fibres of the genioglossi and attachment to the thyroid membrane.
- 3.The lower border of the body provides attachment to the pretracheal fascia.
- 4.The medial border of the greater cornua provides attachment to the thyrohyoid membrane.

Vertebral Column Right lateral view



5. The lateral border of the greater cornua provides insertion to the thyrohyoid muscle anteriorly.

Applied anatomy: -

In a suspected case of murder, fracture of the hyoid bone strongly indicates throttling or strangulation.

RIBS (पर्शुकास्थि)

There are 12 pairs of ribs. A typical rib has following parts

- 1) Anterior end
- 2) Posterior end
- 3) Body (or) shaft

Anterior End

It articulates with its costal cartilage for which it presents a costal depression.

Posterior End

It consists of head, neck and tubercle.

Head

Head has two facets separated by a ridge; lower facets articulate with the body of the same number of upper facet with the body of vertebra above these forms the costo-vertebral joint.

Neck

It has an upper border, which is elevated known as the Crest.

Tubercle

It presents a facet to articulate with the transverse process of the same number of vertebra.

Body (Or) Shaft

It presents superior border inferior border, external and internal surfaces. External surface is convex and smooth. It is twisted in its long axis, there by forming two lines called the angle of the rib.

The angles are 1) Posterior angle
2) Anterior angle

Ribs articulate with the sternum in the anterior side.

The first seven ribs, which are connected through their cartilages to the sternum, are called as true ribs. It is also otherwise known as vertebro sternal ribs. The remaining five are false ribs.

The next eight to tenth ribs are called as False Ribs as they are derived from the seventh intercostal rib.

The eleventh and twelfth are known as Floating Ribs as they are not attached with sternum and remain free at the anterior end.

The first two and last three have special features and are called as atypical ribs. The third to ninth ribs are typical ribs.

Side Determination Of Typical Ribs

- i) The anterior end bears a concave depression. The posterior end bears a head, a neck, and a tubercle.
- 2) The shaft is convex outwards, and is grooved along with the lower part of inner surface so that the lower border is thin and the upper border is rounded.

COASTAL CARTILAGES

The costal cartilages represent the unossified anterior parts of the ribs. They are made up of hyaline cartilage. They contribute materially to the elasticity of the thoracic wall.

The medial ends of the costal cartilages of the first seven ribs are attached directly to the sternum. The 8th, 9th and 10th cartilages articulate with one another and form the costal margin. The cartilages of the 11th and 12th ribs are small. Their ends are free and lie in the muscles of the abdominal wall.

Each cartilage has two surfaces (anterior and posterior), two borders (superior and inferior) and two ends (lateral and medial).

Attachments of costal cartilages

Anterior surface

- 1) This surface of the first costal cartilage articulates with the clavicle and takes part in forming the sternoclavicular joint. It gives attachment to
 - (i) Sternoclavicular disc.
 - (ii) Sternoclavicular ligament.
 - (iii) The subclavius muscle.
- 2) The 2nd to 7th costal cartilages give origin to the pectoralis major.
- 3) The internal oblique muscle is attached to the 7th, 8th and 9th cartilages; and the rectus abdominis to the 5th, 6th and 7th cartilages.

Posterior Surface

- 1) The first cartilage gives origin to the sternothyroid muscle.
- 2) The sternocostalis is inserted to the 2nd to 6th cartilages.
- 3) Diaphragm and transversus abdominis related to 7th to 12th cartilages.

CERVICAL VERTEBRAE

The cervical vertebrae are identified by the presence of foramina transversaria. There are 7 cervical vertebrae out of which the third to sixth are typical while the 1st, 2nd and 7th are typical.

Cervical Vertebrae

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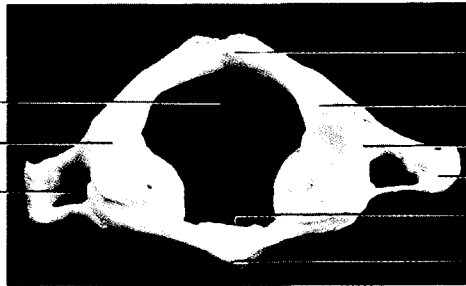
POSTERIOR

Vertebral foramen

Superior articular facet

Transverse foramen

ANTERIOR



Posterior arch

Groove for vertebral artery and first cervical spinal nerve

Lateral mass

Transverse process

Articular surface for dens of axis

Anterior arch

(a) Superior view of the atlas (C1)

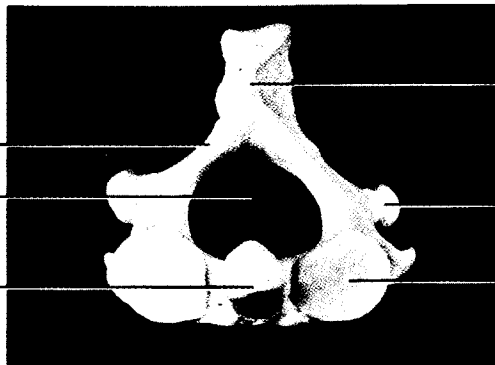
POSTERIOR

Lamina

Vertebral foramen

Dens

ANTERIOR



Spinous process

Transverse process

Superior articular facet

(b) Superior view of the axis (C2)

POSTERIOR

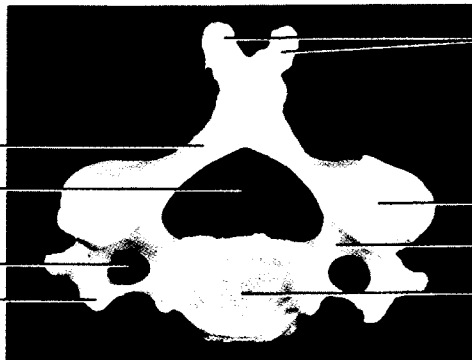
Lamina

Vertebral foramen

Transverse foramen

Transverse process

ANTERIOR



Bifid spinous process

Superior articular facet

Pedicle

Body

(c) Superior view of a typical cervical vertebra

A typical cervical vertebrae consists of the following parts:-

The Body

- i. It is small and broader from side to side than from before backwards.
- ii. Its superior surface is concave transversely with upward projecting lips on each side.
- iii. The inferior surface is saddle shape, being convex from side to side and concave from before backwards.
- iv. The anterior and posterior surfaces resemble those of other vertebrae

Vertebral Foramen

It is larger than the body and triangular in shape because the pedicles are directed backwards and laterally.

Vertebral Arch

1. The pedicles are directed backwards and laterally.
2. The laminae are relatively long and narrow, being thinner above than below.
3. The superior and inferior articular process form articular pillars which project laterally at the junction of the pedicle and the lamina.
4. The transverse processes are pierced by the foramina transversaria.
5. The anterior tubercle of the sixth cervical vertebra is large and is called as carotid tubercle because the common carotid artery can be compressed against it.

Attachments and relations: -

- i. The anterior and posterior longitudinal ligaments are attached to the upper and lower borders of the body in front and behind respectively.
- ii. The upper borders and lower parts of the anterior surfaces of the laminae provide attachment to the ligamenta flava.
- iii. The foramen transversarium transmits the vertebral artery, veins.
- iv. The costotransverse bars are grooved by the anterior primary rami of the corresponding cervical nerves.
- v. The posterior tubercles give origin to the scalenus medius and posterior, the levator scapulae, the splenius cervicis, the longissimus cervicis and the iliocostalis cervicis.
- vi. The spine gives origin to the deep muscles of the back of the neck.

First Cervical Vertebra

It is called the atlas. It is ring shaped and has no body, spine. The atlas has a short anterior arc, a long posterior arc, right and left lateral masses, and transverse processes.

1. Anterior arc is marked by a median anterior tubercle on its anterior aspect.
2. Its posterior surface bears an oval facet, which articulates with the dens.
3. The posterior arc forms about 2/5ths of the ring and is much longer than the anterior arc. Its posterior surface is marked by a median posterior tubercle. The upper surface of the arc is marked by a groove.
4. Each lateral mass shows:-
 - i. Its upper surface bears the superior articular facet. This facet is elongated (forward and medially), concave and is directed upwards and medially.
 - ii. It articulates with the corresponding condyle to form an atlanto-occipital joint.
 - iii. The inferior articular facet marks lower surface.
 - iv. This facet is nearly circular, more or less flat and is directed downwards, medially and backwards.
 - v. It articulates with the corresponding facet on the axis vertebra to form an atlanto axial joint.
 - vi. The medial surface of the lateral mass is marked by a small-roughened tubercle.
5. The transverse process projects laterally from the lateral mass. It is felt between the angle of mandible and mastoid process. It is pierced by the foramen transversarium.

Attachments and relations:-

1. The anterior tubercle provides attachment to the anterior longitudinal ligament and provides insertion to longus colli.
2. In the upper border of the anterior arch give attachment to the anterior atlanto occipital membrane.
3. The lower border of the anterior arch gives attachment to lateral fibres of the anterior longitudinal ligament.
4. The posterior tubercles give attachment to ligamentum nuchae.
5. The upper border of the posterior arch gives attachment to posterior atlanto occipital membrane.
6. The lower border of the posterior arch gives attachment to ligamenta flava.
7. The tubercle on the medial side of the lateral mass gives attachment to the transverse ligament of the atlas.
8. The anterior surface of a lateral mass gives origin to rectus capitis anterior.
9. The transverse process give origin to
 - i) Rectus capitis lateralis
 - ii) Superior oblique
 - iii) Inferior oblique
 - iv) Levator scapulae
 - v) Splenius cervicis
 - vi) Scalenus medius

Second Cervical Vertebra

This is called the axis and identified by the presence of dens (odontoid process).

a) Body and dens

- i. The superior surface of the body is fused with the dens and is encroached upon on each side by the superior articular facet.
- ii. The dens articulate anteriorly with anterior arch of atlas and posteriorly with transverse ligament of the atlas.
- iii. The inferior surface has a prominent anterior margin which projects downwards.
- iv. The anterior surface presents median ridge on each side.

b) Vertebral arch

- i. The superior articular processes conceal the pedicles superiorly.
- ii. The laminae are thick and strong.
- iii. Each superior articular facet occupies the upper surfaces of the body and of the massive pedicle.
- iv. Each inferior articular facet lies posterior to the transverse process.
- v. The transverse process is very small representing the true posterior tubercles only.
- vi. The foremen transversarium is directed upwards and laterally.
- vii. The spine is large, thick, strong and deeply grooved inferiorly.

c) Attachments

- i. The dens provide attachment at its apex to the apical ligament to the alar ligament.
- ii. The anterior surface of the body receives the insertion of the longus colli.
- iii. The posterior surface of the body gives attachment to the posterior longitudinal ligament and membrana tectoria.
- iv. The laminae provide attachment to ligamenta flava .
- v. The inter transverse muscles are attached to the upper and lower surfaces of the process.
- vi. Spine gives attachment to the ligamentum nuchae, semi spinalis cervicis , rectus capitolis posterior major, inferior oblique , spinalis cervicis, interspinalis and multifidus.

Seventh Cervical Vertebra

It is also known as the vertebra prominens because of its long spinous process, the tip of which can be felt through the skin at the lower end of the nuchal forrow.

- i. Its spine is thick, long and nearly horizontal.
- ii. It is not bifid and ends in a tubercle.
- iii. The transverse processes are comparatively large in size.
- iv. The posterior root is larger than the anterior.
- v. The anterior tubercle is absent.
- vi. The foramen transversarium is relatively small, sometimes double or may be entirely absent.

Attachments: -

- i. The tip of the spine provide attachment to the ligamentum nuchae , Trapezius, Rhomboideus minor , Serratus posterior superior, The splenius capitis, the semispinalis thoracis, The spinalis cervicis, The interspinales and the multifidus.
- ii. The foramen transversarium usually transmits only an accessory vertebral vein.
- iii. The posterior tubercle provides attachment to the supra pleural membrane.
- iv. The lower border provides attachment to the levator costarum.
- v. The anterior root of the transverse processes may separate and forms a cervical rib of variable size.

HUMERUS (प्रगण्डास्थि)

It is otherwise known as arm bone, it is the longest and largest bone of the upper limb.

Proximally it articulates with the scapula and distally at the elbow with radius and ulna. It is divided into three parts-

1. Upper end
2. shaft or body
3. lower end

Upper End

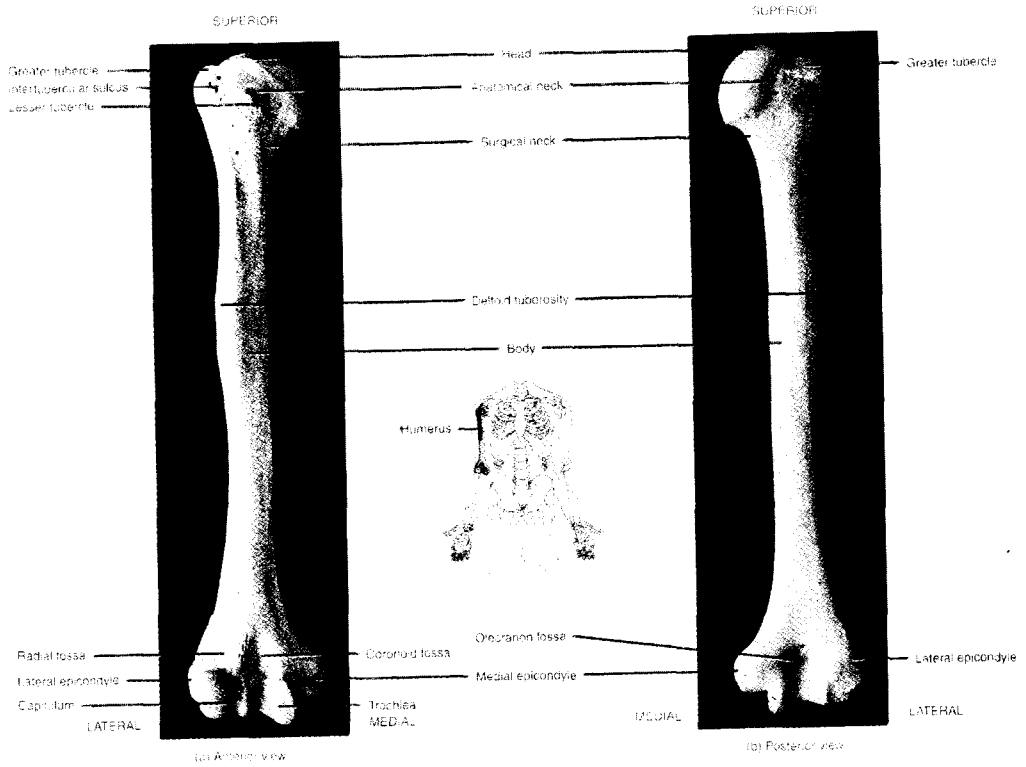
1. The head is directed medially, back wards and upwards. The head of the humerus is articulated with the glenoid cavity of scapula to form the shoulder joint. The head forms one third of a sphere and it is much larger than the glenoid cavity.
2. The line separating the head and rest of the upper end is called the anatomical neck.
3. The lesser tubercle is an elevation of the anterior aspect of the upper end.
4. The greater tubercle is an elevation that forms the lateral part of the upper end. Its posterior aspect is marked by three impressions – upper middle and lower.
5. The inter tubercular sulcus or bicipital groove separates the lesser tubercle and the greater tubercle.
6. The line separating the upper end of the humerus from the shaft is called the surgical neck. It is a constricted portion just distal to the tubercles and is so named because fractures often occur here.

Body (shaft)

The proximal end is cylindrical and it gradually becomes triangular and is flattened and broad at its distal end. It has three borders and three surfaces.

- | | |
|--------------------|--------------------------|
| 1. Anterior border | 1. Anterolateral surface |
| 2. Lateral border | 2. Anteromedial surface |
| 3. Medial border | 3. Posterior surface |

Humerus



Laterally, at the middle portion of the shaft there is a roughened, 'V' shaped area called the deltoid tuberosity. This serves as a point of attachment for deltoid muscle.

Lower End

The lower end of the humerus forms the condyle which is expanded from side to side, and has articular and non – articular parts includes the following:

1. The capitulum is a rounded projection, which is having a rounded knob that articulates with the head of the radius.
2. The trochlea is a pully shaped surface. It articulates with the trochlear notch of the ulna.

The non – articular part includes:

1. Medial epicondyle
2. Lateral epicondyle

These two are rough projections on either side of the distal end to which most muscles of the forearm are attached.

3. Coronoid fossa – it is an anterior depression that receives the coronoid fossa of ulna when the forearm is flexed.
4. Radial fossa – it is a depression present just above the anterior aspect of capitulum. It accommodates the head of the radius when the elbow is flexed.
5. Olecranon fossa – it is just above the posterior aspect of the trochlea. It accommodates the olecranon process of the ulna when the elbow is expanded.

Side Determination:

1. The upper end is rounded to form the head. The lower end is expanded from side to side and flattened before backwards.
2. The head is directed medially and backwards.
3. The lesser tubercle projects from the front of the upper end and is limited laterally by the inter tubercular sulcus (bicipital groove).

Attachments of Humerus:

1. Subscapularis is inserted into lesser tubercle.
2. Supraspinatus is inserted into a greater tubercle.
3. Infraspinatus is inserted into the middle impression on the greater tubercle.
4. The teres minor is inserted into the lower impression on the greater tubercle
5. Pectoralis major is inserted into lateral lip of intertubercular sulcus.
6. The latissimus dorsi is inserted into the floor of the inter tubercular sulcus.
7. The teres major is inserted the medial lip of the inter tubercular sulcus.
8. The deltoid is inserted into the deltoid tuberosity.
9. The coraco brachialis is inserted into the deltoid tuberosity.
10. The brachialis arises from the lower halves of the anteromedial and anterolateral surfaces of shaft.

11. The brachioradialis arises from the upper 2/3rd of the lateral supracondylar ridge.
12. The extensor carpi radialis longus arises from the lower one third of lateral supracondylar ridge.
13. The superficial flexor muscles of the forearm arise by a common origin from the anterior aspect of medial epicondyle.
14. The capsular ligament of the shoulder joint is attached to the anatomical neck except medial side.
15. The capsular ligament of the elbow joint is attached to the end where the radial and coronoid fossa are present anteriorly and the olecranon fossa posteriorly.

Applied anatomy:

1. The common site of fracture is surgical neck, the shaft and the supracondylar region.
 - a. Axillary at the radial groove.
 - b. Radial at the radial groove
 - c. Ulnar behind the medial epicondyle
 That's why it is liable to injury.
3. The head of the humerus commonly dislocates inferiorly.
4. The humerus has a poor blood supply at the junction of its upper and middle thirds. Fracture at this site shows delayed or non-union.

THE RADIUS (बहिःप्रकोष्ठास्थि)

The radius is located on the lateral aspect (thumb side) and it is the lateral bone of the forearm. It is homologous with the tibia of the lower limb. It is a long bone and an example of '*nalakasthi*'. It has three parts.

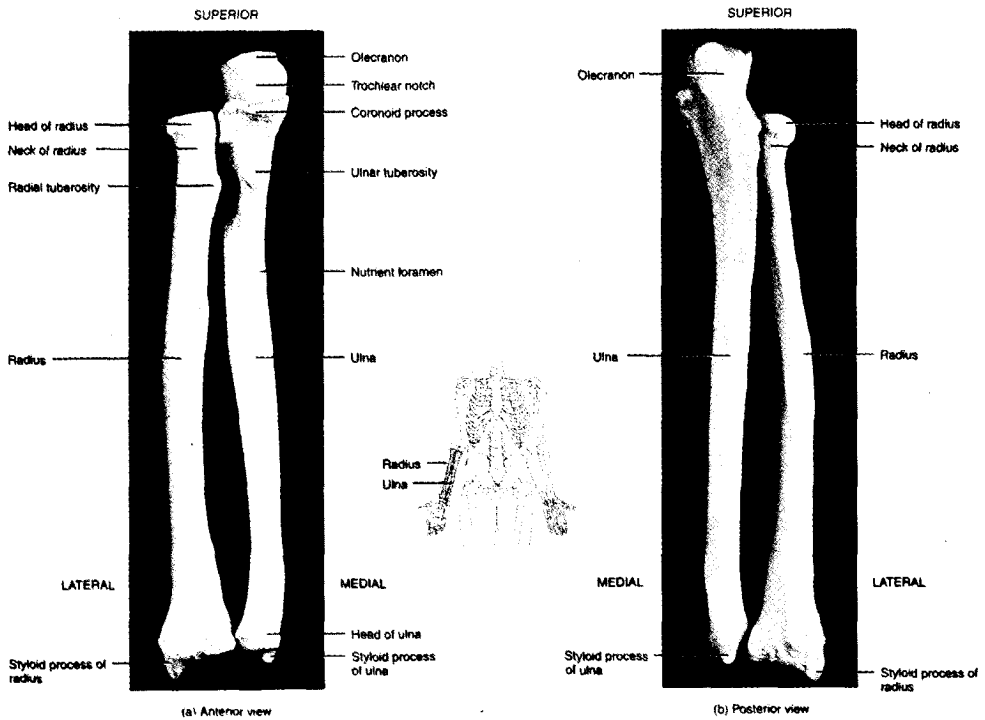
1. An upper end
2. Shaft
3. A lower end

Upper end

It contains three parts.

1. Head-It is disc shaped and is covered with hyaline cartilage. It articulates with the capitulum of humerus and radial notch of the ulna to form another part of the elbow joint.
2. Neck-It is a constricted part present inferiorly to the head. The head and neck are free from capsular attachment and can rotate freely within the socket.

Radius and Ulna



PATELLA (जान्त्रस्थि)

The patella or kneecap is a small, triangular bone located anterior to the knee joint. It is the largest sesamoid bone in the body, developed in the tendon of the Quadriceps femoris. It is situated in front of the lower end of the femur, about 1cm above the knee joint.

Side Determination:

1. The patella is triangular in shape with its apex directed downwards. The apex is non articular posteriorly.
2. The anterior surface is rough and non-articular. The upper three fourth of the posterior surface are smooth and articular.
3. The posterior articular surfaces divide by a vertical ridge into a larger lateral area and a smaller medial area. The bone laid on a table rests on the broad lateral area.

Features:

The patella has an apex, a base, three borders (superior, lateral and medial) and two surfaces (anterior and posterior).

The apex is directed downwards, and lies about 1cm above the knee joint. The pointed inferior end is the apex.

The broad superior end of the patella is called the base.

The anterior surface is convex, rough. It is covered by an expansion from the tendon of the Rectus femoris and is separated from the skin by the pre patellar bursa.

The posterior surface contains two articular facets, one for the medial condyle and the other for the lateral condyle of the femur. The patellar ligament attaches the patella to the tibial tuberosity. The patellofemoral joint, between the posterior surface of the patella and the patellar surface of the femur, is the intermediate component of the tibiofemoral (knee) joint.

Attachments On The Patella:

Superior border – the base provides insertion to the rectus femoris in front and to the vastus intermedius behind.

Lateral border – it provides insertion to the vastus lateralis in its upper one third or half.

Medial border – it provides insertion to the vastus medialis in its upper two thirds or more.

The nonarticular area on the posterior surfaces provides attachment to the ligamentum patellae below, and is related to the infra patellar pad of fat above.

Applied Anatomy

1. Fracture of the patella should be differentiated from a bipartite or a tripartite patella.
2. The patella has a tendency to dislocate outwards because of the outward angulation between the long axes of the thigh and leg.

SCAPULA

Each scapula or shoulder bone is a large, triangular, flat bone situated in the posterior part of the thorax between the levels of the second and seventh ribs. The medial borders of the scapulae (plural) lie about 5cm(2inches) from the vertebral column. It has two surfaces, three borders, three angles and three processes.

The Surfaces:

- 1.Paralysis of serratus anterior causes winging of the scapula. The medial border of the bone The costal surface is concave and is directed medially and forwards. This part of the bone is almost rod like. It acts as a lever for the action of the serratus anterior in overhead abduction of the arm.
- 2.The dorsal surface gives attachment to the spine of the scapula, which divides the surface into a smaller supraspinous fossa and a larger infraspinous fossa. The spinoglenoid notch, situated lateral to the root of the spine, connects the two fossae.

The Borders:

- 1.The superior border is thin and short. Near the root of the coracoid process it presents suprascapular notch.
- 2.The lateral border is thick. At the upper end it presents the infraglenoid tubercle.
- 3.The medial border is thin. It extends from the superior angle to the inferior angle.

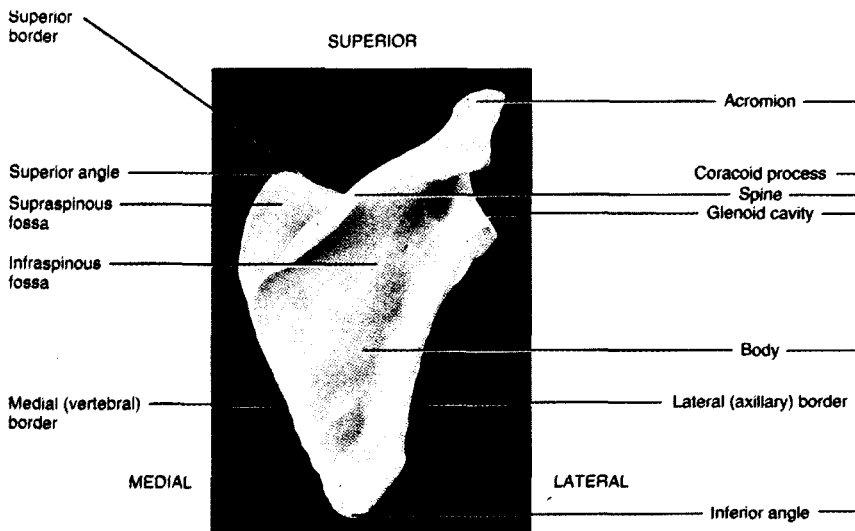
Three Angles:

- 1.The superior angle is covered by the trapezius.
- 2.the inferior angle is covered by latissimus dorsi.
- 3.the lateral (or glenoid) angle is broad and bears the glenoid cavity(or fossa) which is directed forwards, laterally and slightly upwards.

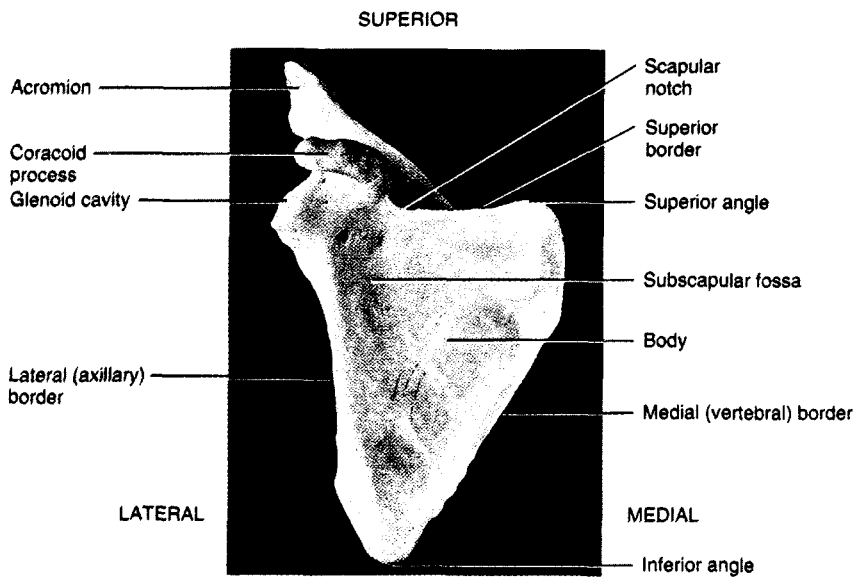
The Processes:

- 1.The spine (or spinous process) is a triangular plate of bone with three borders and 2 surfaces. It divides the dorsal surface of the scapula into the supraspinous and infraspinous fossae.
- 2.the acromion has two borders, medial and lateral; two surfaces superior and inferior, and a facet for the clavicle.
- 3.the coracoid process is directed forwards and slightly laterally.

Scapula



(b) Posterior view



(a) Anterior view

Determination Of The Side:

- 1.The lateral (glenoid) angle is large and bears the glenoid cavity.
- 2.the dorsal surface is convex and is divided by the triangular spine into the supraspinous and infraspinous fossae.
- 3.the lateral thickest border runs from the glenoid cavity above to the inferior angle below.

Attachments Of Scapula:

- 1.Subscapularis arises from the medial 2/3rd of the subscapular fossa.
- 2.Serratus anterior is inserted along the medial border of the costal surface.
- 3.Supraspinatus arises from the medial 2/3rds of the supraspinous fossa.
- 4.Infraspinatus arises from the medial 2/3rds of the infraspinous fossa.
- 5.The deltoid arises from the lower border of the crest of the spine from the lateral border of the acromion.
- 6.Trapezius is inserted into the upper border of the crest of spine into the medial border of the acromion.
- 7.Coracobrachialis arises from the medial part of the tip of the coracoid process.
- 8.Pectoralis minor is inserted into the medial border and superior surface of the coracoid process.
- 9.Rhomboideus minor is inserted into the medial border opposite the root of the spine.
- 10.Rhomboideus major is inserted into the medial border between the root of spine and inferior angle.

Applied anatomy-

- 1.become unduly prominent and the arm cannot be adducted.
2. In a developmental anomaly called scaphoid scapula, the medial border is concave.

CLAVICLE (जतुकास्थि)

It is otherwise known as collarbone. It is long, slender S-shaped bone with two curves, one convex and one concave. It supports the shoulder so that the arm can swing clearly away from the trunk. The clavicle transmits the weight of the limb to the sternum.

The bone has a cylindrical part called the shaft, two ends

1. Medial (sternal) end
2. Lateral (acromial) end.

Shaft:

The shaft is divisible into lateral one third and the medial two thirds. The lateral one third of the shaft is flattened from above downwards. It has two borders- Anterior.

-Posterior.

Anterior border is *concave* forwards.

Posterior border is *convex* backwards.

This part of the bone has two surfaces. The superior surface is subcutaneous. The inferior surface presents an elevation called the conoid tubercle and a ridge called the trapezoid ridge.

The medial two thirds of the shaft is rounded and is said to have four surfaces. The anterior surface is convex forwards. The posterior surface is smooth. The superior surface is rough in its medial part. The inferior surface has a rough oval impression at the middle end. A nutrient foramen lies at the lateral end of the groove.

Lateral End:

It is also known as acromial end. It is flattened from above downwards. It bears a facet that articulates with the acromion process of the scapula to form the acromioclavicular joint.

Medial End:

It is quadrangular and articulates with the clavicular notch of the manubrium sterni to form the sternoclavicular joint. The articular surface extends to the inferior aspect for articulation with the first costal cartilage.

The conoid tubercle on the inferior surface of the lateral end of the bone serves as a point of attachment for the conoid ligament. The costal tuberosity on the inferior surface of the medial end also serves as a point of attachment for the costoclavicular ligament.

Side Determination:

The side to which a clavicle belongs can be determined by the following characters.

1. The lateral end is flat and the medial end is large and quadrilateral.
2. The shaft is slightly curved, so that it is convex forwards in its medial 2/3, and concave forwards in its lateral 1/3.
3. The inferior surface is grooved longitudinally in its middle 1/3.

Attachments Of The Clavicle:

1. Lateral 1/3rd of shaft:

- a. Anterior border gives origin to deltoid.
- b. Posterior border provides insertion to trapezius.
- c. The conoid tubercle gives attachment to the conoid and trapezoid parts of the coraco-clavicular ligament.

2. Medial 2/3rd of shaft:

- d. The anterior surface gives origin to pectoralis major.
- e. The rough superior surface gives origin to the clavicular head of sternocleidomastoid.
- f. The subclavian groove gives insertion to subclavius muscle.
- g. The oval impression on the inferior surface at the medial end gives attachment to the costoclavicular ligament.

3. At the lateral end: - the margin of the articular surface for the acromioclavicular joint gives attachment to the joint capsule.

4. At the medial end: - the margin of articular surface gives attachment to the fibrous capsule and inter clavicular ligament.

Ossification: - the clavicle is the first bone in the body to ossify. It ossifies from the primary centers and one secondary center. The two primary centers appear in the shaft between the fifth and sixth weeks of intrauterine life and fuses about the 45th day. The secondary center for the medial end appears during 15-17 years and fuses with the shaft at the age of 21-22 years.

Sex Determination: -

1. In females the clavicle is shorter, lighter, thinner, smoother and less curved than in males.
2. In females, the lateral end of the clavicle is a little below the medial end, in males the lateral end is either at the same level or slightly higher than the medial end.

Peculiarities Of Clavicle: -

1. It is the only long bone that lies horizontally.
2. It is the first bone to start ossifying.
3. It is the only long bone, which has two primary centers of ossification.

Applied anatomy: -

1. The clavicle is commonly fractured by falling on the outstretched hand (indirect violence). The commonest site of fracture is the junction between two curvatures of the bone, which is the weakest point.

2. The clavicle may be congenitally absent or imperfectly absent (in a disease called cleido-cranial dysostosis).

MANDIBLE (हन्वस्थि)

The mandible (mandere=to chew) or lower jawbone is the largest, strongest facial bone. It is the only skull bone, which moves. (Other than auditory ossicles). It has a horse-shoe shaped body which lodges the teeth, and a pair of rami which project upwards from the posterior ends of the body and provide attachment of muscles. In the lateral view, the mandible consists of a curved, horizontal portion, the body, and two perpendicular portions, the rami. The angle of mandible is the area where each ramus meets the body.

The Body: -

Each half of the body has outer and inner surfaces and upper and lower borders. The outer surface presents the following features.

1. The symphysis menti – It is the line, where right and left halves of the bone meet each other. A faint ridge marks it.
2. The mental foramen is approximately inferior to second pre molar teeth. It is near this foramen that dentist reach the mental nerve when injecting anesthetics.

The inner surface presents the following features.

1. Mylohyoid line is a prominent ridge that runs obliquely down wards and forwards from below the third molar tooth to the median area below the genial tubercles.
2. Below the Mylohyoid line the surface is slightly hollowed out to form the sub mandibular fossa, which lodges the sub mandibular gland.
3. Above the Mylohyoid line there is a sub lingual fossa in which the sub lingual gland lies.

The upper border bears sockets for the teeth.

The lower border of the mandible is also called the base. Near the mid line the base shows an oval depression called the digastric fossa.

The Ramus: -

The ramus is quadrilateral in shape. It has 2 surfaces lateral and medial, 4 borders, upper, lower, anterior and posterior; and the coronoid and condyloid processes. The lateral surface is flat and bears a number of oblique ridges.

The medial surface presents the following;

1. The mandibular foramen lies little above the center of the ramus at the level of occlusal surfaces of the teeth. It leads into the mandibular canal, which descends into the body of the mandible and opens at the mental foramen.
2. The mylo-hyoid groove begins just below the mandibular foramen and runs downwards and forwards to be gradually lost over the sub-mandibular fossa.
3. The upper border of the ramus is thin and is curved downwards forming the mandibular notch.

4. The lower border is the backward continuation of the base of the mandible.
5. The anterior border is thin, while the posterior border is thick.
6. The coronoid process is a flattened triangular upward projection from the antero-superior part of the ramus.
7. The condyloid process is a strong upward projection from the postero-superior part of the ramus. Its upper end is expanded from side to side to form the head. The constriction below the head is the neck. Its anterior surface presents a depression called the pterygoid fovea.

Attachments and relations of the mandible: -

1. The oblique line (on the lateral side of the body) gives origin to the buccinator.
2. Mentalis is originated from the incisive fossa.
3. Mylo-hyoid muscle originated from mylo-hyoid line.
4. The superior constrictor muscle of the pharynx arises from the posterior end of the Mylo-hyoid line.
5. Genioglossus is originated from the lower part of the Geniohyoid.
6. The platysma is inserted into the lower border.
7. The medial pterygoid muscle is inserted on the medial surface of the ramus.
8. The lateral pterygoid muscle is inserted into the pterygoid fovea on the anterior aspect of the neck of the ramus.
9. The temporalis is inserted into the apex and medial surface of the coronoid process.

Age changes in the mandible: -

a) In Infants And Children: -

The two halves of the mandible fuse during the first year of life. At birth the mental foramen opens below the sockets for the two deciduous molar teeth near the lower border. The angle is obtuse because the head is in line with the body. The coronoid process is large and projects upwards above the level of the condyle.

b) In Adults: -

The mental foramen opens midway between the upper and lower borders because the alveolar parts of the bone are equally developed. The angle reduces to about 110 or 120 degrees because the ramus becomes almost vertical.

c) In Old Age: -

Teeth fall out and the alveolar border is absorbed so that the height of the body is markedly reduced. The mental foramen and the mandibular canal are close to the alveolar border. The angle again becomes obtuse.

Relations To Nerves And Vessels: -

- 1.The mental foramen transmits the mental nerve and vessels.
- 2.The mylohyoid nerve and vessels lie in the mylohyoid groove.
- 3.The lingual nerve is related to the medial surface of the ramus.
- 4.The masseteric nerve and vessels pass through the mandibular notch.
- 5.The auriculo-temporal nerve is related to the medial side of the mandible.

Applied Anatomy: -

- 1.The mandible is commonly fractured at the canine socket where it is weak.
- 2.The next common fracture of the mandible occurs at the angle.

HYOID BONE

The hyoid bone is “U” shaped. It is situated in the anterior midline of the neck between the chin and the thyroid cartilage. At rest it lies at the level of the third cervical vertebra behind and the base of the mandible in front. It is kept suspended in position by muscles and ligaments. The hyoid bone provides attachment to the floor of the mouth and to the tongue above, to the larynx below and to the epiglottis and pharynx behind.

The bone consists of central part called the body and of two pairs of cornua, greater and lesser.

The body: -

It has two surfaces i.e anterior and posterior, two borders i.e upper and lower

The greater cornua: -

These are flattened from above downwards. Each cornu tapers posteriorly, but ends in tubercle. It has 2 borders i.e medial and lateral and 2 surfaces i.e upper and lower.

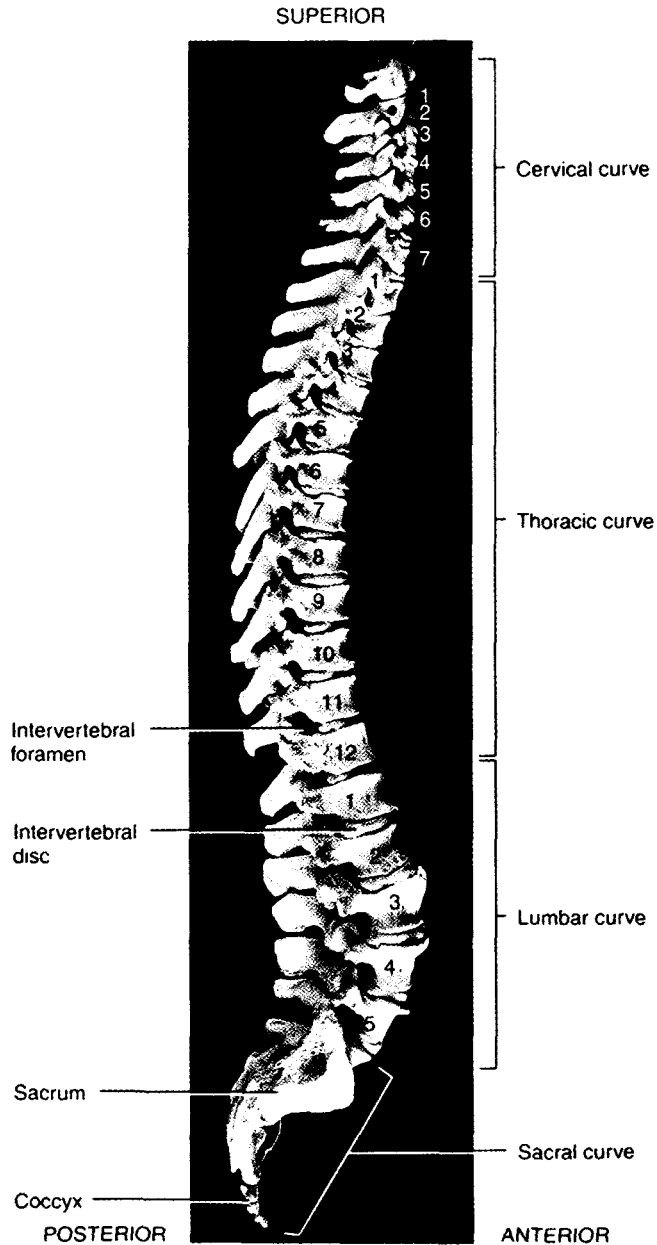
The Lesser Cornua: -

These are small conical pieces of bone, which project upwards from the junction of the body and greater cornua. The lesser cornua are connected to the body by fibrous tissue.

Attachments on the hyoid bone: -

- 1.The anterior surface of the body provides insertion to the geniohyoid and mylohyoid muscles and gives origin to a part of the hyoglossus.
- 2.The upper border of the body provides insertion to the lower fibres of the genioglossi and attachment to the thyroid membrane.
- 3.The lower border of the body provides attachment to the pretracheal fascia.
- 4.The medial border of the greater cornua provides attachment to the thyrohyoid membrane.

Vertebral Column Right lateral view



5. The lateral border of the greater cornua provides insertion to the thyrohyoid muscle anteriorly.

Applied anatomy: -

In a suspected case of murder, fracture of the hyoid bone strongly indicates throttling or strangulation.

RIBS (पर्शुकास्थि)

There are 12 pairs of ribs. A typical rib has following parts

- 1) Anterior end
- 2) Posterior end
- 3) Body (or) shaft

Anterior End

It articulates with its costal cartilage for which it presents a costal depression.

Posterior End

It consists of head, neck and tubercle.

Head

Head has two facets separated by a ridge; lower facets articulate with the body of the same number of upper facet with the body of vertebra above these forms the costo-vertebral joint.

Neck

It has an upper border, which is elevated known as the Crest.

Tubercle

It presents a facet to articulate with the transverse process of the same number of vertebra.

Body (Or) Shaft

It presents superior border inferior border, external and internal surfaces. External surface is convex and smooth. It is twisted in its long axis, there by forming two lines called the angle of the rib.

The angles are 1) Posterior angle

- 2) Anterior angle

Ribs articulate with the sternum in the anterior side.

The first seven ribs, which are connected through their cartilages to the sternum, are called as true ribs. It is also otherwise known as vertebro sternal ribs. The remaining five are false ribs.

The next eight to tenth ribs are called as False Ribs as they are derived from the seventh intercostal rib.

The eleventh and twelfth are known as Floating Ribs as they are not attached with sternum and remain free at the anterior end.

The first two and last three have special features and are called as atypical ribs. The third to ninth ribs are typical ribs.

Side Determination Of Typical Ribs

- 1) The anterior end bears a concave depression. The posterior end bears a head, a neck, and a tubercle.
- 2) The shaft is convex outwards, and is grooved along with the lower part of inner surface so that the lower border is thin and the upper border is rounded.

COASTAL CARTILAGES

The costal cartilages represent the unossified anterior parts of the ribs. They are made up of hyaline cartilage. They contribute materially to the elasticity of the thoracic wall.

The medial ends of the costal cartilages of the first seven ribs are attached directly to the sternum. The 8th, 9th and 10th cartilages articulate with one another and form the costal margin. The cartilages of the 11th and 12th ribs are small. Their ends are free and lie in the muscles of the abdominal wall.

Each cartilage has two surfaces (anterior and posterior), two borders (superior and inferior) and two ends (lateral and medial).

Attachments of costal cartilages

Anterior surface

- 1) This surface of the first costal cartilage articulates with the clavicle and takes part in forming the sternoclavicular joint. It gives attachment to
 - (i) Sternoclavicular disc,
 - (ii) Sternoclavicular ligament.
 - (iii) The subclavius muscle.
- 2) The 2nd to 7th costal cartilages give origin to the pectoralis major.
- 3) The internal oblique muscle is attached to the 7th, 8th and 9th cartilages; and the rectus abdominis to the 5th, 6th and 7th cartilages.

Posterior Surface

- 1) The first cartilage gives origin to the sternothyroid muscle.
- 2) The sternocostalis is inserted to the 2nd to 6th cartilages.
- 3) Diaphragm and transversus abdominis related to 7th to 12th cartilages.

CERVICAL VERTEBRAE

The cervical vertebrae are identified by the presence of foramina transversaria. There are 7 cervical vertebrae out of which the third to sixth are typical while the 1st, 2nd and 7th are typical.

Cervical Vertebrae

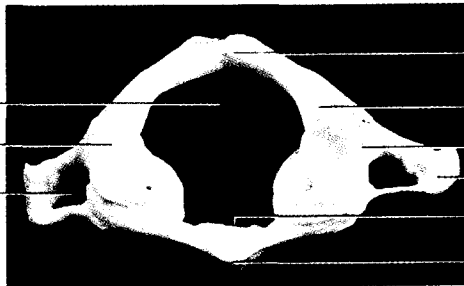
206 POSTERIOR

Vertebral foramen

Superior articular facet

Transverse foramen

ANTERIOR



Posterior arch

Groove for vertebral artery and first cervical spinal nerve

Lateral mass

Transverse process

Articular surface for dens of axis

Anterior arch

(a) Superior view of the atlas (C1)

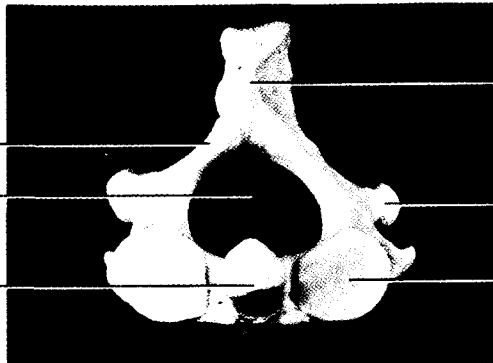
POSTERIOR

Lamina

Vertebral foramen

Dens

ANTERIOR



Spinous process

Transverse process

Superior articular facet

(b) Superior view of the axis (C2)

POSTERIOR

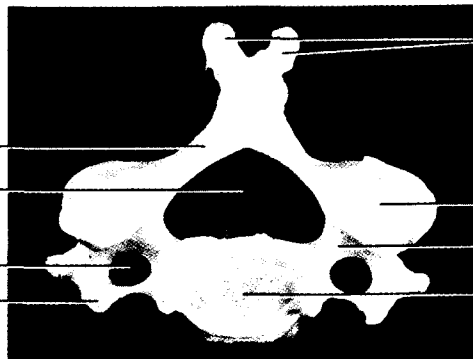
Lamina

Vertebral foramen

Transverse foramen

Transverse process

ANTERIOR



Bifid spinous process

Superior articular facet

Pedicle

Body

(c) Superior view of a typical cervical vertebra

A typical cervical vertebrae consists of the following parts:-

The Body

- i. It is small and broader from side to side than from before backwards.
- ii. Its superior surface is concave transversely with upward projecting lips on each side.
- iii. The inferior surface is saddle shape, being convex from side to side and concave from before backwards.
- iv. The anterior and posterior surfaces resemble those of other vertebrae

Vertebral Foramen

It is larger than the body and triangular in shape because the pedicles are directed backwards and laterally.

Vertebral Arch

1. The pedicles are directed backwards and laterally.
2. The laminae are relatively long and narrow, being thinner above than below.
3. The superior and inferior articular process form articular pillars which project laterally at the junction of the pedicle and the lamina.
4. The transverse processes are pierced by the foramina transversaria.
5. The anterior tubercle of the sixth cervical vertebra is large and is called as carotid tubercle because the common carotid artery can be compressed against it.

Attachments and relations: -

- i. The anterior and posterior longitudinal ligaments are attached to the upper and lower borders of the body in front and behind respectively.
- ii. The upper borders and lower parts of the anterior surfaces of the laminae provide attachment to the ligamenta flava.
- iii. The foramen transversarium transmits the vertebral artery, veins.
- iv. The costotransverse bars are grooved by the anterior primary rami of the corresponding cervical nerves.
- v. The posterior tubercles give origin to the scalenus medius and posterior, the levator scapulae, the splenius cervicis, the longissimus cervicis and the iliocostalis cervicis.
- vi. The spine gives origin to the deep muscles of the back of the neck.

First Cervical Vertebra

It is called the atlas. It is ring shaped and has no body, spine. The atlas has a short anterior arc, a long posterior arc, right and left lateral masses, and transverse processes.

1. Anterior arc is marked by a median anterior tubercle on its anterior aspect.
2. Its posterior surface bears an oval facet, which articulates with the dens.
3. The posterior arc forms about $\frac{2}{5}$ ths of the ring and is much longer than the anterior arc. Its posterior surface is marked by a median posterior tubercle. The upper surface of the arc is marked by a groove.
4. Each lateral mass shows:-
 - i. Its upper surface bears the superior articular facet. This facet is elongated (forward and medially), concave and is directed upwards and medially.
 - ii. It articulates with the corresponding condyle to form an atlanto-occipital joint.
 - iii. The inferior articular facet marks lower surface.
 - iv. This facet is nearly circular, more or less flat and is directed downwards, medially and backwards.
 - v. It articulates with the corresponding facet on the axis vertebra to form an atlanto axial joint.
 - vi. The medial surface of the lateral mass is marked by a small-roughened tubercle.
5. The transverse process projects laterally from the lateral mass. It is felt between the angle of mandible and mastoid process. It is pierced by the foramen transversarium.

Attachments and relations:-

1. The anterior tubercle provides attachment to the anterior longitudinal ligament and provides insertion to longus colli.
2. In the upper border of the anterior arch give attachment to the anterior atlanto occipital membrane.
3. The lower border of the anterior arch gives attachment to lateral fibres of the anterior longitudinal ligament.
4. The posterior tubercles give attachment to ligamentum nuchae.
5. The upper border of the posterior arch gives attachment to posterior atlanto occipital membrane.
6. The lower border of the posterior arch gives attachment to ligamenta flava.
7. The tubercle on the medial side of the lateral mass gives attachment to the transverse ligament of the atlas.
8. The anterior surface of a lateral mass gives origin to rectus capitis anterior.
9. The transverse process give origin to
 - i) Rectus capitis lateralis
 - ii) Superior oblique
 - iii) Inferior oblique
 - iv) Levator scapulae
 - v) Splenius cervicis
 - vi) Scalenus medius

Second Cervical Vertebra

This is called the axis and identified by the presence of dens (odontoid process).

a) Body and dens

- i. The superior surface of the body is fused with the dens and is encroached upon on each side by the superior articular facet.
- ii. The dens articulate anteriorly with anterior arch of atlas and posteriorly with transverse ligament of the atlas.
- iii. The inferior surface has a prominent anterior margin which projects downwards.
- iv. The anterior surface presents median ridge on each side.

b) Vertebral arch

- i. The superior articular processes conceal the pedicles superiorly.
- ii. The laminae are thick and strong.
- iii. Each superior articular facet occupies the upper surfaces of the body and of the massive pedicle.
- iv. Each inferior articular facet lies posterior to the transverse process.
- v. The transverse process is very small representing the true posterior tubercles only.
- vi. The foremen transversarium is directed upwards and laterally.
- vii. The spine is large, thick, strong and deeply grooved inferiorly.

c) Attachments

- i. The dens provide attachment at its apex to the apical ligament to the alar ligament.
- ii. The anterior surface of the body receives the insertion of the longus colli.
- iii. The posterior surface of the body gives attachment to the posterior longitudinal ligament and membrana tectoria.
- iv. The laminae provide attachment to ligamenta flava .
- v. The inter transverse muscles are attached to the upper and lower surfaces of the process.
- vi. Spine gives attachment to the ligamentum nuchae, semi spinalis cervicis , rectus capitolis posterior major, inferior oblique , spinalis cervicis, interspinalis and multifidus.

Seventh Cervical Vertebra

It is also known as the vertebra prominens because of its long spinous process, the tip of which can be felt through the skin at the lower end of the nuchal forrow.

- i. Its spine is thick, long and nearly horizontal.
- ii. It is not bifid and ends in a tubercle.
- iii. The transverse processes are comparatively large in size.
- iv. The posterior root is larger than the anterior.
- v. The anterior tubercle is absent.
- vi. The foramen transversarium is relatively small, sometimes double or may be entirely absent.

Attachments: -

- i. The tip of the spine provide attachment to the ligamentum nuchae , Trapezius, Rhomboideus minor , Serratus posterior superior, The splenius capitis, the semispinalis thoracis, The spinalis cervicis, The interspinales and the multifidus.
- ii. The foramen transversarium usually transmits only an accessory vertebral vein.
- iii. The posterior tubercle provides attachment to the supra pleural membrane.
- iv. The lower border provides attachment to the levator costarum.
- v. The anterior root of the transverse processes may separate and forms a cervical rib of variable size.

HUMERUS (प्रगण्डास्थि)

It is otherwise known as arm bone, it is the longest and largest bone of the upper limb.

Proximally it articulates with the scapula and distally at the elbow with radius and ulna. It is divided into three parts-

1. Upper end
2. shaft or body
3. lower end

Upper End

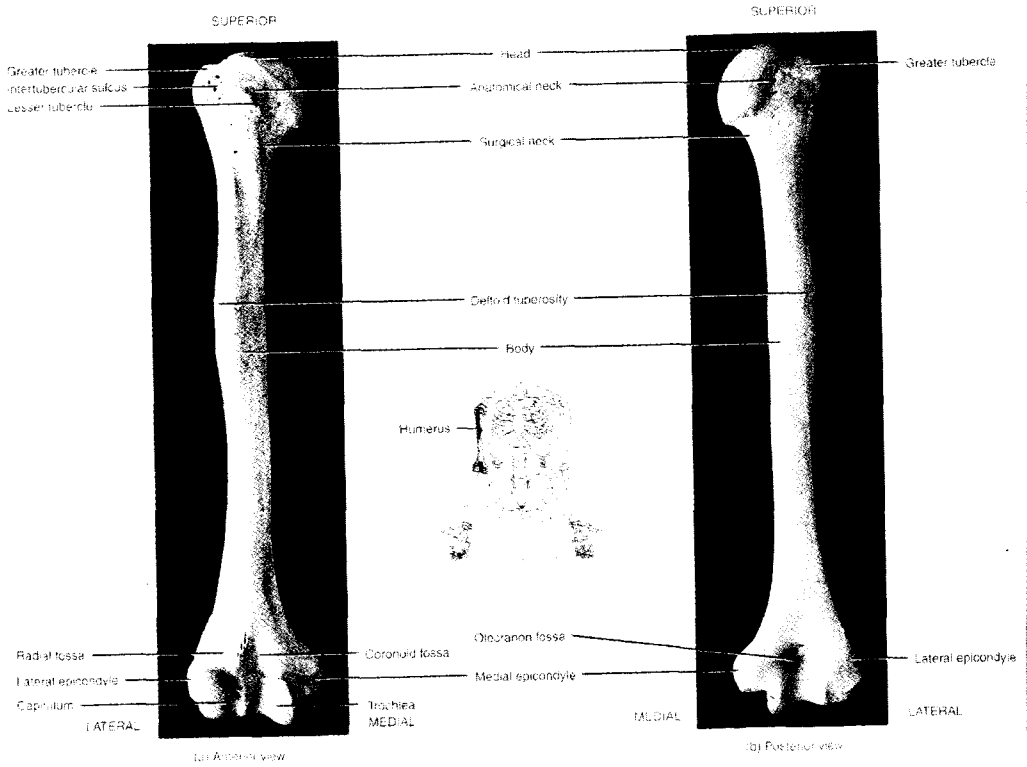
1. The head is directed medially, back wards and upwards. The head of the humerus is articulated with the glenoid cavity of scapula to form the shoulder joint. The head forms one third of a sphere and it is much larger than the glenoid cavity.
2. The line separating the head and rest of the upper end is called the anatomical neck.
3. The lesser tubercle is an elevation of the anterior aspect of the upper end.
4. The greater tubercle is an elevation that forms the lateral part of the upper end. Its posterior aspect is marked by three impressions – upper middle and lower.
5. The inter tubercular sulcus or bicipital groove separates the lesser tubercle and the greater tubercle.
6. The line separating the upper end of the humerus from the shaft is called the surgical neck. It is a constricted portion just distal to the tubercles and is so named because fractures often occur here.

Body (shaft)

The proximal end is cylindrical and it gradually becomes triangular and is flattened and broad at its distal end. It has three borders and three surfaces.

- | | |
|--------------------|--------------------------|
| 1. Anterior border | 1. Anterolateral surface |
| 2. Lateral border | 2. Anteromedial surface |
| 3. Medial border | 3. Posterior surface |

Humerus



Laterally, at the middle portion of the shaft there is a roughened, 'V' shaped area called the deltoid tuberosity. This serves as a point of attachment for deltoid muscle.

Lower End

The lower end of the humerus forms the condyle which is expanded from side to side, and has articular and non – articular parts includes the following:

1. The capitulum is a rounded projection, which is having a rounded knob that articulates with the head of the radius.
2. The trochlea is a pulley shaped surface. It articulates with the trochlear notch of the ulna.

The non – articular part includes:

1. Medial epicondyle
2. Lateral epicondyle

These two are rough projections on either side of the distal end to which most muscles of the forearm are attached.

3. Coronoid fossa – it is an anterior depression that receives the coronoid fossa of ulna when the forearm is flexed.
4. Radial fossa – it is a depression present just above the anterior aspect of capitulum. It accommodates the head of the radius when the elbow is flexed.
5. Olecranon fossa – it is just above the posterior aspect of the trochlea. It accommodates the olecranon process of the ulna when the elbow is extended.

Side Determination:

1. The upper end is rounded to form the head. The lower end is expanded from side to side and flattened before backwards.
2. The head is directed medially and backwards.
3. The lesser tubercle projects from the front of the upper end and is limited laterally by the inter tubercular sulcus (bicipital groove).

Attachments of Humerus:

1. Subscapularis is inserted into lesser tubercle.
2. Supraspinatus is inserted into a greater tubercle.
3. Infraspinatus is inserted into the middle impression on the greater tubercle.
4. The teres minor is inserted into the lower impression on the greater tubercle
5. Pectoralis major is inserted into lateral lip of intertubercular sulcus.
6. The latissimus dorsi is inserted into the floor of the inter tubercular sulcus.
7. The teres major is inserted the medial lip of the inter tubercular sulcus.
8. The deltoid is inserted into the deltoid tuberosity.
9. The coraco brachialis is inserted into the deltoid tuberosity.
10. The brachialis arises from the lower halves of the anteromedial and anterolateral surfaces of shaft.

11. The brachioradialis arises from the upper 2/3rd of the lateral supracondylar ridge.
12. The extensor carpi radialis longus arises from the lower one third of lateral supracondylar ridge.
13. The superficial flexor muscles of the forearm arise by a common origin from the anterior aspect of medial epicondyle.
14. The capsular ligament of the shoulder joint is attached to the anatomical neck except medial side.
15. The capsular ligament of the elbow joint is attached to the end where the radial and coronoid fossa are present anteriorly and the olecranon fossa posteriorly.

Applied anatomy:

1. The common site of fracture is surgical neck, the shaft and the supracondylar region.
2. Three nerves are directly related to the humerus
 - a. Axillary at the radial groove.
 - b. Radial at the radial groove
 - c. Ulnar behind the medial epicondyle
 That's why it is liable to injury.
3. The head of the humerus commonly dislocates inferiorly.
4. The humerus has a poor blood supply at the junction of its upper and middle thirds. Fracture at this site shows delayed or non-union.

THE RADIUS (बहिःप्रकोष्ठास्थि)

The radius is located on the lateral aspect (thumb side) and it is the lateral bone of the forearm. It is homologous with the tibia of the lower limb. It is a long bone and an example of '*nalakasthi*'. It has three parts.

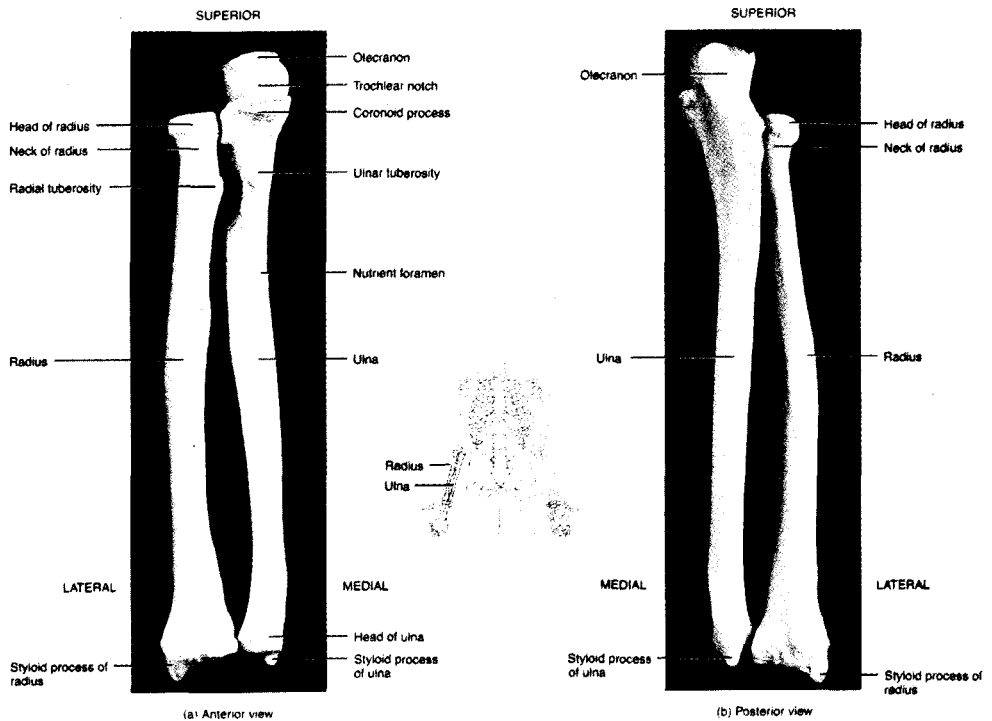
1. An upper end
2. Shaft
3. A lower end

Upper end

It contains three parts.

1. Head-It is disc shaped and is covered with hyaline cartilage. It articulates with the capitulum of humerus and radial notch of the ulna to form another part of the elbow joint.
2. Neck-It is a constricted part present inferiorly to the head. The head and neck are free from capsular attachment and can rotate freely within the socket.

Radius and Ulna



3. The tuberosity lies just below the medial part of the neck. its anterior part is smooth and posterior part is rough.

The shaft (body)-It has three borders and three surfaces.

1. Anterior border-it extends from the anterior margin of the radial tuberosity to the styloid process.

2. Posterior border

3. Medial (or interosseus) border-It extends from the radial tuberosity to the posterior margin of the ulnar notch.

Three surfaces: -

1. Anterior surface-It lies between the anterior and interosseus border.

2. The posterior surface lies between the posterior and interosseus borders.

3. The lateral surface lies between the anterior and posterior borders.

The lower end:

It is the widest part of the bone. It has five surfaces.

1. Anterior surface

2. Posterior surface

3. Medial surface, which is occupied by the ulnar notch for the head of the ulna.

4. Lateral surface is prolonged downwards to form the styloid process.

5. The inferior surface bears a triangular area for the scaphoid bone, and a medial quadrangular area for the lunate bone.

The surfaces take part in the forming the wrist joint.

Attachment Of The Radius:

1. Biceps brachii is inserted into the rough posterior part of the radial tuberosity.

2. The supinator is inserted into the upper part of lateral surface.

3. The pronator teres is inserted into the middle of the lateral surface.

4. The brachioradialis is inserted into the lowest part of the lateral surface just above the styloid process.

5. The radial head of flexor digitorum superficialis takes origin from the anterior oblique line.

6. Flexor pollicis longus takes origin from the upper 2/3rd of the anterior surface.

7. The abductor pollicis longus and extensor pollicis brevis arise from the posterior surface.

8. The articular disc of the inferior radioulnar joint is attached to the anterior and posterior margins of inferior articular surface.

Clinical Features:

Colles's fracture – The radius commonly fractures about 2cm above its lower end (Colles's fracture). This fracture is caused by a fall on the outstretched hand.

THE ULNA (अन्तःप्रकोष्ठास्थि)

The ulna is located on the medial aspect (little finger side) of the forearm. It is longer than the radius. It is homologous with fibula of the lower limb. It has

1. Upper end
2. Lower end
3. A shaft.

Upper End

It has the following parts.

1. Olecranon and coronoid processes.
2. Trochlear and radial notches.

The olecranon process-, which projects upwards from the shaft. It has superior, anterior, posterior, medial and lateral surfaces. The anterior surface is articular: it forms the upper part of the trochlear notch. The posterior surface forms a triangular subcutaneous area, which is separated from the skin by bursa.

The coronoid process-, which projects forwards from the shaft, just below the olecranon and has four surfaces, superior, anterior, medial and lateral. The radial notch for the head of the radius marks the upper part of its lateral surface. The annular ligament is attached to the anterior and posterior margins of the notch. The lower part of the lateral surface forms a depressed area (to accommodate the radial tuberosity). A ridge called the supinator crest limits it behind.

The trochlear notch- it forms an articular surface that articulates with the trochlea of the humerus to form the elbow joint.

The radial notch- it articulates with the head of the radius to form the superior radioulnar joint.

The shaft- the shaft has three borders and three surfaces.

1. the interosseous border
2. the anterior border
3. the posterior border

Three surfaces-1. The anterior surface
2. The medial surface
3. The posterior surface

The lower end-

It is made up of the head and the styloid process. The head articulates with the ulnar notch of the radius to form the inferior radioulnar joint. It is separated from the wrist joint by the articular disc.

The styloid process projects downwards from the posteromedial side of the lower end of the ulna. Posteriorly, between the head and the styloid process there is a groove for the tendon of the extensor carpi ulnaris.

Side determination-

1. the upper end is hook-like, with its concavity directed forwards.
2. the lateral border of the shaft is sharp and crest-like.

Attachment of the ulna-

Muscles-

1. The triceps is inserted into the posterior part of the superior surface of the olecranon.
2. The brachialis is inserted into the anterior surface of the coronoid process including the tuberosity of the ulna.
3. The supinator arises from the supinator crest and from the triangular area in front of the crest.
4. Flexor digitorum superficialis arises from a tubercle at the upper end of coronoid process.
5. The ulnar head of the pronator teres arises from the medial margin of the coronoid process.
6. The flexor digitorum profundus arises from the upper 3/4th of the anterior surface.
7. The flexor carpi ulnaris (ulnar head) arises from the oblique ridge on the lower part of the anterior surface.
8. The pronator quadratus takes origin from the oblique ridge on the lower part of the anterior surface.
9. The extensor carpi ulnaris arises from the posterior border.
10. The anconeus is inserted into the lateral aspect of the olecranon process and upper 1/4th of the posterior surface.
11. The lateral part of the posterior surface gives origin to the abductor pollicis longus, the extensor pollicis longus and extensor indicis.

Applied anatomy

1. Dislocation of the elbow is produced by a fall on the out stretched hand with the elbow slightly flexed.
2. Fracture of the olecranon is common and is caused by a fall on the point of the elbow. Fracture of the coronoid process is uncommon and usually accompanies dislocation of the elbow.
3. Madelung's deformity is dorsal subluxation (displacement) of the lower end of the radius.

STERNUM (उरःफलक)

The sternum or the breastbone is a flat, narrow bone measuring about 15 cm. (6 inches) in length. This bone is forming the anterior medial part of the thoracic skeleton. In shape it resembles a short sword. It is larger in males than in females. The sternum consists of three parts.

1. Manubrium (corresponding to handle), superior portion
2. Body (resembling the blade), middle portion
3. Xiphoid process (forming the point of the sword).

The manubrium:

It is quadrilateral in shape. It is the thickest and strongest part of the sternum. It has two surfaces (anterior and posterior) and four borders (superior, inferior, and two lateral.).

Anterior surface is convex from side to side, where the posterior surface is concave. The superior border is thick, rounded and concave. It has a depression and it is marked by the supra sternal notch (jugular notch or inter clavicular notch). It is a point of articulation between the sternum and medial end of the clavicle to form the sterno clavicular joint.

The inferior border forms the secondary cartilageneous joint with the body of the sternum. The lateral border forms the primary cartilageneous joint with the first costal cartilage, and presents a demi-facet for articulation (synovial) with the upper part of the second costal cartilage.

Attachments on the manubrium

1. The anterior surface gives to (a) pectoralis major (b) sternal head of sterno cleo mastoid
 2. The posterior surface gives origin to (a) sternohyoid (b) sternothyroid muscles.
- The lower half of the surface is related to the arch of the aorta. The upper half is related to the left brachiocephalic vein, brachiocephalic artery, the left common carotid artery and the left subclavian artery.

The body

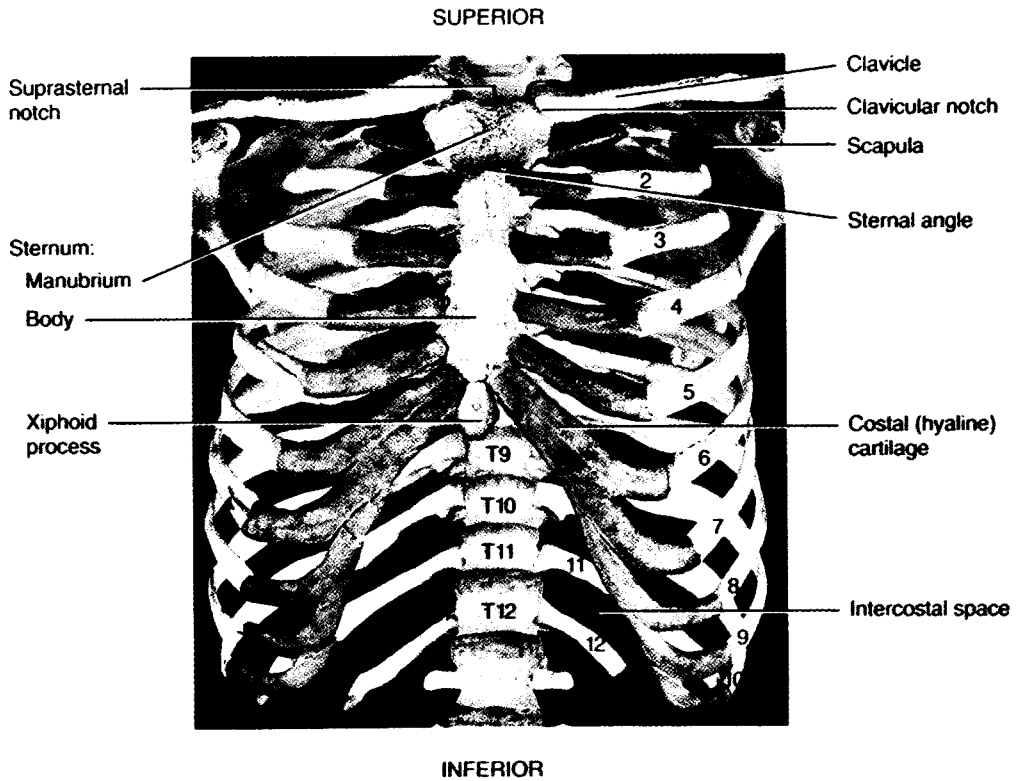
The body is longer, narrower and thinner than the manubrium. It is widest close to its lower end opposite the articulation with the 5th costal cartilage. It has 2 surfaces (anterior and posterior), 2 borders (lateral) and 2 ends (upper and lower).

The body of sternum articulates directly or indirectly with the costal cartilages of the second through tenth ribs.

Attachments on the border of the sternum

1. The anterior surface gives origin to the pectoralis major muscle.

Thoracic Cage



2. The lower part of the posterior surface gives origin to the sterno-costalis muscle.
3. Between the facets for articulation with the costal cartilages, the lateral borders provide attachment to the external intercostals muscles and to the internal intercostals muscles.

The xiphoid process

This is the smallest part of the sternum. It is at first cartilaginous, but in the adult it becomes ossified near its upper end. It varies greatly in shape and may be bifid or perforated. It lies in the floor of the epigastric fossa.

Attachments on the xiphoid process

1. The anterior surface provides insertion to the medial fibres of the rectus abdominis, and to the aponeurosis of the external and internal oblique muscles of the abdomen.
2. The posterior surface gives origin to the diaphragm. It is related to the anterior surface of the liver.
3. The lateral borders of the xiphoid process give attachment to the aponeuroses of the internal oblique and transverse abdominis.
4. The lower end attached to the linea alba.

Applied Anatomy-

1. Bone marrow for examination is usually obtained by sternal (manubrial puncture).
2. In the anomalously funnel chest the sternum is depressed.
3. In another anomaly called pigeon chest there is forward projection of the sternum (like the keel of a boat) and flattening of the chest wall on either side.

THE CARPAL BONES (कुचास्थि)

The carpus is made up of 8 carpal bones, which are arranged in two rows.

1. The proximal row contains (from lateral to medial side)
 - a. Scaphoid
 - b. Lunate
 - c. Triquetrum
 - d. Pisiform
2. The distal row contains (from lateral to medial side)
 - a. Trapezium
 - b. Trapezoid
 - c. Capitate
 - d. Hamate

Identification

1. The scaphoid is boat shaped and has a tubercle on its lateral side.
2. The lunate, is half-moon-shaped or crescentic

- 3.The triquetralis pyramidal in shape, and has an isolated oval facet on the distal part of the palmar surface.
- 4.The pisiform is a pea-shaped and has only one oval facet on the distal proximal part of its dorsal surface.
- 5.The trapezium is quadrangular in shape, and has a crest and a groove anteriorly,it has a concavo-convex articular surface distally.
- 6The trapezoid resembles the shoe of a baby.
- 7.The capitate, is the largest carpal bone, with a rounded head.
- 8.The hamate is wedge –shaped with a hook near its base.

SKULL

The skull contains 22 bones, which rests on the superior end of the vertebral column and it is composed of two sets of bones: cranial bones and facial bones.

Cranial bones-8

Facial bones-14

The cranial bones enclose and protect brain.

The 8 cranial bones are

- (1)-Frontal bone
- (2-3)-Parietal bones (2)
- (4-5)-Temporal bones (2)
- (6)-Occipital bone (1)
- (7)-Sphenoid bone (1)
- (8)-Ethmoid bone (1)

There are 14 facial bones:

- (1-2)-Nasal bones (2)
- (3-4)-Maxillae (2)
- (5-6)-Zygomatic bones (2)
- (7)-Mandible (1)
- (8-9)-Lacrimal bones (2)
- (10-11)-Palatine bones (2)
- (12-13)-Inferior nasal conchae (2)
- (14)-Vomer (1)

FONTANELS

The skeleton of a newly formed embryo consists of cartilage or fibrous membrane structures shaped like bones. Gradually the cartilage or fibrous membrane is replaced by bone, a process called Ossification. At birth, membrane-filled spaces called fontanels (=little fountains) are found between cranial bones.

Skull, right lateral view



These “soft spots” are areas of dense connective tissue where intramembranous ossification will eventually replace the membrane-filled spaces with bones.

They

- 1.Enable the fetal skull to compress as it passes through the birth canal.
- 2.Permit rapid growth of the brain during infancy.
- 3.Facilitate determination of the degree of brain development by their state of closure.
- 4.Aid in determining the position of the fetal head prior to birth.

Although an infant may have many fontanelles at birth, the form and location of six are fairly constant.

The anterior (frontal) fontanel: - It is located between the angles of two parietal bones and the two segments of the frontal bone. This fontanel is roughly diamond shaped and it is the largest of the six fontanelles. It usually closes 18 to 24 months after birth.

The posterior (occipital) fontanel:- It is situated between the two parietal bones and the occipital bone. This diamond shaped fontanel is considerably smaller than the anterior fontanel. It generally closes about 2 months after birth.

The anterolateral (sphenoidal) fontanelles: - These fontanelles are paired, quite small and irregular in shape. One is located on each side of the skull at the junction of the frontal, parietal, temporal and sphenoid bones. They normally close about three months after birth.

The posterolateral (mastoid) fontanelles:- These are also paired and irregular shape on each side of the skull at the junction of the parietal, occipital and temporal bones. They begin to close 1 or 2 months after birth.

CRANIAL BONES (कपालास्थि)

Frontal bone: पुरःकपाल

The frontal bone forms the forehead (the anterior part of the cranium), the roof of the orbits (eye sockets) and most of the anterior part of the floor. Soon after the birth, the frontal suture unites the left and the right sides of the frontal bones, which usually disappears at the age of 6. If it persists throughout life, it is referred to as the *metopic suture*. This scale like plate, which corresponds to the forehead, gradually slopes down to form the coronal suture, and then turns abruptly downwards. Above the orbit, the frontal bone thickens, forming the *supraorbital margin*. From this margin the frontal bone extends posteriorly to form the roof of orbit and the part of the floor of the cranial cavity. Within the supraorbital margin, slightly medial to its mid point, is a hole called the supraorbital foramen (notch). The frontal sinuses lie deep to the frontal squama. The upper part of the frontal bone is smooth and convex, but the lower part is irregular and by the anterior bony aperture of the nose.

Parietal bones:

The two parietal bones form the greater portion of the sides and the roof of the cranial cavity. The internal surfaces of the parietal bones contain many protrusions and depressions that accommodate the blood vessels supplying the outer meninx (covering) of the brain called the dura mater.

Temporal bones: (शंखास्थि)

The two temporal (tempora = temples) bones form the inferior sides of the cranium and part of the cranial floor. The temporal squama, which is thin, flat portion of the temporal bones that forms the anterior and the superior part of the temple.

Projecting from the inferior portion of the temporal squama is the *zygomatic process*, which articulates with the temporal process of the zygomatic bone. The zygomatic process of the temporal bone and the temporal process of the zygomatic bone constitute the *zygomatic arch*.

At the floor of the cranial cavity is the petrous portion of the temporal bone. This portion is triangular and located at the base of the skull between the sphenoid and occipital bones. The petrous portion houses the internal and middle ear, structures involved in hearing and equilibrium (balance). It also contains the *carotid foramen* (canal). Posterior to the carotid foramen and anterior to the occipital bone is the *jugular foramen*.

Between the squamous and petrous portion of the temporal bone is a socket called the *mandibular (glenoid) fossa*. Anterior to the mandibular fossa is a rounded eminence, the articular tubercle. The mandibular fossa and articular tubercle articulate with the condylar process of the mandible (lower jawbone) to form the temporomandibular joint (TMJ). The mandibular fossa and articular tubercle are seen here.

In the lateral view of the skull is the mastoid portion of the temporal bone. It is located posterior and inferior to the external auditory (acoustic) meatus, or ear canal. In the adult, this portion of the bone contains several *mastoid air "cells"*. There are air spaces, separated from the brain only by thin bony portions. If *mastoiditis* (inflammation of these bony cells) occurs, the infection may spread to the brain or its outer covering.

The *mastoid process* is a round projection of the temporal bone posterior to the external auditory meatus. It serves as a point of attachment for several neck muscles. Near the posterior border of the mastoid process is the *mastoid foramen*. The external auditory (acoustic) meatus is the canal in the temporal bone that leads to the middle ear. The *internal auditory (acoustic) meatus* is superior to the jugular foramen. The *styloid process* projects downwards from the under surfaces of the temporal bone and serves as a point of attachment for muscles and ligament of the tongue and neck.

Occipital Bone (पश्चिम कपाल): -

The *occipitalbone* (ok- sip- i - tal) forms the posterior part and most of the base of the cranium.

The *foramen magnum* is the large hole in the inferior part of the bone. The medulla oblongata (the part of the brain that is continuous with the spinal cord) and the vertebral and spinal arteries pass through this foramen.

The *occipital condyles* are oval processes with convex surfaces one on either side of the foramen magnum that articulate (form a joint) with depressions on the first cervical vertebra. Superior to each condyle is the *hypoglossal canal (fossa)*. The *external occipital protuberance* is a predominant projection on the posterior surface of the bone just superior to the foramen magnum. you can feel this structure as a definite bump on the back of your head, just above neck. A large fibrous and elastic ligament, *the ligamentum nuchae*, extends from the external occipital protuberance to the 7th cervical vertebra. The extending laterally from the protuberance are two curved lines, the *superior nuchal lines*, and below these two *inferior nuchal lines*, which are areas of muscle attachments.

ARTHROLOGY (सन्धि शारीरम्)

The world sandhi means joining of two or more structures. There are innumerable structures are present like arteries, veins muscles, Nerves.

Sushruta clarified that

अस्थनां तु सन्धयो ह्येते केवलाः परिकीर्तिताः ॥

पेशीस्त्रायुसिराणां तु सन्धिसंख्या न विद्यते ॥२८॥ (Su. Sh. 5/28)

As the other sandhis are innumerable so sushruta counted only the asthisandhis. He has not counted the other Sandhis like peshisandhi (Joint in between muscle) Sanyusandhis (Joint in between nerves) sirasandhi (Joint in between veins, Arteries and capillaries)

An articulation (joint) is a point of contact between bones between cartilage and bones or between teeth and bones.

Joint is a point Where two or more bones are articulated with each other.

When we say that one bone articulates with another, we mean that one bone forms a joint with another bone.

No. of Sandhis

संख्यातस्तुदशोत्तरे द्वे शते । तेषां शाखास्वष्टषष्टिः, एकोनषष्टिः कोष्ठे, ग्रीवां प्रत्यूर्ध्वं त्र्यशीतिः । एकैकस्यां पादाङ्गुल्यां त्र्यस्रयः, द्वावङ्गुष्ठे, ते चतुर्दश, जानुगुल्फङ्क्षणोष्केकैकः, एवं सप्तदशैकस्मिन् सक्थि भवन्ति, एतेनेतरसक्थि बाहू च व्याख्यातौ, त्रयः कटीकपालेषु, चतुर्विंशतिः पृष्ठवंशे, तावन्त एव ग्रीवायां, त्रयः कण्ठे, नाडीषु हृदयक्लोमनिबद्धास्वष्टादश, दन्तपरिमाणा दन्तमूलेषु, एकः काकलके नासयां च, द्वौ वर्त्मण्डलयोर्नेत्राश्रयौ, गण्डकर्णशङ्खोष्केकैकः, द्वौ हनुसन्धी, द्वावुपरिष्ठाद्भ्रुवोः शङ्खयोश्च, पञ्च शिरःकपालेषु, एको मूर्ध्नि ॥ (Su. Sh. 5/26) ॥

Total the number of Sandhis - 210

They are

In 4 Sakhas (limbs) 4 x 17 - 68

In Madhyashareera - 59

In head and neck - 83

Classification Of Joint

Joint may be categorized into structural classes based on anatomical characteristics or into functional classes, based on the type of movement they permit.

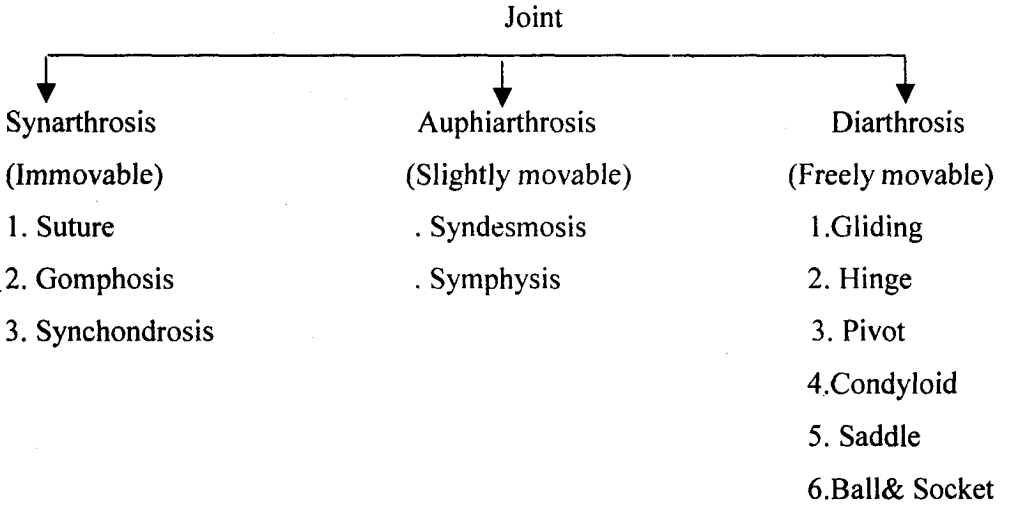
Structural Classification: -

The structural Classification of joint is based on the presence or absence of a space between the articulating bones that is called a synovial (joint) cavity.

Structurally a joint is classified as

1. Fibrous if there is no synovial cavity and the bones are held together by fibrous connective tissue
2. Cartilaginous – If there is no synovial cavity and the bones are held together by cartilage.
3. Synovial – If there is a synovial cavity and the bones forming the joint are united by a surrounding articular capsule and frequently by accessory ligaments.

Functional Classification



सन्धयस्तु द्विविधाश्चेष्टावन्तः, स्थिराश्च ॥ (Su. Sh. 5/24) ॥

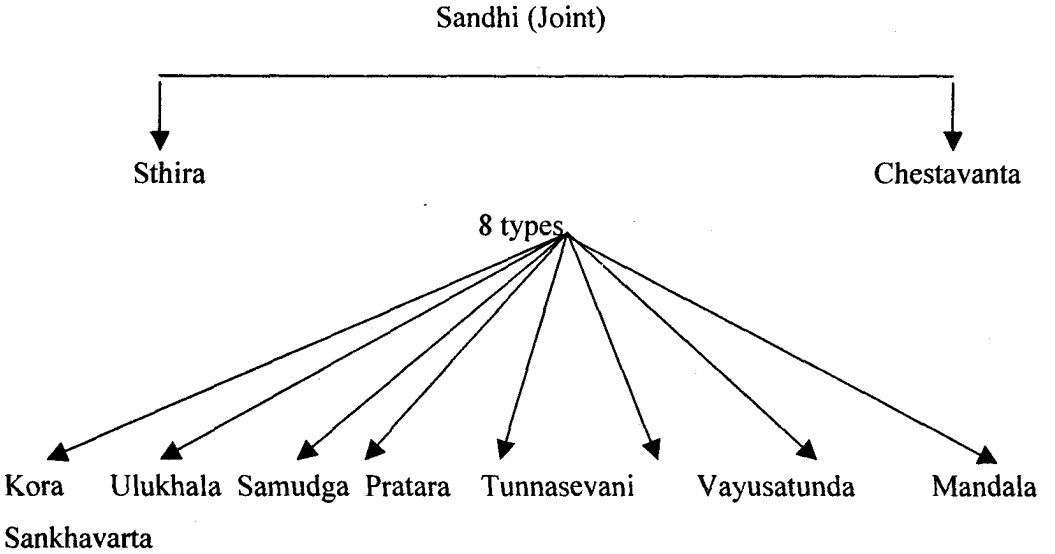
शाखासु हन्वोः कट्यां च चेष्टावन्तस्तु सन्धयः ॥ शेषास्तु सन्धयः सर्वे विज्ञेया हि स्थिरा बुधैः

॥ (Su. Sh. 5/24) ॥

All the sakha sandhi (for example – Mani bandha Wrist joint kurpara (Elbow joint) Kaksha Sandhi (Shoulder Joint) Gulpha Sandhi (Ankle Joint) Janu sandhi (Knee Joint) Bankshana Sandhi (Hip joint) Hanu Sandhi (Temporo mandibular Joint) & Katisandhi (Lumbo – sacral Joint) are the examples of chestabanta sandhi (Movable & Slightly movable joint).

Other than the above-mentioned sandhis are known as sthira sandhi (Immovable joint)

Classification:



त एते सन्धयो अष्टविधाः - कोरोलूखलसामुद् गप्रतरतुन्नसेवनीवायसतुण्डमण्डलशङ्खावर्ताः ।
(Su. Sh. 5/27)

Kora sandhi (Hinge Joint)

तेषामङ्गुलिमणिबन्धगुल्फजानुकूर्परेषु कोराः सन्धयः ।(Su. Sh. 5/27)

This joint can be compared with hinge joint because the motion is similar to that of a hinged door.

In a hinge joint the convex surface of one bone fits into the concave surface of another one. Hinge joint includes the knee, elbow, ankle and interphalangeal joint. Movement is primarily in a single plane, and the joint is therefore known as monaxial or uniaxial.

Ulukhala sandhi (Ball and socket Joint)

कक्षावङ्क्षणदशनेषुलूखलाः ।(Su. Sh. 5/27)

A ball and socket joint consists of a ball – like surface of one bone fitted into a cup like depression of another bone.

The only examples of ball and socket joints are the shoulder joint and hip joint. Because head of the humerus (Which is ball – shape) is articulated with glenoid cavity of the scapula (which is cup- shape) Hip joint – joint formed by the head of femur (ball shape) and the acetabulum of the hip bone (cup-shape)

Their two joints are said to be triaxial because they permit movement in three planes.

1. Flexion – Extension
2. Abductions – Adduction
3. Rotation and circumfusion

Samudga sandhi (saddle joint)

अंसपीठगुदभगनितम्बेषु सामुद् गाः I(Su. Sh. 5/27)

In a saddle or sellaris joint, the articular surface of one bone is saddle – shaped and the articular surface of the other bone is shaped like the legs of a rider sitting in the saddle. The joint between the trapezium of the carpus and metacarpal of the thumb is an example of a saddle joint.

Movements at a saddle joint are side to side and back and forth

These saddle joints are biaxial and also permit circumduction. In circumduction, the thumb is moved in a circle.

The Pratara Sandhi (Gliding Joint)

ग्रीवापृष्ठवंशयोः प्रतराः I(Su. Sh. 5/27)

The articulating surface of bones in a gliding joint are usually flat.

A gliding movement is the simplest kind that can occur at a joint. Only side to side and back and forth movements are permitted.

The heads and tubercles of ribs glide on the bodies and transverse processes of vertebra. Also, the clavicle glides on the sternum and the scapula.

Twisting and rotation are prevented at gliding joints

The Tunnasevani Sandhi (Suture)

शिरःकटीकपालेषु तुन्नसेवन्यः I(Su. Sh. 5/27)

A Suture is a fibrous joint composed of a thin layer of dense fibrous connective tissue that unites bones of the skull. An example of a suture is the coronal suture between the frontal and parietal bones. The irregular, interlocking edges of sutures give them added strength and decrease their change of fractures.

Tunnasevani are present in cranium, flat bones and in the hipbone before puberty

The Vayusatunda Sandhi(Condylar joint)

हन्वोरुभयतस्तु वायसतुण्डाः I(Su. Sh. 5/27)

Vayusatunda are the two mandibular joint.

In a condyloid or ellipsoidal joint an oval shaped condyle of one bone fits into an elliptical cavity of another bone. The joint at the wrist between the radius and carpals is condyloid.

The movement is biaxial (Flexion – extension, abduction – adduction)

Mandala sandhi's

कण्ठनेत्रहृदयक्लोमनाडीषु मण्डलाः ।(Su. Sh. 5/27)

Mandala sandhi's are present in trachea, heart, eyes, kloma and nadi.
The shape of this sandhi just look like a conch- shell.

Shankhabarta

शाोत्रशृङ्गाटकेषु शङ्खावर्ताः ।(Su. Sh. 5/27)

Shankhabarta sandhis are present in cochlea and nose where sringataka marmas are situated

Types Of Other Joints Are:

Gomphosis:(Gomphosis = to bolt together). It is a type of fibrous joint in which a cone – shaped peg fits into a socket. The substance between the two is the periodontal ligament. The only examples are the articulation of the roots of the teeth with the sockets of the alveolar processes of the maxillae and mandible.

Synchondrosis (syn = together; chondros = cartilage).It is a type of cartilaginous joint in which the connecting material is hyaline cartilage. The most common type synchondrosis is the epiphyseal plate. Such a joint connects the epiphysis and diaphysis of a growing bone. Since the hyaline cartilage is eventually replaced by bone or fibro cartilage when growth ceases, the joint is temporary. It is replaced by synostosis or symphysis.

Syndesmosis: (syndesmo = band or ligament). It is a type of fibrous joint in which there is considerably more fibrous connective tissue than there is in a suture. As a result, the fit between the bones is not quite as tight. The fibrous connective tissue forms an interosseus membrane or ligament than permits some degree of flexibility and movement.

Example- distal articulation between the tibia and fibula.

Symphysis: (symphysis = growing together) it is a type of cartilaginous joint in which the connecting material is a broad, flat disc of fibrocartilage. This type of joint is found in intervertebral disc between the bodies of the vertebra. The outer portion of an intervertebral disc is fibrocartilaginous material (annulus fibrosus). The pubic symphysis between the anterior surfaces of the hipbones is another example of a symphysis.

Skull, Superior view

ANTERIOR

FRONTAL BONE

Coronal suture

PARIETAL BONE

Sagittal suture

Lambdoid suture

OCCIPITAL BONE



POSTERIOR

Skull, Posterior view

SUPERIOR

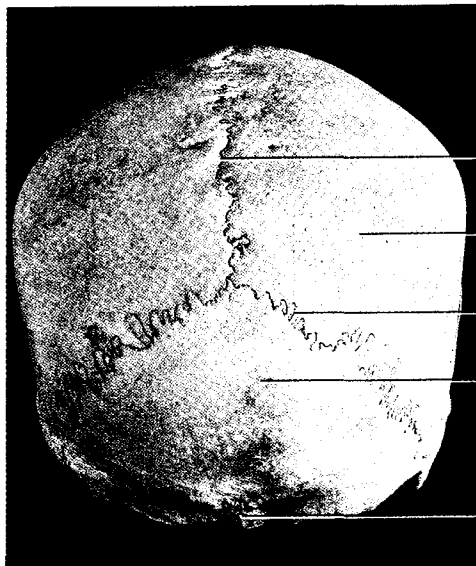
Sagittal suture

PARIETAL BONE

Lambdoid suture

OCCIPITAL BONE

External occipital
protuberance



INFERIOR

Pivot joint:

it is also called as trochoid joint. (trochoid = trochos = wheel). It is a rounded or pointed surface of one bone articulates with in a ring formed partially by another bone and partly by a ligament. The primary movement permitted is rotation. Where a bone moves in a single plane around its longitudinal axis. The joint is therefore monaxial.

During rotation, no other motion is permitted. The atlas rotates around the dens of the axis when you turn your head from side to side to indicate “no”. Another pivot joint is found between the proximal ends of the radius and ulna and it allows us to turn the palms forward (or upwards) and backwards (or downwards).

SUMMARY OF MOVEMENTS AT SYNOVIAL JOINTS

Movement	Definition
GLIDING	One surface moves back and forth and from side to side over another surface without angular or rotatory motion.
ANGULAR	There is an increase or decrease at the angle between the bones.
Flexion	Involves a decrease in the angle between the surfaces of the articulating bones.
Extension	Involves an increase in the angle between the surfaces of the articulating bones.
Hyper extension	Continuation of extension beyond anatomical position
Abduction	Movement of a bone away from the mid line.
Adduction	Movement of a bone towards the mid line.
Circumduction	A combination of flexion – extension and abduction – adduction: In succession in which a part of the body moves in a circle
ROTATION	Movement of a bone around its longitudinal axis: may be medial or lateral.

SPECIAL	Occur at specific joints
Inversion	Movement of the sole of the foot inward so that the soles face towards each other.
Eversion	Movement of the sole of the foot outward so that the soles face away each other.
Dorsiflexion	Bending the foot in the direction of the dorsum (upper surface).
Plantarflexion	Bending the foot in the direction of the plantar (sole).
Protraction	Movement of the mandible or shoulder girdle forward on a plane parallel to ground.
Retraction	Movement of a protracted part backward on a plane parallel to ground
Supination	Movement of the forearm in which the palm is turned anteriorly or superiorly.
Pronation	Movement of the forearm in which the palm is turned posteriorly or inferiorly.
Elevation	Movement of a part of a body upward.
Depression	Movement of a part of a body downward.

SHOULDER JOINT (अंससन्धि)

The other name of this joint is glenohumeral joint. The head of the humerus and glenoid cavity of the scapula forms the shoulder joint. Bones Involved in this joint are Scapula and humerus

Type of joint ball and socket

Movements permitted by this movable this joint flexion, extension, adduction, abduction, medial rotation, lateral rotation, and circumduction.

Structurally it is a weak joint because the glenoid cavity is too small and shallow to hold the head of the humerus in place. The head is four times side of the glenoid cavity however this arrangement permits great mobility.

Ligaments of the joint

1. The capsular ligament – it is very loose, thin and permits free movements. The capsule is lined with synovial membrane. Medially the capsule is attached to the scapula. Laterally it is attached to anatomical neck, Inferiorly it is attached to surgical neck. Inferiorly it is attached to surgical neck. Anteriorly 3 supplemental bands called the superior middle and inferior gleno humeral ligaments reinforce the capsule.

2. The coracohumeral ligament it gives strength to the capsular ligaments. It extends from the coracoid process of the scapula to the greater tubercle of the humerus

3. The gleno humeral ligaments it extended from the glenoid cavity to the lesser tubercle and anatomical neck of the humerus. These ligaments provide only minimal strength.

4. The transverse humeral ligament is a narrow sheet extending from the greater tubercle to the lesser tubercle of the humerus

5. Glenoid labrum is a narrow rim of fibro cartilage around the edge of the glenoid cavity. The tendon of the long head of biceps brachii passes deep to the ligament.

Bursae related to the shoulder joint

1. Subscapular bursa
2. Subdeltoid bursa
3. Subacromial bursa
4. Subcoracoid bursa

Blood supply

1. Anterior circumflex humeral artery
2. Posterior circumflex humeral artery
3. Sub scapular artery and
4. Supra scapular artery

Nerve supply

1. Axillary's nerve
2. Supra scapular nerve
3. Muscle cutaneous nerve

Muscles involved in shoulder joint

1. Pectoralis major
2. Deltoid
3. Latissimus dorsi
4. Serratus anterior
5. Supraspinatus
6. Infraspinatus
7. Short & long head of biceps
8. Long head of triceps
9. Coracobrachialis
10. Subscapularis
11. Teres major
13. Teres minor

Applied anatomy

1. **Dislocation:** - The shoulder joint is more prone to dislocation than any other joint because of laxity of the capsule and disproportionate area of the articular surface usually the head of the humerus becomes displaced inferiorly where the articular capsule is least protected. This dislocation is usually caused by a blow or fall.

2. **Frozen shoulder:-** This is a common occurrence pathologically the two layers of synovial member become adherent to each other. Clinically, the patient usually 40-60 years of age complains of progressively increasing pain in the shoulder

3. **Referred should tip pain:** – Irritation of the diaphragm from any pathology causes referred pain in the shoulder. This is because of the phrenic nerve and the suprascapular nerves both arise from spinal segments C3-C4

ELBOW JOINT

This joint is formed by capitulum and trochlea of the humerus, upper surface of the head of the radius articulates with the capitulum, and trochlear notch of ulna articulates with the trochlea of the humerus.

Bones involved in this joint: - Humerus radius and ulna type of joint hinge joint

Structural classification: – Synovial joint is movable (Hinge variety)

Functional Classification – diarthrosis

Movements permitted by this joint

Flexion and extension of forearm

The elbow joint is continuous with the superior radioulnar joint. The humeroradial the humeroulnar and the superior radioulnar joint are together known as cubital articulations

The transverse axis of the joint is directed medially and downwards. As a result the long axis of the arm makes an angle of about 170 with the long axis of the forearm when the forearm is extended and supinated this angle is known as the carrying angle.

The angle disappears in full flexion of the elbow and (ii) in pronation

Ligaments: -

1. Capsular ligament superiorly it is attached to the lower end of the humerus in such a way that the capitulum the trochlea, the radial fossa the crooned fossa and the orcranon fossa are intracapsular

Infer medially it is attached to the margin of the trochlear notch of the ulna except laterally inferolaterally it is attached to the annular ligament of superior radioulnar joint. The synovial membrane covers the capsule and fossa.

2. The ulnar collateral ligament it is triangular in 13 shapes its apex is attached to the medial epicondyle of the humerus and it base to the ulna. The ligament has thick anterior a posterior hands these are attached below to the coronoid process and the olecranon respectively.

3. The radiocollateral ligament is a fan shaped band extending from the lateral epicondyle to the annular ligament. It gives origin to the supinator and to the extensor carpi radialis brevis.

Relations of elbow joint

1. Anteriorly – Brachialis median nerve brachial artery and tendon of biceps
2. Posterior – Triceps and anconeus
3. Medially – ulnar nerve flexor carpi ulnaris and common flexors
4. Laterally – supinator extensor carpi radialis brevis and other common extensors

Blood supply: - From anastomosis round the elbow joint

Nerve supply: – The joint receives branches from the following nerves

- a. Ulnar nerve
- b. Median nerve
- c. Radial nerve
- d. Musculocutaneous nerve through its branch to the brachialis

Movements: 1 flexion is brought about by

- i. Brachialis
- ii. Biceps
- iii. The brachioradialis
- iv. Extension is produced by
 - a) Triceps and
 - b) Anconeus

Applied anatomy:

1. **Dislocation** - dislocation of elbow is usually posterior, and it is often associated with fracture of the coronoid process. The triangular relationship between the olecranon and the two humeral epicondyles is lost.
2. **Tennis elbow** – Abrupt pronation may lead to pain and tenderness over the lateral epicondyle this is possible due to
 - i) Sprain of radial collateral ligament
 - ii) Tearing of fibers of the extensor carpi radialis brevis
 - iii) Inflammation of the bursa of the last named muscle
3. **Subluxation of the head of the radius (pulled down)** occurs in children when the forearm is suddenly pulled in pronation. The head of the radius slips out from the annular ligament

THE WRIST JOINT (मणिबंधसन्धि)

This is also known as radiocarpal joint

Bones involved in joint:

Lower end of radius articular disc of inferior radioulnar joint scaphoid, lunate and triquetral bones.

Type of joint; Synovial joint of the ellipsoid cavity

Movements: Movements at the wrist are usually associated with the movements at the mid carpal joint

1. Flexion
2. Extension
3. Abduction
4. Adduction
5. Circumduction

Ligaments:

1. Articular capsule: - It surrounds the joint it is attached above to the lower ends of the radius and ulna and below to the proximal row of carpal bones. A protrusion of synovial membrane, called the styloid recess, lies in front of the articular disc. It is bounded inferiorly by a small meniscus projecting inwards from the anterior collateral ligament between the styloid process and triquetral bone

2. On the palmar aspect there are two palmar carpal ligaments.

The palmar radiocarpal ligament is a broad band it begins above from the anterior margin of the lower end of the radius and its styloid process runs downwards and medially and it is attached below to the anterior surface of the scaphoid lunate and triquetral bones

3. The palmar ulnocarpal ligament begins above from the base of the styloid process of the ulna and the anterior margin of the articular disc, runs downwards and laterally and it is attached to lunate and triquetral bones.

4. Dorsal radiocarpal ligament is weaker than the palmar ligaments it begins from the posterior margin of the lower end of the radius runs downwards and medially and it is attached below to the dorsal surfaces of the scaphoid lunate and triquetral bones.

5. The radial collateral ligament extends from the tip of the styloid process of the radius to the anterior side of the scaphoid bone it is related to the radial artery.

6. The ulnar collateral ligament extends from the tip of the styloid process of the ulna to the triquetrum and pisiform bones.

Relations:

Anterior - median nerve and long flexor tendons

Posterior – extensor tendons of the wrist

Lateral – radial artery

Blood supply - Anterior and posterior carpal arches

Nerve supply – Anterior and posterior interosseous membrane

Applied anatomy 1. The wrist joint is commonly involved in rheumatoid arthritis in which collagen tissue is mostly affected

KNEE JOINT (जानुसन्धि)

It is also called as tibiofemoral joint. It is the largest joint of the body.

Actually it consists of three joints

1. An intermediate patellofemoral joint between the patella and the patellar surface of femur.
2. A lateral fibiofemoral joint between the lateral condyle of the femur, lateral meniscus and the lateral condyle of the tibia.
3. A medial tibiofemoral joint between the medial condyle of the femur, medial meniscus and medial femoral condyle of the tibia.

The patellofemoral joint is a gliding joint. The lateral and medial tibiofemoral joints are hinge joints.

Bones involved in this joint – patella, tibia and femur.

Type of joint – partly it is gliding and hinge joint.

Movements permitted by this joint

Flexion, extension, medial rotation and lateral rotation.

The anatomical components are

1. Articular capsule – the ligamentous sheath surrounding the joint consists mostly of muscle tendons or expansions of them.
2. Medial and lateral patellar retinacula – fused tendons of insertion of the quadriceps femoris muscle and the fascia lata strengthen the anterior surface of the joint.
3. Patellar ligament – central portion of the common tendon of insertion of the quadriceps femoris muscle that extends from the patella to the tibial tuberosity. The ligament also strengthens the anterior surface of the joint.

Other ligaments, which are present in the knee joint, are

- a) Oblique popliteal ligament.
- b) Arcuate popliteal ligament.
- c) Tibial collateral ligament.
- d) Fibular collateral ligament.
- e) Intra articular ligaments – ligaments within the capsule that connect the tibia and femur.
Anterior cruciate ligament
Posterior cruciate ligament

The principal bursae of the knee include

- a) Anterior bursae
- b) Medial bursae
- c) Lateral bursae

Blood supply – popliteal vein and artery

Applied anatomy

1. A dislocated knee refers the displacement of the tibia relative to the femur. The most common type is anterior dislocation, resulting from hypertension of the knee.
2. It is usually involved in Rheumatoid arthritis, Osteoarthritis.

HIP JOINT (वक्षणसन्धि)

It is also called as coxal joint.

The head of the femur articulates with the acetabulum of the hipbone to form the hip joint

Bones involved in this joint – femur and hipbone

Type of joint – ball and socket (spheroid)

Structural classification – synovial joint

Functional classification – diarthrosis

Movements permitted by this joint – flexion extension abduction adduction circumduction and rotation

The head of the femur forms more than half a sphere and is covered with hyaline cartilage except of the fovea capitis.

The acetabulum presents a horseshoe shaped lunate articular surface an acetabular notch and an acctabular fossa the lunate surface is covered with cartilage.

Though the articular surface on the head of the femur and on the acetabulum are reciprocally curved they are not co- extensive.

The hip joint is unique in having a high degree of stability as well as mobility.

The stability or strength depends upon

2. Depth of acetabulum
3. Tension and strength of ligaments
4. The strength of surrounding muscles
5. The length and obliquity of the neck of femur

Ligaments: The ligaments include

2. Fibrous capsule
3. Iliofemoral ligament
4. Pubofemoral ligament
5. Ischi – femoral ligament
6. Ligament of the head of the femur
7. The acetabular labrum
8. Transverse acetabular ligament

The fibrous capsule is attached:

- a) On the hip bone to the acetabular labrum including the transverse acetabular ligament and to bone above and behind the acetabulum
- b) On the femur to the intertrochanteric line in front and 1cm medial to the intertrochanteric crest behind

Anteroposteriorly the capsule is thick and firmly attached this part is subjected to maximum tension in the standing posture. Posteroinferiorly the capsule is thin and loosely attached to bone.

The synovial membrane lines the fibrous capsule the intrascapular portion of the neck of femur both surfaces of the acetabular labrum the transverse ligament and fat in the acetabular fossa it also invests the round ligament of the head of the femur.

OTHER JOINTS OF THE BODY

ANKLE JOINT (गुल्फसन्धि)

This joint is formed by the

1. The distal end of the tibia and its medial malleolus and the talus.
2. The lateral malleolus of the fibula and talus.

It is a type of both synovial and hinge joint.

It permits dorsiflexion and plantar flexion.

INTER VERTEBRAL JOINTS

This joint is formed between the

- (i) Vertebral bodies and
- (ii) Vertebral arches.

Joints between vertebral bodies are the example of cartilaginous joint.

Joints between vertebral arches – synovial, gliding.

It permits flexion, extension, lateral displacement and rotation.

ATLANTO – OCCIPITAL JOINT

Joint formed by the superior articular surfaces of the atlas and the occipital condyles of the occipital bone.

It is a type of synovial, ellipsoidal type.

It permits flexion, extension and slight lateral tilting of head to either side.

TEMPEROMANDIBULAR JOINT

It is formed by the mandibular condyle of the mandible and mandibular fossa and articular tubercle of temporal bone. It is the only movable joint between the skull bones, all other skull joints are sutures and therefore immovable.

It is a type of synovial joint which includes hinge and gliding joint.

It permits some movements like depression, elevation, protraction, retraction, lateral displacement and slight rotation.

LUMBOSACRAL JOINT

The body of the fifth lumbar vertebra and the superior surface of the first sacral vertebra of the sacrum form it.

It is a type of cartilaginous, symphysis type.

It permits flexion, extension, lateral displacement and rotation.

SIRA DHAMANI SROTAS

Introduction:

सिरा, धमनी and स्रोतस् are nothing but channels present inside the body. Several authorities opine that all the three are but different forms of the same structure. According to acharya Susruta, the above three are different from each other owing to their diverse nature, origin and functions. Hence, in the Susruta samhitha, these are described under separate chapters. However inspite of this diversity, they seem to be one, because of their minuteness, properties and basic function of transporting substances from one part of the body to another part of the body. Acharya charaka has therefore considered सिरा, धमनी and स्रोतस् as a single structure being called by different names, according to the function, nature etc of each structure.

In the “धमनीव्याकरणं शारीरम् ” of Susruta samhitha, the reasons for these structures being considered different from one another are said to be-

“व्यञ्जनान्यत्वान्मूलसत्रियमात् कर्मवैशेष्याद् आगमाच्च ।” (Su. Sha 9/3)

That is because of their different feature, originating point, specific functions and scriptural authority. Hence each of these is dealt separately.

सरणात् सिराः (Ch.Su.30/12)

सरणात् अवयवान्तरगमनात्

Siras are tubular structures, which carry the vital fluid. Sarana means passing from one organ to another. Siras are like fine fibres in the leaf of a tree, thick at their roots and becoming finer towards the end; the branches of the siras resemble the tendrils; the first branch gives out a branch; this again gives out another branch, and so on.

सप्त सिराशतानि भवन्ति । (Su.Sha. 7/3)

There are 700 siras present in the body. Siras are divided according to the doshas that move inside them and according to their colour.

1.Dosa vahini siras: The principal siras are forty;of these 10 each are vata vahini, Pitta vahiniand Kapha vahini and 10 siras of them carrying the blood.

a. The vata vahini siras, when they reach the organs of the body where vata predominates, divide into 175 branches.

b. The pitta vahini and c. Kapha vahini similarly divide when they reach their predominating regions.

d. The blood carrying siras, however, reach the liver and spleen and ramify there in. The classification of siras based on dosas is not correct as two or even three doshas flow through any of them. The siras are thus sarva-vaha and permit any other Dosa to flow through. Secondly, when doshas are excited, they mix up with each other and rush every-where. They thus leave their proper channels and thrust into any other sira.

Circulation-

Vyana-vayu causes, by suitable mechanism, the Rasa Dhatu to spread instantaneously in all directions and at all times.

Siras are classified into four types.

a. Aruna-, which is controlled by vata, which is red in colour.

b. Neela-, which is controlled by pitta, which is, warm & blue in colour.

c. Sthira-, which is controlled by kapha, which is cold & white in colour.

d. Rohini-The siras, which convey pure blood and red in colour and are neither warm nor very cold.

Distribution-

There are 25 Vata-vahini siras in one extremity and the same number in the other.

There are 34 siras in the trunk, of which 8 are in the pelvis near the anus and penis, 4 in two sides; 6 each in the back and the abdomen and 10 in the thorax.

There are 41 Vata-vahini siras in the neck and the head;of these 14 are in the neck, 4 in two ears, 9 in the tongue, 6 in the nose, and 8 in the eyes.

The distribution of the other pitta-vaha, Kapha-vaha and Rakta-vaha siras is of similar nature. Of the pitta- vaha, 10 are in two eyes and only two are in the ears.

Function-

The body is nourished by the siras, like a garden that is watered and refreshed by conduits, or like a field that is drenched by channels. The siras thus protect and sustain the body.

a. When vata controls the siras, the activities can be freely carried out and perception is precise.

b. When pitta controls the same, the skin becomes lustrous, appetite is good and food is relished, and there is freedom from disease.

c. When kapha controls them, the skin remains properly moist; the joints are well lubricated; the limbs become firm, strong and well developed.

d. When healthy rakta courses through its own channels, the several tissues develop fully, complexion becomes lustrous, touch becomes very keen and perception acute. The blood, which is carried everywhere in the body by the vessels, is the main sustainer (life) of all animals. Charaka says "such purified blood maintains strength, complexion, and happy-life of an animal and as such, life depends mostly on blood".

Developments Of Siras In Foetal Life

In foetal life, the siras start in the navel region and spread out in all directions above, below and sideways. From the navel, they ramify in all directions. The vitality of animals is centred in the navel; the activities of life are thus dependant on it, as it is surrounded by siras, like the hub of a wheel surrounded by spokes.

सिरा s: -

“सरणात् सिराः। (Ch.Su.30/12)

सन्धबन्धनकारिण्यो दोषधातुवहाः सिराः।”(Sharangadhara samhita)

सरणात् अवयवान्तरगमनात्

Siras are tubular structures, which carry the vital fluid. Sarana means passing from one organ to another. Siras are like fine fibres in the leaf of a tree, thick at their roots and becoming finer towards the end; the branches of the siras resemble the tendrils; the first branch given out a branch; this again gives out another branch, and so on.

Siras are found all over the body in the form of a network. They travel to various parts of the body. Hence the definition “सरणात्” indicates the spreading out of siras all over the body as Chakrapani mentions, “सरणात् देशान्तरगमनात्”. Siras nourish the entire body just as how water channels (canals) nourish fields.

Siras are spread out to different parts of the body. These are extensively branched like the veins formed to branch out over the surface of leaves.

The नाभि is the मूलस्थान (site of origin) of all the सिरा. They arise from the नाभि just as how spokes of the wheel arise from its center. Then they move upwards, downwards and obliquely in the body, producing several ramifications. Thus they make 700 in total. As the नाभि is the seat of Prana, सिरा and Prana also exist as आधार and आधेय. Hence सिरा are considered to be vital elements that constitute the human body. Some of the सिरा are grouped under marmas due to this. Thus, care should be taken while performing venesection (सिराव्यध) and hence the सिरा that are not recommended for venesection should not be hurt by any cause.

सिरा also carry वायु, पित्तम्, कफम्, and रक्तम्. There is not a single one in the body that carries just one of the above substances alone. Hence सिरा are called “सर्ववहिन्यः” as they carry all of them, but with the predominance of one of these substances.

सप्त सिराशतानि भवन्ति। (Su.Sha. 7/3)

There are 700 सिरा s. These may be broadly classified intoस्थूल and सूक्ष्म सिरा.

Classification:

Out of the 700, there are 40 मूलसिरा. They are: -

- 1) वातवहिन्यः-10
- 2) पित्तवहिन्यः -10
- 3) श्लेष्मवहिन्यः -10
- 4) रक्तवहिन्यः-10.

Each of these मूलसिरा consists of 175 सिरा s each (ie) there are 175 वातवहिन्यः, 175 पित्तवहिन्यः &so on.

These 175 सिरा s is distributed in the body thus: -

- 1)सविथ (Lower extremity) – 25 each (25+25=50)
- 2)बाहु (Upper extremity) – 25 each (25+25=50)
- 3) शाखा and कोष्ठः -34 Siras spread out as: -
 - (1) गुद, मेद्र, श्रोणि -8
 - (2) पार्श्व (2+2) -4
 - (3) पृष्ठ -6
 - (4) उदर -6
 - (5) वक्ष-10

4). ऊर्ध्वजत्रुगत सिराः :-41 सिरा s distributed as:-

(1) ग्रीवा -14

(2) जिह्वा -9

(3) नासिका -6

(4) कर्ण -4(2 in the case of पित्त, श्लेष्मा and रक्तवहसिरा)

(5) नेत्रम्-8(10 in the case of पित्त, श्लेष्मा and रक्तवहसिरा)

This classification is common to all types of सिरा s.

Specific Colours Of The सिरा s:

1) वातवहसिराः - These are अरुण in colour.

2) पित्तवहसिराः - these are नील (blue) in colour, and ऊष्ण (warm) to touch.

3) श्लेष्मवहसिराः -these are शीत, (cold) in touch, white in colour and स्थिर (firm) in nature.

4) रक्तवहसिराः-these are red in colour and अनुष्णशीत (neither warm nor cold) in nature.

The conditions arising in the body due to the abnormal and normal functioning of the सिरा s are described in Su.sh.7/8-15

धमन्यः :-

ध्मानाद् धमन्यः (Ch.Su.30/12)

ध्मानाद् अनिलपूरणात् धमन्यः रसवाहिन्यः (sharangadhara samhita)

The term धमनी is derived from the root “ध्मा” meaning to be filled with (ध्मानात् पूरणात्). धमनीS are constantly filled with substances like रस etc. hence these structures are always found to pulsate in the body. धमनीS also originate from the नाभि and move upwards, downwards and obliquely in the body. They are 24 in number. They carry वायु, पित्तम्, कफम्, रसः& , रक्तम्. धमनीS can be compared to the stalk of the lotus. They conduct nutrients to different parts of the body just as how the stalk conducts water to the plant.

“यथा स्वभावतः खानि मृणालेषु विसेषु च।

धमनीनां तथा खानि रसो यैरुपचीयते ।।(Su.Sha. 9/9)

Distribution: -

The 24 धमनीs are distributed as follows: -

(1) ऊर्ध्वगाः-10

(2) अधोगाः-10

(3) तिर्यग्गाः-4

These 10 धमनीs, when they reach the level of the हृदय, divide into 3 branches each forming a total of 30 धमनीs. These 30 धमनीs are meant to perform specific functions:

1. 10 धमनीs carry वायु, पित्तम्, कफम्, रसः &, रक्तम् (2 each).
2. 8 धमनीs transmit the stimuli to the senses of शब्द, रूप, रस, and गन्ध (2 each)
3. 2 धमनीs for speech.
4. 2 धमनीs for producing sound.
5. 2 धमनीs for sleeping & 2 धमनीs for waking up.
6. 2 धमनीs act as channels for tears (अश्रुवाहिन्यौ)
7. 2 धमनीs for the passage of breast milk (in females) and the same for the passage of शुक्र in males.

All these धमनीs support & sustain the region above the नाभि. The specific functions of these धमनीs are शब्द, स्पर्श, रूप, रस, गन्ध, प्रश्वास, उच्छ्वास जृम्भा (yawning), hunger, laughing, speech, weeping etc.

अधोगाः धमन्यः :-

These also, similar to the ऊर्ध्वगा धमनी branch into 30 at the region in between the आमाशय and पक्वाशय thus moving downwards. These 30 धमनीs are: -

1. 10 धमनीs carry वायु, पित्तं, कफं, रसं and रक्तं
2. 2 धमनीs carry the सिराs of आहार (अन्नवाहिन्यौ). They are present in the अन्न (intestines).
3. 2 धमनीs carry the fluid wastes to the bladder. These are called तोयवाहिन्यः.
4. 2 धमनीs carry मूत्र from the bladder and are called मूत्रवाहिनी.
5. 2 धमनीs are present to carry शुक्र. Another 2 धमनीs are present for the transmission and ejaculation of शुक्र. In females the same धमनीs carry the आर्तव and act as a passage for menstrual fluid.
6. 2 धमनीs present in the स्थूलान्त्र (large intestine) carry the solid wastes (घन भाग of किट्ट produced after digestion). This becomes वर्च (faecal matter) when it reaches the उण्डुक (caecum).

7. 8 धमनीS convey स्वेद to the तिर्यग्गधमनी, which are responsible for perspiration. All the अधोग धमनी carry वात, मूत्र, पुराष, शुक्र आर्तव etc downwards. In the पित्ताशय , these धमनीS perform the function of separating out the आहार सार भाग immediately after the process of digestion gets over. These also carry the obtained सार to the site of रस (ie) हृदय. From here, again the रसधातुS carried to different parts of the body by the धमनीS. The अधोग धमनी do not directly reach the हृदय as it is present above the नाभि. Hence these धमनीS convey the आहार सार to the उर्ध्वग and तिर्यग्गधमनी which inturn carry the सार to the हृदय and disperse it to different parts of the body.

तिर्यग्गधमनी: -

These 4 धमनीS run obliquely in the body. Each of them divides and redivides into hundreds and thousands of branches. Thus, they are innumerable and form a big network inside the body. They open up on the layer of the skin as pores and are called रोमकूप. Hair follicles are thus present over the skin. These धमनीS are responsible for carryingस्वेद. It is through these pores on the skin that the essence of substances applied as लेप,अभ्यङ्ग, परिषेक , अवगाह etc enter the body. These are conveyed into the body through these धमनीS. These धमनीS are said to be responsible for the perception of touch. रस also gets transferred through these धमनीS. Hence the तिर्यग्गधमनी maintain the entire body as a whole.

स्त्रोतस् :-

स्त्रवणात् स्त्रोतांसि ।(Ch.Su.30/12)

मूलात् खादन्तरं देहे प्रसृतं त्वभिवाहि यत् ।

स्त्रोतस्तदिति विज्ञेयं सिराधमनिर्वजितम् ।।(Su.Sha.9/15)

स्त्रोतांसि खलु परिणाममापद्यमानानां धातुनां अभिवाहिनि भवन्त्ययनार्थेन (Ch.Vi.9/15)

स्त्रवणात् रसादेः पोष्यस्य पोष्यधातु रस हृदय छिद्र

स्वधातुसमवर्णानि वृत्तस्थूलान्यणूनि च ।

स्त्रोतांसि दीर्घाण्याकृत्या प्रतानसदृशानि च ।।(A.H Sha. 3/43)

Srotases are channels in the body that carry Dhatus like rasa etc. the term स्त्रवणात् indicates रसादेः पोष्यस्य स्त्रवणात् (ie) the flow of पोष्यधातु Like रस etc.

According to Acharya Susruta, srotases are channels that originate from hollow spaces in the body (like the हृदय) or from other openings (छिद्र) of the body. Any

other structure except the Siras and dhamanis is called as Srotas. Srotases differ from the other two in many ways even though the basic functions of these structures may appear to be the same.

Srotases form the base for the process of transformation of one Dhatu to another. Thus, they are responsible for the maintenance of equilibrium of the Dhatus.

Nature Of Srotases: -

“स्वधातुसमवर्णानि वृत्तस्थूलान्यणूनि च ।

स्रोतांसि दीर्घाण्याकृत्या प्रतानसदृशानि च ॥ (Ast.Hru.Sha.3/43)

Srotases are of the same colour as that of the Dhatus they carry in them. Some of them are round, स्थूल some are elongated and long, minute and appear as a network inside of the body.

They are channels that contain the transforming Dhatus.

Number Of Srotases: -

यावन्तः पुरुषे मूर्तिमन्तो भावविशेषास्तावन्तः एव अस्मिन् स्रोतसां प्रकार विशेषाः । (Ch.Vi.5/2)

अतिबहुत्वात् केचिदपरिसङ्खेयानि अचक्षते स्रोतांसि परिसङ्खेयानि पुनरन्ये । (Ch.Vi.5/4)

The numbers of Srotases in the human body are as many as the number of मूर्तः substances in the body. Hence, some of them opine that Srotases are innumerable, while others specify definite numbers. According to आरुत्रेद रहस्यदीपिका “मूर्तिमन्तः भावविशेषाः” indicates substances like प्राण, जल, अन्न, सप्तधातु, त्रिमला and त्रिदोष Any how, the त्रिदोष do not have separate Srotases as they are सर्वशरीरव्यापकः (ie) they are present everywhere in the body.

वातपित्तस्लेष्मणां पुनः सर्वशरीरचराणां सर्वाणि स्रोतांसि अयनभूतानि (Ch.Vi.5/5)

Thus the त्रिदोष do not have a separate Srotas, but are carried by all other Srotases in the body.

Classification: -

Srotases are basically classified into two namely:

- 1) बहिर्मुख स्रोतस् or बाह्यस्रोतस्.
- 2) योगवाहि or आभ्यन्तर स्रोतस्.

However, these types are mentioned under different names in different classics. The अष्टाङ्ग संग्रहः uses the terms “बाह्यानि” and “आन्तराणि” while the same is mentioned as “दृश्यानि” and “अदृश्यानि” in the commentary of अष्टाङ्ग हृदय

बाह्य स्रोतस् :-

“स्रोतांसि नासिके कर्णौ नेत्रे पाय्वास्यमेहनम्।

स्तनौ रक्तपथश्चेति नारीणां अधिकं त्रयम्।। (Ast.Hru.Sha.3/43)

श्रवणनवदनघ्राणगुदमेद्राणि नव स्रोतांसि नराणांबहिर्मुखानि।

एतान्येवस्त्रीणामपराणि च त्रीणि, द्वे स्तनयोः अधस्तदरक्तवहश्च धमन्यः।। (Su.Sha.5/10)

There are 9 such Srotases in the body. They are openings found on the body and also called नवच्छिद्राणि .

They are:-

- 1) नासिका -2
- 2) नेत्रम् -2
- 3) कर्ण -2
- 4) पायु -1
- 5) आस्य -1
- 6) मेहनम् -1

In females, there are three more Srotases-2 स्तन and 1 Srotas meant for the passage of menstrual fluid.

आभ्यन्तर स्रोतस् :-

“जीवितायतनान्यतः स्रोतांस्याहुत्रयोदश।

प्राणदातुमलाम्मोन्नवाहीनिअहितसेवनात्।।

तानि दुष्टानि रोगाय विशुद्धानि सुखाय च। (Ast.Hru.Sha.3/41, 42)

“प्राणोदकन्नरसरुधिरमांसमेदो अस्थिमज्जशुक्रमूत्रपुरीषस्वेदवहानीति। (Ch.Vi.5/8)

These Srotases are present interiorly, and cannot be seen over the surface of the body.

According to Acharya Charaka. There are 13 Srotases- प्राण, अन्न, उदक, त्रिमला and सप्तधातुवहा's, आर्तववहस्रोतस् has been included by Acharya Susruta, but there is no mention of अस्थि, मज्जा and स्वेदवहास्रोतस् in the Susruta samhitha. Acharya Susruta mentions 11 pairs of Yogavahi srotases.

Acharya Charaka does not mention आर्तववहस्रोतस्, as he considers आर्तव as nothing but a product from रसधातु (उपधातु of रस), and moreover आर्तव is present in the place of शुक्र, in females.

These Srotases are said to be जीवितायतनानि or जीविताधिष्ठानानि

As they are essential for sustenance, Health or disease is caused only by the proper existence or abnormality of these Srotases.

Causes For स्रोतोदुष्टि :-

“आहारश्च विहारश्च यः स्याद्दोषगुणैः समः ।

धातुभिर्विगुणो यश्च स्रोतसां स प्रदूषकः ॥ (Ch.Vim.5/9)

The main causes for vitiation of Srotases are improper आहार and विहार those आहार and विहार that are similar to the nature of Doshas, while at the same time, opposite to the nature of the Dhatus produce स्रोतोदुष्टि.

There are specific आहार and विहार that cause the vitiation of each one of the Srotases. These are described in the स्रोतोविमानम् chapter of Charaka samhitha.

Effects Of स्रोतोदुष्टि: -

“अतिप्रवृत्तिः सङ्गो वा सिराणां ग्रन्थयो अपि वा ।

विमार्गतो वा गमनं स्रोतसां दुष्टिलक्षणम् ॥ (Ast. Hru. Sha. 3/45)

The following are observed as a result of स्रोतोदुष्टि: -

- 1) अतिप्रवृत्तिः - Excess functioning like in the case of बहुमूत्रता in प्रमेह and in अतिसार, where there is अतिप्रवृत्ति of मूत्र and पुरीष respectively.
- 2) सङ्गः - It is अप्रवृत्ति. in cases like मूत्रकृच्छ्र or passing of stools little by little with difficulty, it can be seen.
- 3) ग्रन्थिः - कुटिलीभावत्वम् (curved, bent nature) of Srotases.
- 4) विमार्गगमनम् - Movement of substances in an improper direction inside the body. This can be observed in conditions like vomiting etc.

Srotases have a major role to play, in the process of treatment. The संशोधनं therapies for any disease are performed only after clearing the Srotases. This is because clearing the openings of the Srotases (स्रोतोमुखविशोधन) allows the movement of the Doshas from the शाखा to the कोष्ठ. This allows the free and easy elimination of Doshas thereafter by means of संशोधनं produces like बस्ति, वमन and विरेचन.

Synonyms of स्रोतस्: -

स्रोतांसि, सिराः, धमन्यः, रसायन्यः, रसवाहिन्यः, नाड्यः, पन्थानः, मार्गाः, शरीरच्छिद्रणि, संवृतासंवृतानि, स्थानानि, आशयाः, निकेताश्चेति शरीरधात्वक्काशानां लक्ष्यालक्ष्याणां नामानि भवन्त ॥

(Ch.vim.5/9)

Sira, dhamani, rasayana, rasavaahini, naadi, panthana, marga, shareera chidrani, aashaya, nikhetha, are the synonyms of srotas.

तानि तु प्राणात्रोदकरसरक्तमांसमेदोमूत्रपुरीषशुक्रार्तववहानि । (Su.sha 9/12)

तद्यथा - प्राणोदकात्ररसरुधिरमांसमेदोस्थिमज्जशुक्रमूत्रपुरीषस्वेदवहानीति ॥ (Ch.vim.5/8)

According to charaka there are 13 srotases present in the body whereas according to Susruta it is of 11 pairs. Charaka has included asthivaha, majjavaha & swedavaha srotas and excluded aarthava vaha srotas. whereas Susruta has ommited asthi, majja & swedavaha srotas and included aarthava vaha srotas.

Origin Of Srotas

तत्र प्राणवहे द्वे, तयोर्मूलं हृदयं रसवाहिन्यश्च धमन्यः । (Su.sha 9/12)

तत्र प्राणवहानां स्रोतसां हृदयं मूलं महास्रोतश्च । (Ch.vim.5/8)

The prana vaha srotas originates from hrudaya and maha srotas and it gets nourishment from hrudaya and rasa vaha dhamanis.

अन्नवहे द्वे, तयोर्मूलमामाशयो अन्नवाहिन्यश्च धमन्यः । (Su.Sha 9/12)

अन्नवहानां स्रोतसामामाशयो मूलं वामं च पार्श्वं ॥ (Ch.Vim.5/8)

The anna vaha srotas originates from aamashaya and vaama paarshva and it gets nourishment from aamashaya and anna vaahini dhamanis.

उदकवहे द्वे, तयोर्मूलं तालुं क्लोमं च । (Su.Sha 9/12)

उदकवहानां स्रोतसां तालुमूलं क्लोमं च ॥ (Ch.Vim.5/8)

The udaka vaha srotas originates from talu and kloma

रसवहे द्वे, तयोर्मूलं हृदयं रसवाहिन्यश्च धमन्यः । (Su.sha 9/12)

रसवहानां स्रोतसां हृदयं मूलं दश च धमन्यः ॥ (Ch.Vim.5/8)

The rasa vaha srotas originates from hrudaya and dasa (10) dhamanis and it gets nourishment from hrudaya and rasa vaha dhamanis.

रक्तवहे द्वे, तयोर्मूलं यकृत्प्लीहानौ रक्तवाहिन्यश्च धमन्यः । (Su.Sha 9/12)

शोणितवहानां स्रोतसां यकृन्मूलं प्लीहा च ॥ (Ch.Vim.5/8)

The raktha vaha srotas originates from yakrut and pleeha.

मांसवहे द्वे, तयोर्मूलं स्नायुत्वचं रक्तवहाश्च धमन्यः । (Su.Sha 9/12)

मांसवहानां च स्रोतसां स्नायुमूलं त्वक् च ॥ (Ch.Vim.5/8)

The maamsa vaha srotas originates from snayu moola and twacha.

मेदोवहे द्वे, तयोर्मूलं कटी वृक्कौ च । (Su.Sha 9/12)

मेदोवहानां स्रोतसां वृक्कौ मूलं वपावहनं च ॥ (Ch.Vim.5/8)

The medo vaha srotas originates from vrukka and vapa vahana.

अस्थिवहानां स्रोतसां मेदोमूलं जघनं च ॥ (Ch.Vim.5/8)

The asthi vaha srotas originates from medo moola and jagana

मज्जवहानां स्रोतसामस्थिनिमूलं सन्धयश्च ॥ (Ch.vim.5/8)

The majja vaha srotas originates from asthi moola and Sandhi.

शुक्रवहे द्वे, तयोर्मूलं स्तनौ वृषणौ च । (Su.Sha 9/12)

शुक्रवहानां स्रोतसां वृषणौ मूलं शफश्च ॥ (Ch.Vim.5/8)

The sukra vaha srotas originates from vrushana and sepha.

मूत्रवहे द्वे, तयोर्मूलं बस्तिमेदुं च । (Su.Sha 9/12)

मूत्रवहानां स्रोतसां बस्तिर्मूलं वङ्क्षणौ च ॥ (Ch.vim.5/8)

The mootra vaha srotas originates from basti moola and vankshana.

पुरीषवहे द्वे, तयोर्मूलं पक्काशयो गुदं च । (Su.Sha. 9/12)

पुरीषवहानां स्रोतसां पक्काशयो मूलं स्थूलगुदं च ॥ (Ch.Vim.5/8)

The puresha vaha srotas originates from pakwashaya and sthoola gudham.

स्वेदवहानां स्रोतसां मेदोमूलं लोमकूपाश्च ॥ (Su.Sha 9/12)

The sweda vaha srotas originates from medas and loma koopam.

आर्तववहे द्वे, तयोर्मूलं गर्भाशय आर्तववाहिन्यश्च धमन्यः । (Su.sha 9/12)

The aarthava vaha srotas originates from garbhashaya and aarthava vahini dhamanis.

BLOOD VESSELS

Introduction

As William Harvey discovered in the seventeenth century, blood is pumped away from the heart but it all returns to the heart after circulation throughout the body. Arteries are the vessels that carry the blood away from the heart, and veins are the vessels that carry it back to the heart.

Movement and exchange of materials in the watery medium of living tissue takes place by diffusion, most commonly along chemical ingredients.

Schematically one can envisage that the circulatory system is made up of the

1. Heart- a central pump and the main motor of the system.
2. By a vast array of tubes that lead away from the heart (as arteries) and carry the blood to the "periphery" of the body; at the periphery that is within organs and tissues the tubes loop back and (as veins) reach the heart again where the blood eventually returns.

From the center to the periphery, the vascular tree shows three main changes.

1. The arteries increase in number by repeated division and by issuing of side branches.
2. The arteries also decrease in diameter, although not to the same extent as they increase in number.
3. Among the other structural changes, the wall of the arteries decreases in thickness, although this is not as substantial as the reduction of the vessel diameter.

Vessel Number:

The aorta, the single systemic artery emerging from the heart, gives origin by successive branching to hundreds of arteries of progressively small calibre by further branching these produce about 4×10^6 arterioles and four times as many as capillaries. Blood vessels form a closed system of tubes that carries blood away from the heart, transport it to the tissues of the body and then return it to the heart. The blood pumped out from the left ventricle is carried by the branches of the aorta around the body and is returned to the right atrium of the heart by the superior and inferior vena cavae.

The circulatory or vascular system is divided for descriptive purposes into two main types.

1. The blood circulatory system, consisting of the heart, which acts as a pump, and the blood vessels through which the blood circulates.
2. The lymphatic system, consisting of lymph nodes and lymph vessels through which colorless lymph follows.

The two systems communicate with one another and are intimately associated.

Blood vessels are several types:

1. Arteries
2. Veins
3. Arterioles
4. Venules
5. Capillaries
6. Vasa vasorum

1. Arteries:

- a. These are vessels that carry blood from the heart to the tissues. Large elastic arteries leave the heart and divide into medium sized, muscular arteries that branch out into the various regions of the body.
- b. This vessel usually carries pure (oxygenated) blood except in the case of umbilical and pulmonary arteries.

2. Arterioles:

- a. When medium sized arteries divide into small arteries, they again divide into still smaller arteries called arterioles

3. Veins:

- a. These are the blood vessels that transport blood from the tissues to the heart.
- b. Veins usually carry impure (deoxygenated) blood except in umbilical and pulmonary veins.

3. Venules:

These are the branches of larger veins called as venules.

4. Capillaries:

When the smallest arterioles enter a tissue, they divide into countless minute microscopic vessels called capillaries.

Arteries:

In ancient times it was thought to contain only air after death. But due to recent advancement in medical sciences and continuous research in the particular field it was found that the artery contains many structures.

a. Lumen – it is the hollow center through which blood flows away from the heart.

b. Coats/layers – the surrounding arterial wall has three coats/layers.

i. Tunica interna (intima) – it is the inner most layer composed of a lining of simple squamous epithelium that is in contact with blood, a basement membrane and a layer of elastic tissue called the internal elastic lamina.

ii. Tunica media- it is the thickest layer of the artery. It consists of elastic tissues and smooth muscle fibers.

iii. Tunica externa (adventitia) – it is the outermost layer and principally composed of elastic and collagen fibers.

In muscular arteries an external elastic lamina composed of elastic tissues, separates the tunica externa from the tunica media

The smooth muscles of arteries are arranged in a circular manner around the lumen. Sympathetic nerve fibers of the autonomic nervous system are supplied to the vascular smooth muscle.

When there is Sympathetic stimulation, the smooth muscles contract, squeeze the lumen wall and narrow the blood vessel and produce a decrease in the size of the lumen of a blood vessel.

Conversely when Sympathetic stimulation decreases the smooth muscle fibers relax, produce an increase in the size of lumen and it is called vaso dilation.

Elastic Arteries:

Large arteries are referred to as elastic (conducting) arteries. These are called as elastic arteries because the wall of the elastic arteries is relatively thin in proportion to their diameter and their tunica media contains more elastic fibers and less smooth muscle.

According to the contraction and forces of the heart these elastic arteries stretch to accommodate the surge of the blood and store the pressure energy.

During the relaxation the wall of the elastic arteries recoils to create pressure moving the blood forward in a more continuous flow.

The examples of elastic arteries –

Aorta, brachiocephalic, common carotid, subclavian, vertebral and common iliac arteries.

Elastic arteries are also referred as conducting arteries because they conduct blood from the heart to medium – sized muscular arteries.

Muscular Arteries:

Medium sized arteries are called as muscular (distributing) arteries because the tunica media contains more smooth muscles than elastic fibers and they are capable of greater vaso constriction and vaso dilation to adjust the volume of blood to suit the needs of the structure supplied.

The walls of these arteries are relatively thick, mainly due to the large amounts of smooth muscle.

Examples – axillary, brachial, radial, femoral, popliteal, tibial, splenic, mesenteric arteries.

They are also called as distributing arteries because they distribute blood to various parts of the body.

Anastomoses:

The junction of two or more blood vessels supplying the same area is called anastomoses. It forms a link between arteries supplying an area.

Usually distal end of the blood vessels unite together to form anastomoses.

It may also occur between the origins of veins between arterioles and venules.

Anastomoses between arteries provide alternate routes by which blood can reach a tissue or organ.

The alternate route of blood to a body part through anastomoses is known as collateral circulation

Arteries that do not anastomose are known as end arteries. Occlusion of an end artery interrupts the blood supply and produces necrosis.

Arterioles:

An arteriole is a very small almost microscopic artery that delivers bloods to capillaries.

Arterioles play an important role in regulating blood flow from arteries into capillaries. It is also having three layers.

1. Tunica interna – inner layer
2. Tunica media – middle layer, which is composed of smooth muscles and elastic fibers.
3. Tunica externa – outer layer, which is composed of elastic and collagenous fibers.

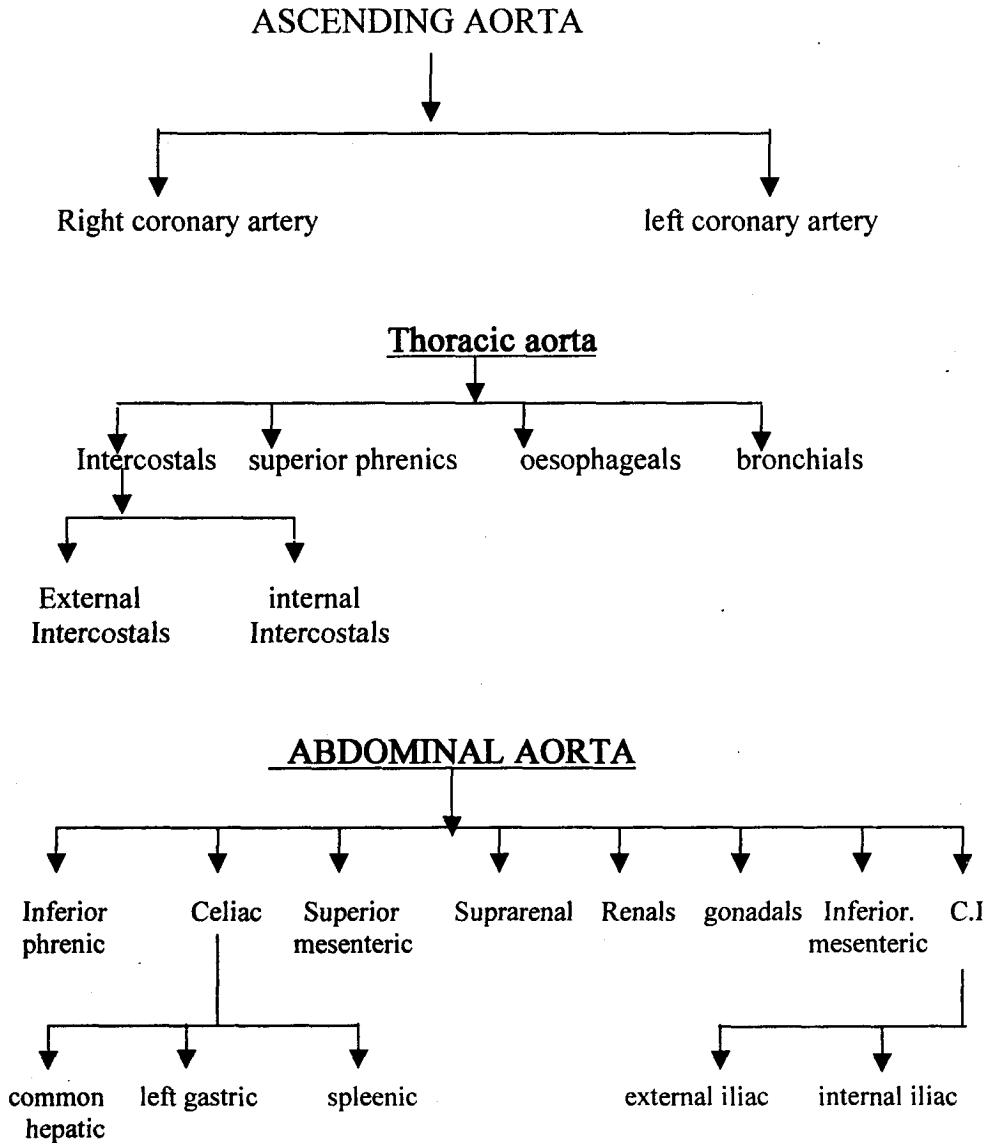
Arterioles are also subjected to vasoconstriction and vasodilation.

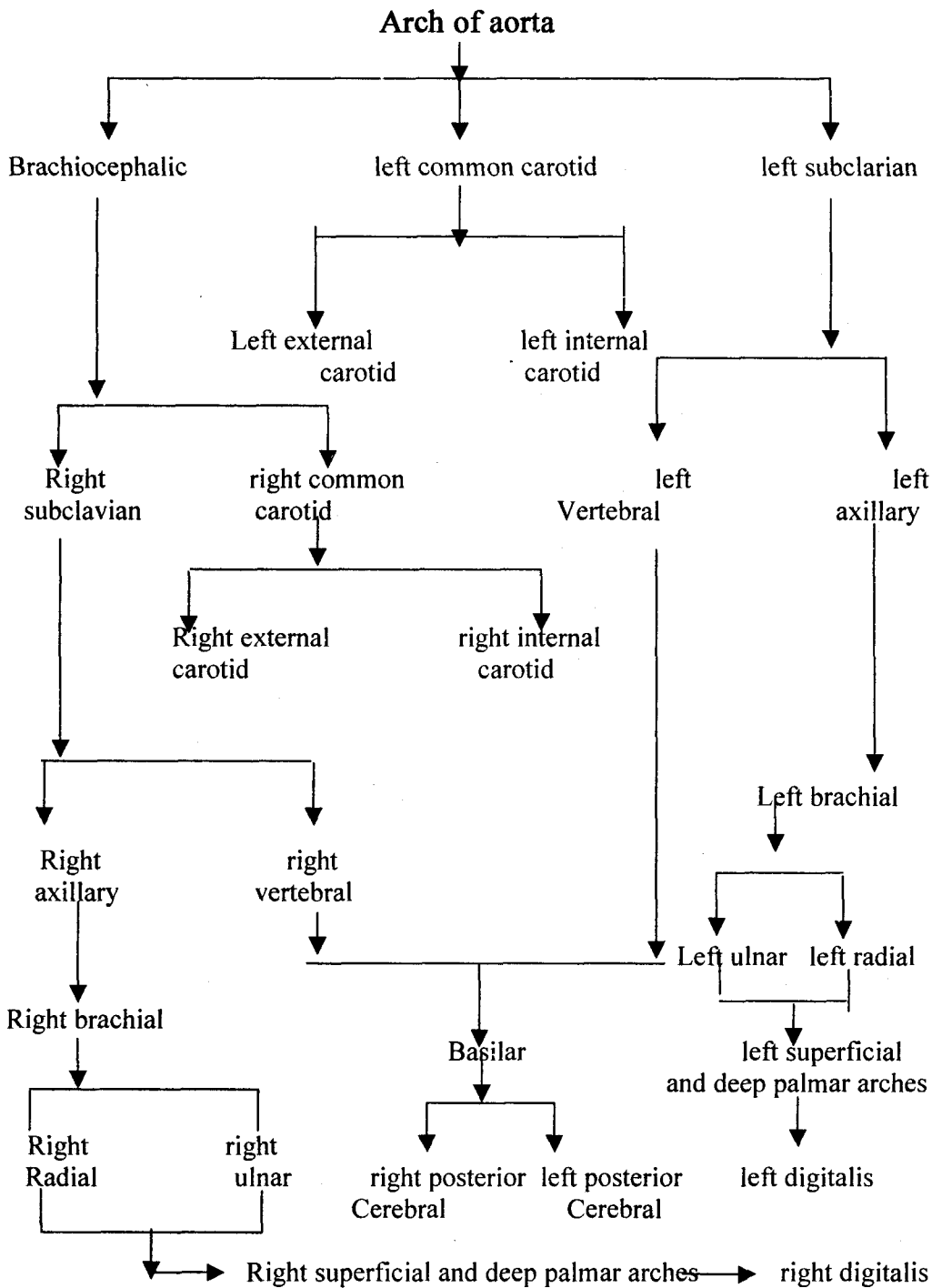
Applied Anatomy:

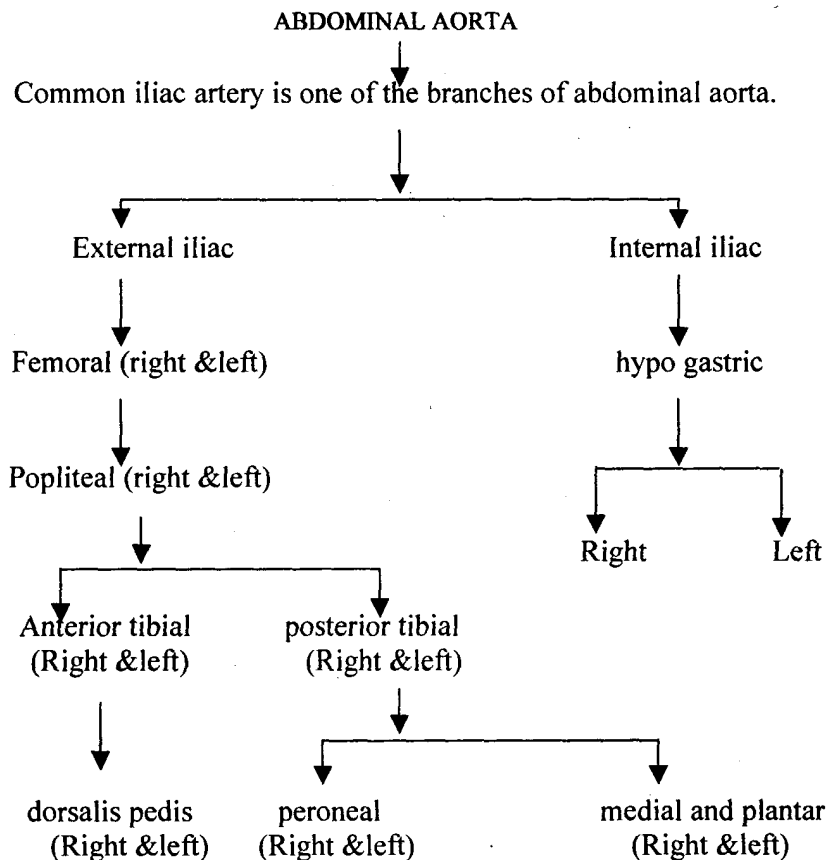
A little change in the diameter of arterioles has a significant effect on blood pressure.

Digital subtraction Angiography.

THE DISTRIBUTION OF ARTERIES:







Veins:

Veins are blood vessels that transport blood to the heart.

It has three layers it to arteries but there are variations in their relative thickness.

The walls of the veins are thinner than those of arteries but have the same three layers of tissues.

Layers Of Veins:

1. Tunica interna – the innermost layer and it is externally thin compared with that of their accompanied arteries.

2. Tunica media – it is much thinner than that of accompanied arteries and it is the middle layer of veins.

3. Tunica externa – it is the external layer of vein and it is thicker than the arteries. Many veins especially those in the limbs contain valves and prevent the back flow. Normal valves help the flow of blood towards the heart. Valves are absent in very small and very large veins in the thorax and abdomen.

A fold of tunica interna, strengthened by connective tissues, forms the valves. They are semi lunar in shape with the concavity towards the heart.

Venules:

When several capillaries unite they form small veins called venules. Venules collect blood from capillaries and drain into vein. It is made up of three layers;

1. Tunica interna – innermost structure made up of endothelial.

2. Tunica median – middle layer

3. Tunica externa – outermost layer

The venules become larger as they approach veins; here they also contain the tunica externa, characteristic of veins.

Capillaries:

Capillaries are microscopic vessels that usually connect arterioles and venules. It is almost found near to every cell.

Capillaries richly supply those areas of the body, which are highly active.

The flow of blood from arterioles to venules through capillaries is called as microcirculation. Distribution of capillaries varies with the metabolic activities of the tissues.

The primary function of a capillary is to permit the exchange of nutrients and wastes between the blood and tissue cells through interstitial fluid.

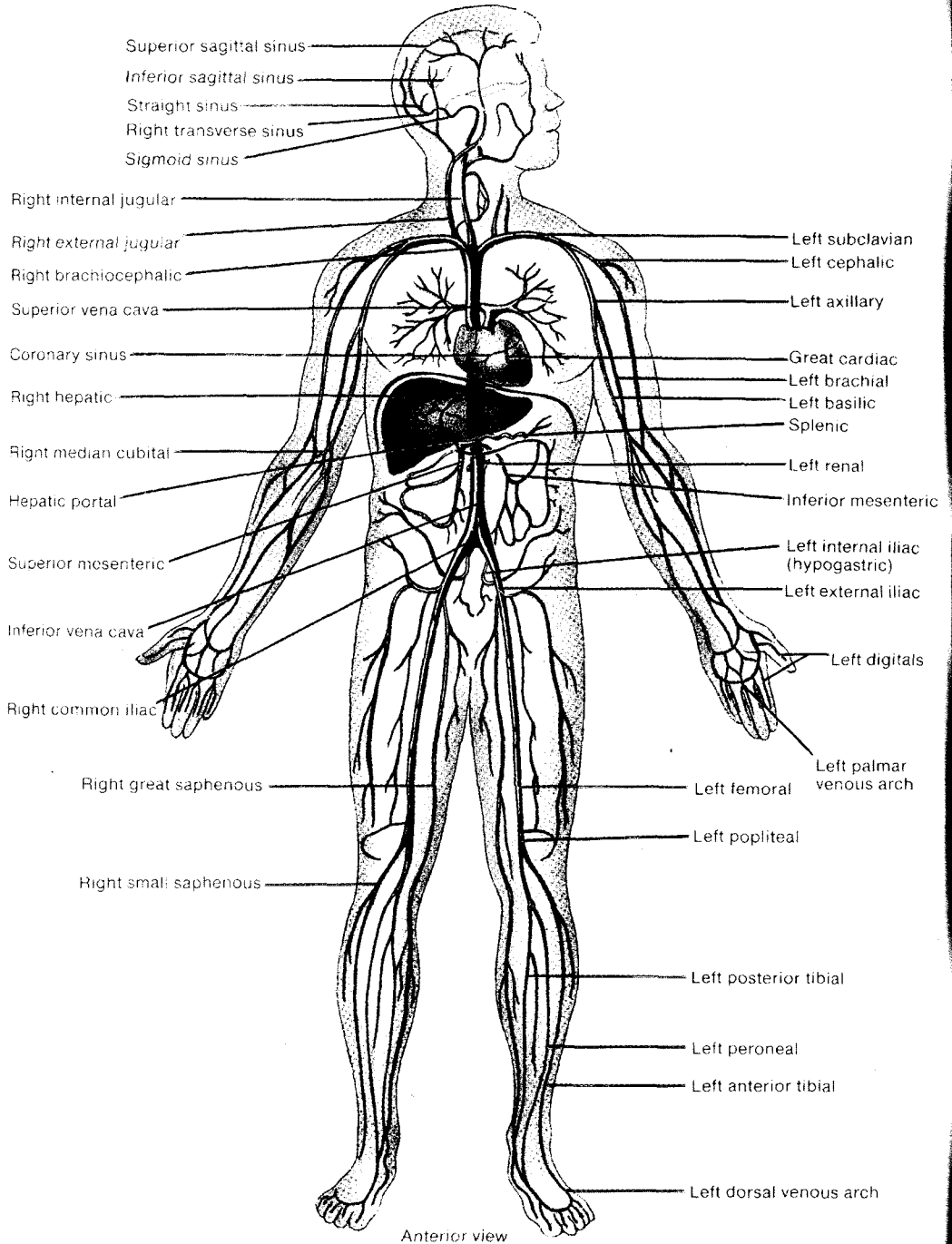
Capillary walls are composed of only a single layer of epithelial cells (endothelium) and a basement membrane. They have no tunica media or tunica externa.

Thus a substance in a blood passes through just one cell layer of interstitial fluid before reaching tissue cells. The exchange of materials occurs only through capillary walls.

Capillaries form extensive branching network that increase the surface area of diffusion and filtrations and there by allow rapid exchange of large quantities of materials. In most of tissue, blood flows through a small portion of capillary network. When metabolic needs are low, but when a tissue is active such as while contracting a muscle, the entire capillary fills with blood.

Vessels with smooth muscles and their walls regulate the flow of blood through capillaries. The Meta arteriole is a vessel that emerges from an arteriole. It passes through the capillary network and empties into a venule.

Principal veins of human body



The proximal portion of the Meta arteriole is surrounded by scattered smooth muscle fibers whose contraction and relaxation help to regulate blood flow and pressure. The distal portion of the Meta arterioles, which empties into a venule has no smooth muscle fibers and it is called a through fare channel.

Veins Of Systemic Circulation:

Deoxygenated blood returns to the right atrium from three veins:-

1. Coronary sinus
2. Superior vena cava and
3. Inferior vena cava

Coronary Sinus –

It receives blood from cardiac vein, which are supplied to myocardium. It is located in the coronary sulcus and opens into right atrium between the orifice of the inferior vena cava and the tricuspid valve.

Superior Vena Cava (SVC)-

The SVC is about 7.5 cm long and empties its blood into the superior part of the right atrium. It begins posterior to the right first costal cartilage by the union of the right and left brachiocephalic veins and at the level of right third costal cartilage, where it enters the right atrium. It drains blood from the head, neck, upper limbs and thoracic wall.

Inferior Vena Cava (IVC)-

The IVC is the largest vein in the body about 3.5 cm in diameter. It begins anterior to the fifth lumbar vertebra by the union of common iliac veins ascends behind the peritoneum to the right of midline, pierces the costal tendon of the diaphragm at the level of the eighth thoracic vertebra, and enters inferior part of the right atrium. The IVC is commonly compressed during the later stages of pregnancy by the enlarging uterus. This produces oedema of the ankles and feet and temporary varicose veins. IVC drains the blood from the lower limbs, most of the abdomen walls and abdominal viscera.

IMPORTANT ARTERIES OF THE BODY

1. Brachiocephalic artery – it is the first branch off arch of aorta. It divides to form right subclavian artery and right common carotid artery.
2. Right subclavian artery – it is supplied to arm, fore arm and hand. Continuation of this artery into axilla is called axillary artery. From here it continues into arm as branchial artery. Again branchial artery divides into medial ulnar and lateral radial arteries.
3. Right common carotid artery – it passes upward in neck. At upper level of larynx, it divides into right external and right internal carotid arteries. External carotid supplies right side of thyroid gland, tongue, throat, face, ear, scalp and duramater. Internal carotid supplies brain, right eye, and right sides of forehead and nose

4. Left common carotid – it is the second branch off arch of aorta. Corresponding to right common carotid, it divides into basically same branches with same names.
5. Left subclavian – it is the third branch off arch of aorta. It distributes blood to left vertebral artery and vessels of left upper extremity. Arteries branching from left subclavian are named like those of right subclavian.
6. Bronchial artery – it is the branch of thoracic aorta, which runs from fourth to twelfth thoracic vertebra. Along its course, it sends off numerous small arteries to viscera and skeletal muscles of the chest.

Bronchial arteries are three in number. One right and two bronchial arteries supply the bronchial tubes, visceral pleura, bronchial lymph nodes and esophagus.

7. Celiac artery – it is the first visceral aortic branch below diaphragm. It has three branches
 - (i) Common hepatic artery
 - (ii) Left gastric artery
 - (iii) Splenic artery

The common hepatic artery has three main branches

1. *Hepatic artery proper* – which supplies the liver and gall bladder.
 2. *Right gastric artery* – which supplies the stomach and duodenum.
 3. *Gastroduodenal artery* -which supplies the stomach, duodenum and pancreas.
8. Superior mesenteric artery – it has several principal branches
 1. Inferior pancreaticoduodenal artery which supplies the pancreas and duodenum.
 2. Jejunal and ileal arteries which supplies the jejunum and ileum.
 3. Ileocolic artery - which supplies the ileum and ascending colon.
 4. Right colic artery – which supplies the ascending colon.
 5. Middle colic artery – which supplies the transverse colon.
 9. Inferior mesenteric artery – the principal branches of this artery are
 1. Left colic artery, which supplies the transverse and descending colon.
 2. Sigmoid arteries, which supply the descending and sigmoid colons.
 3. Superior rectal artery, which supplies the rectum.

10. Common Iliac Arteries – at about level of fourth lumbar vertebra, abdominal aorta divides into right and left common iliac arteries. Each passes downward about 5cm (2inches) and gives rise to two branches internal iliac and external iliac.

IMPORTANT VEINS OF THE BODY

1. *Superior Vena cava (SVC)* – Veins of the head and neck, upper extremities and some from the thorax empty into the superior vena cava.
2. *Internal jugulars* – Right and left internal jugular veins receive blood from face and neck. They arise as continuation of sigmoid sinuses at base of skull.

Other sinuses that drain into internal jugular include superior sagittal sinus, inferior sinus and transverse sinuses. Internal jugular descend on either side of neck and pass behind clavicles, where they join with the right and left subclavian veins. Unions of internal jugulars and subclavians from right and left brachiocephalic veins.

3. *External jugulars*:- right and left external jugular veins run down neck along outside of internal jugulars. They drain blood from parotid (Salivary) glands, facial muscles, scalp and other superficial structures into subclavian veins.

4. *Brachiocephalic Vein*:- it is the important vein of thorax. Right and left brachiocephalic veins formed by union of subclavians and internal jugulars; drain blood from head, neck, upper extremities, mammary glands and upper thorax. Brachiocephalic unite to form superior vena cava.

5. *Inferior vena cava (IVC)* it is the largest vein in the body. It is about 3.5 cm in diameter. It begins at the fifth lumbar vertebrae by the union of two common iliac veins, ascends behind the peritoneum to the right of the mid line, pierces the costal tendon of the diaphragm at the level of eighth thoracic vertebrae and enters the inferior part of right atrium.

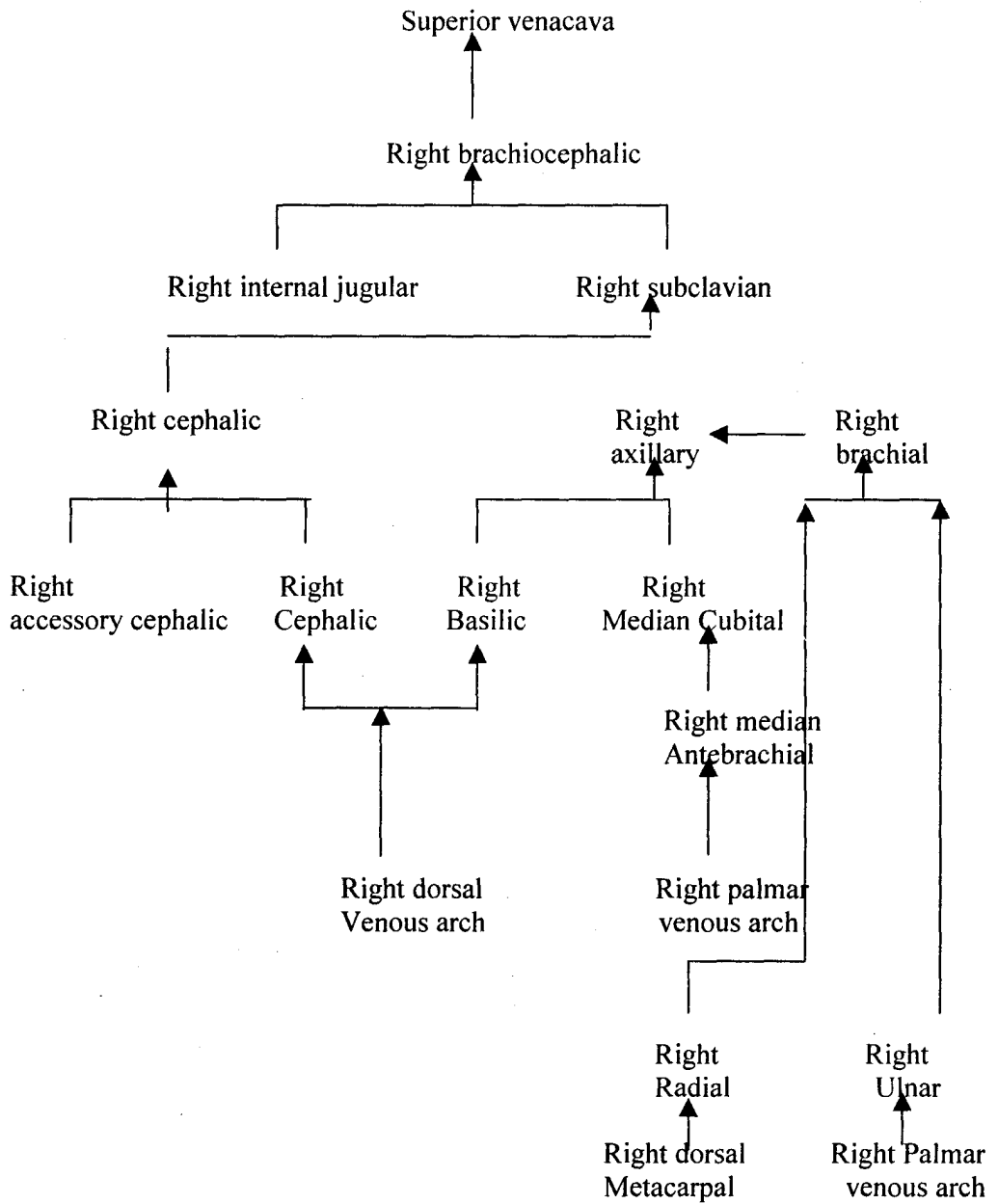
6. *Great saphenous vein*: - it is the longest vein in the body. It begins at medial end of dorsal venous arch of foot. It passes in front of medial malleolus and then upward along medial aspect of leg and thigh. It empties femoral vein in groin.

7. *Femoral vein*: - it is upward continuation of popliteal just above knee. Femoral run up posterior of thighs and drain deep structures of thighs. After receiving great saphenous veins on groin, they continue as right and left external iliac veins.

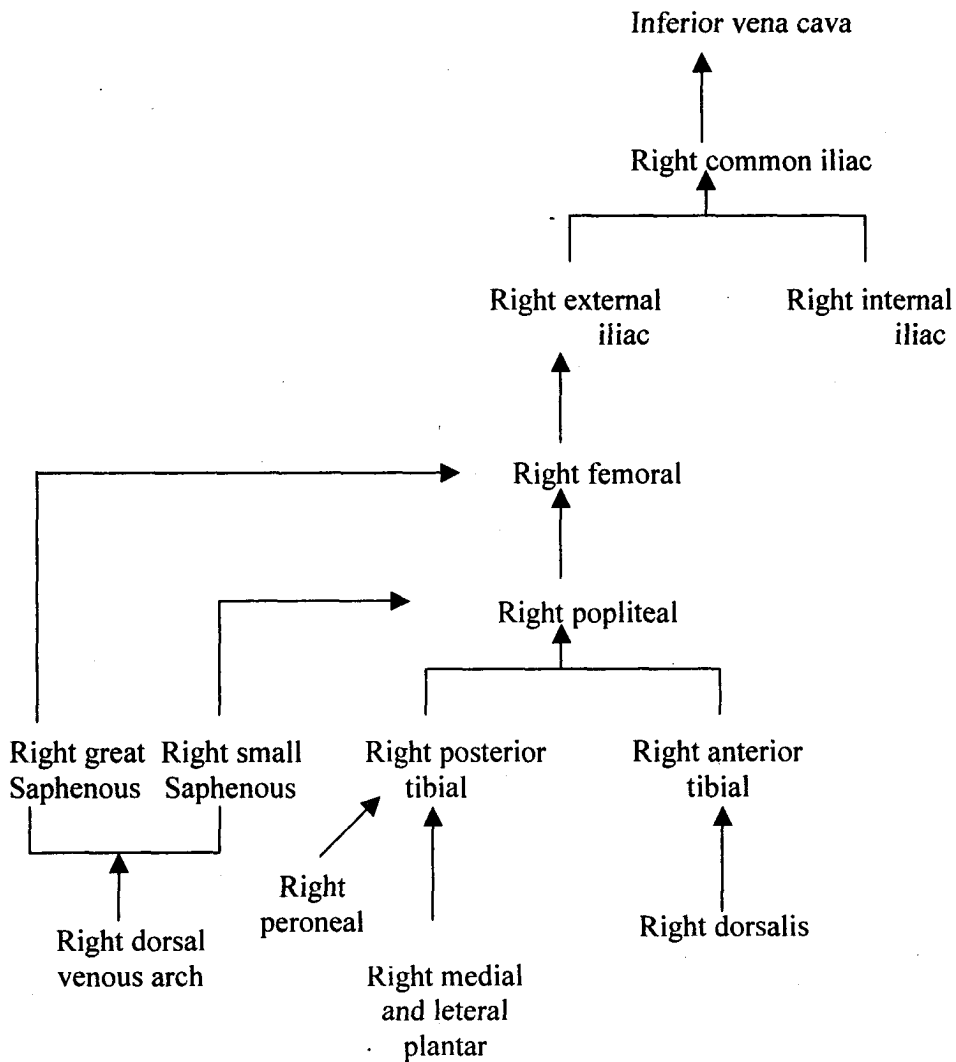
Differences Between The Artery And The Vein.

S.no	Artery	Vein
1	Arteries does not have valves	Veins especially those in limbs Contains valves.
2	Tunica interna – thicker	Tunica interna – thinner
3	Tunica media – thicker	Tunica media – thinner
4	Tunica externa – thinner	Tunica externa – thicker
5	External and internal elastic laminae are present.	External and internal elastic Laminae are absent.
6	Lumen of artery is small.	Lumen of vein is larger.
7	Changes of back flow of blood in Arteries due to lack of valves.	No chance of back flow of blood Due to presence of valves.
8	Arterioles are the branches of Arteries.	Venules are the branches of veins
9	Arteries have more blood pressure than veins.	Veins has less blood pressure than Arteries.
10	Arteries carry blood from the heart.	Veins carry blood towards the heart.

VEINS OF UPPER EXTREMITIES



VEINS OF LOWER EXTREMITIES



HEART (हृदयं)

There are many descriptions regarding the location, function and applied aspects,

1. स्तनयोर्मध्यं अधिष्ठाय उरस्य आमाशयद्वारं
सत्वरजः तमसां अधिष्ठानं हृदयं नाम मर्म तत्र
सद्य एव मरणम् ॥ (Su.Sha.6/25)

The heart is situated in between the two breasts and occupying a position in the mediastinum. It is the seat of three gunas-Satva, Rajas and tamas. It is also present near the cardiac orifice of the stomach. The हृदयं is a marma which when hurt causes instantaneous death.

2. शोणित कफप्रसादजं हृदयम् ।
यदाश्रया हि धमन्यः प्रामवहाः ।
तस्याधो वामतः प्लीहा फुफ्फुसश्च,
दक्षिणतो यकृत् क्लोम च । तत् वशेषेण चेतनास्थानम् ॥ (Su.Sha.4/31)

The हृदयं is formed from the essence part of shonita and kapha. It is the seat of Pranavaha dhamanis.

Some structures are present just inferior to the heart.

1. Left side-Pleeha (spleen) and Phupphusa (lung)
2. Right side-Liver and Kloma.

3. पुण्डरिकेण सदृश्यं हृदयं स्यात् अधोमुखम्
जाग्रतस्त विकसति स्वपतश्च निमिलती ॥ (Su.Sha.4/32)

Heart resembles just like a lotus bud and it is inverted position in an awakened person it is more active and during sleep it is less active.

4. दश जीवित धामनि शिरोरसन बंधनम्
कण्ठोअस्त्रं हृदयं नाभिर्वस्तिः शुक्रोजसि गुदम् ॥ (A.H.)

Out of 10 pranayatanas (the seats of life), हृदय is one. The other pranayatanas are Shira, Jihwa, Kantha, Mukha, Nabhi, Vasti, Sukra, Oja and Guda.

5. सप्तोत्तरम् मर्मशं त यदुक्तं शरिर संख्यां अदिकृत्य तेभ्यः ।
मर्माणि बस्तिं हृदयं शिरश्च प्रधान भूतानि वदन्ति संज्ञाः ॥ (Ch.Chi.26/3)

There are 107 marmas are present in the body. Out of 107 marmas charaka has given importance to 3 marmas (Vasti, Hridaya and Shira)

6. हृदयं चेतनास्थानं उक्तं सुश्रुतदेहिनाम् (Su.Sha.4/34)
हृदय is the site of chetana (consciousness).

THE HEART

The heart is a hollow cone-shaped muscular organ situated in the middle mediastinum. The heart is enclosed with a fibro serous sac called as pericardium. It pumps the blood to various parts of the body to meet their nutritive requirement.

The heart is placed obliquely behind the body of the sternum and adjoining parts of the costal cartilages. $\frac{1}{3}^{\text{rd}}$ of it lies to the right side and $\frac{2}{3}^{\text{rd}}$ to the left side of the median plane.

The heart is 12 cm long, 9 cm wide at its broadest point and 6 cm thick. It weighs about 300 gm in males and 250gms in females.

The average weight: 260 - 320gm in male
240 - 280gm in females.

The heart has an apex and a base.

Apex. - It is formed by the tip of the left ventricle and pointed towards the inferior end of the heart and towards left side.

Base. - It is broad and rather flat, like base of a pyramid. The base of the heart is formed by the atria, mostly the left atrium.

Special Features Of The Heart:

- The heart has 4 chambers.
- The heart has 4 borders.
- The heart has 2 surfaces.
- The heart is covered by 3 layers.

Chambers Of The Heart:

The human heart is divided into four compartments called chambers. The two superior chambers called the right atrium and left atrium, two inferior chambers called as right ventricle and left ventricle.

The atria lie above to the ventricles.

The atria are separated from the ventricle by the help of an atrio ventricular groove. The both atria are separated by the inter atrial groove. The ventricles are separated from each other by an inter ventricular groove.

Borders Of The Heart:

Four borders are present in the heart.

1. Upper border- It is slightly oblique and is formed by the two atria mainly the left atrium.
2. Inferior border- it is horizontal and is formed mainly by the right ventricle.
3. Right border- it is more or less vertical and is formed by the right atrium.
4. Left border- it is oblique and curved. Mainly the left ventricle forms it.

Surface Of The Heart:

It has two surfaces.

1. Anterior or sternocostal surface.
2. Inferior or diaphragmatic surface.

Anterior Or Sternocostal Surface:

It is formed mainly by the right atrium and right ventricle; and partly by the left ventricle and left auricle.

Lungs cover most of the parts of anterior surface, but a part of it that lies behind the cardiac notch of left lung is uncovered.

Clinically on percussion the physician gets dull sound that's why it is called as superficial cardiac dullness.

Inferior Or Diaphragmatic Surface:

The inferior surface rests on the central tendon of the diaphragm. It is formed in its left two third by left ventricle and in its right one third by the right ventricle.

Layers Of The Heart:

Three layers form the wall of the heart-

1. Epicardium- external layer of the heart
2. Myocardium- middle layer of the heart
3. Endocardium- inner layer of the heart

The outermost epicardium called as the visceral layer of serous pericardium is composed of mesothelium and delicate connective tissue that imparts smooth, slippery texture to the outermost surface of the heart.

Myocardium is the cardiac muscle tissue that makes up the bulk of the heart and is responsible for its pumping action. Cardiac muscle tissues are involuntary in nature. They are branched and striated.

Endocardium: -The innermost is a thin layer of endothelium overlying a thin layer of connective tissue. It provides a smooth lining for the inside of the heart and covers the valves of the heart.

Circulation Of Blood:

The right atrium receives deoxygenated blood from the whole body by the help of superior and inferior venaecavae and the coronary sinus. After receiving the blood the right atrium contracts and sends the blood to right ventricle through the right atrio ventricular orifice (tricuspid valve).

The right ventricle contracts and propels the blood into the pulmonary trunk, the pulmonary and finally to the lungs where the blood is oxygenated.

The oxygenated blood returns to the heart through the 4 pulmonary veins and enters the left atrium. The left atrium contracts and sends its blood through the left atrio ventricular orifice (bicuspid valve) into the left ventricle, which in turn contracts and drives the blood into the ascending aorta and its ramifications.

Valves Of The Heart:

There are two pairs of valves in the heart, a pair of atrio ventricular valves and a pair of semilunar valves.

Total four valves are present in the heart

1. Right Atrioventricular valve- Tricuspid valve- It has three cusps.
2. Left atrioventricular valve- Bicuspid valve- It has two cusps. It is otherwise known as mitral valve.
3. Semilunar valves are two in number, which include the aortic and pulmonary valves. Each is having three semilunar cusps. Both valves are similar to each other. The cusps are folds of endocardium, strengthened by an intervening layer of fibrous tissue.

The valves of the heart maintain unidirectional flow of blood and prevent its regurgitation in the opposite direction.

Atrioventricular Valves:

Both mitral and tricuspid valves are made up of the following components.

1. A fibrous ring to which the cusps are attached.
2. The cusps are flat and project into ventricular cavity.
3. The valves are closed during ventricular systole by opposition of the atrial surface near the serrated margins.
4. The atrio ventricular valves are kept competent by active contraction of papillary muscles, which pull on chordae tendinae during ventricular systole.
5. The tri cuspid valve has three cusps and can admit the tips of three fingers. The three cusps (anterior, posterior or inferior and septal) lie against the three walls of the left ventricle.
6. The mitral (bi cuspid) valve has two cusps, large anterior or aortic cusps, and a small posterior cusps. It admits the tips of two fingers. The anterior cusps lies between the mitral and aortic orifices. The mitral cusps are smaller and thicker than those of tri cuspid valve.

Apex Of The Heart:

This is formed by the left ventricle. It is directed downwards, forwards and to the left and is overlapped by the anterior border of the left lung. It is situated in the left 5th intercostals space 3 1/2 inches lateral to the midsternal line, just medial to the clavicular line. In the living subject pulsations may be seen and felt over this region.

Base Of The Heart:

The base of the heart forms its posterior surface. It is formed mainly by the left atrium and by a small part of the right atrium. In base there are openings of four pulmonary veins, which open into the left atrium; and of the superior and inferior venaecvae, which open into the right atrium. It is related to the middle four thoracic vertebrae (T5-T8) in the lying posture, and descends by one vertebra (T6-T9) in the erect posture. It is separated from the vertebral column by the pericardium, the right pulmonary veins, the oesophagus and the aorta.

Right Atrium:

It is the right upper chamber of the heart. It receives venous blood from the whole body and pumps it to the right ventricle through the right atrioventricular (tricuspid) opening.

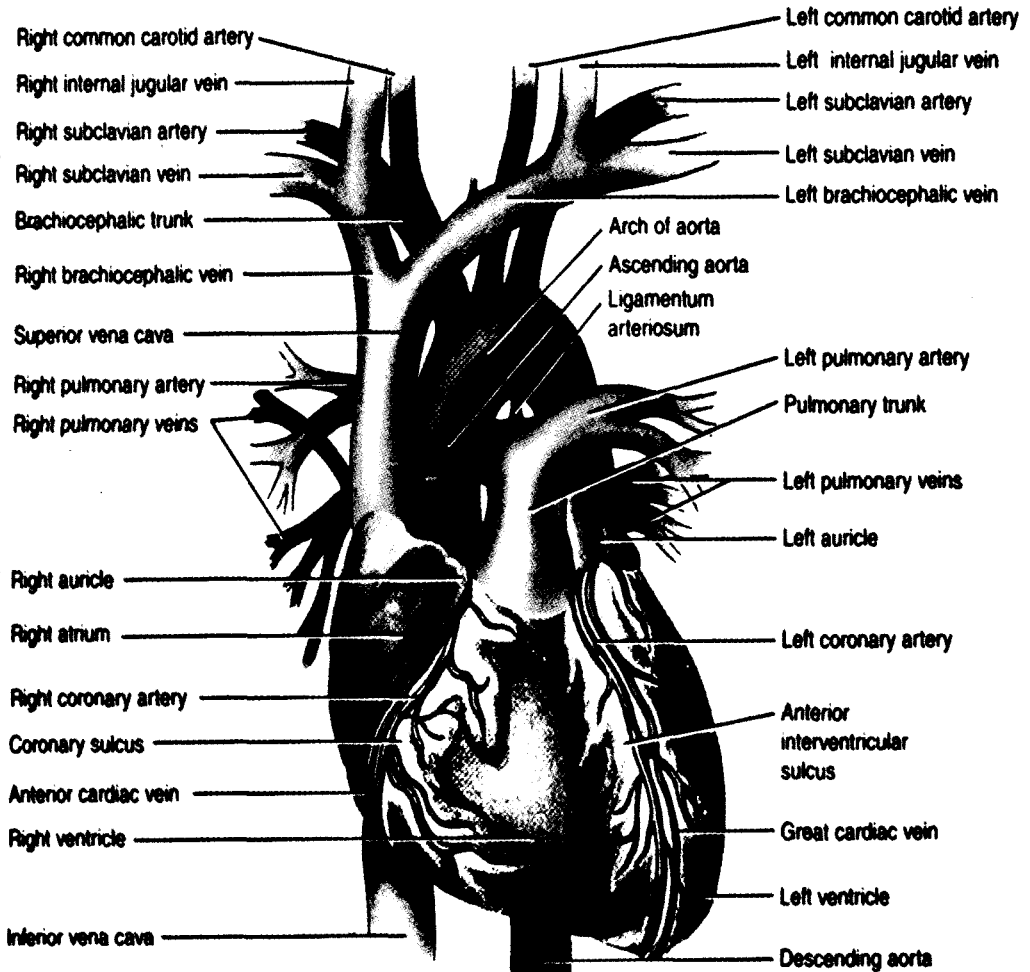
External Features:

1. The chamber is elongated vertically, receiving the superior venecava at the upper end and the inferior venecava at the lower end.
2. The upper end is prolonged to the left to form the right auricle. The auricle covers the root of the ascending aorta and partly overlaps the infundibulum of the right ventricle.
3. The right atrio ventricular groove separates the right atrium from the right ventricle.
4. Along the right border of the atrium there is a shallow vertical groove, which passes from the superior venacava to the inferior venacava. The groove is called sulcus terminalis. An internal muscular ridge called the crista terminalis produces it. The upper part of the sulcus contains the sinuatrial (SA) node acts as the pacemaker of the heart.

Tributaries Of Right Atrium:

- i. Superior venacava.
- ii. Inferior venacava.
- iii. Coronary sinus.
- iv. Anterior cardiac veins.
- v. Venae cordis minimi.
- vi. Right marginal vein.

The Heart - Anterior View



Right Atrioventricular Orifice:

Blood passes out of the right atrium through the right atrio ventricular (tricuspid) orifice and goes to the right ventricle. The tricuspid orifice is guarded by the tricuspid valve, which maintains unidirectional flow of blood.

Right Ventricle:

It is a triangular chamber, which receives blood from the right atrium and pumps it to the lungs through the pulmonary trunk and pulmonary arteries. It forms the inferior border, a large part of the sternocostal surface, and a small part of the diaphragmatic surface of the heart.

It has two surfaces

1. Anterior (sternocostal)
2. Interior (diaphragmatic)

The interior has two parts

a). The inflowing part is rough due to the presence of muscular ridges called trabecular Carneae. b). The out flowing part or infundibulum is smooth and forms the upper conical part of the right ventricle. The wall of the right ventricle is thinner than that of the left ventricle, in a ratio of 1: 3

The Left Atrium:

It is a quadrangular chamber, situated posteriorly its appendage, the left auricle projects anteriorly to overlap the infundibulum of the right ventricle. The left atrium forms the left $\frac{2}{3}^{\text{rd}}$ of the base of the heart. It receives oxygenated blood from the lungs through four pulmonary veins, and pumps it to the left ventricle through the left atrio ventricular (bicuspid or mitral) orifice, which is guarded by the valve of the same name. Two Pulmonary veins open into the atrium on each side of posterior wall.

The Left Ventricle The left ventricle receives oxygenated blood from the left atrium and pumps it into the aorta. It forms the apex of the heart, a part of sternocostal surface, most of the left border and left surface, and the left $\frac{2}{3}^{\text{rd}}$ of the diaphragmatic surface. Externally, the left ventricle has three surfaces anterior (Sternocostal), inferior (diaphragmatic) and left. The interior is divisible into two parts. The lower rough part with (trabeculas carneae) develops from the primitive ventricle of the heart tube. The upper smooth part (aortic vestibule) gives origin to the ascending aorta.

Blood Supply of Heart:

Arteries:

The heart is supplied by two coronary arteries, arising from the ascending aorta. Both arteries run in the coronary sinus.

Right Coronary Artery – It is smaller than the left coronary artery. It arises from the anterior aortic sinus. Left Coronary Artery – It is larger than the right coronary artery. It arises from the left posterior aortic sinus.

Veins

Greater Cardiac Vein

Middle Cardiac Vein

Smaller Cardiac Vein

Posterior vein of left ventricle

Oblique vein of left atrium

The right marginal Vein

The anterior cardiac veins

Venae cordis minimae

Coronary sinus is the largest vein of the heart. It is situated in the left posterior coronary sulcus. It is about 3 cm long. It ends by opening into the posterior wall of right atrium.

Lymphatics Of The Heart:

Lymphatics of the heart accompany the coronary arteries and form two trunks. The right trunk ends in the brachiocephalic nodes and the left trunk ends in the tracheobronchial lymph nodes at the bifurcation of the trachea.

Nerve Supply Of The Heart:

Parasympathetic nerves reach the heart via the vagus. These are cardio inhibitory on stimulation nerves are derived from the upper 3 – 5 thoracic segments of the spinal cord. Both parasympathetic and sympathetic nerves form the superficial and deep cardiac plexuses, the branches of which run along the coronary arteries to reach the myocardium.

The Conducting System Of The Heart

Heart is made up of myocardium that is specialized for initiation and conduction of the cardiac impulse. His fibres are finer than other myocardial fibres, and are completely cross – striated.

The conducting system comprises of the following parts.

1. Sinuatrial Node (SA Node) – It is known as the “pace maker” of the heart. It generates an impulse at the rate of about 70 / min. and initiates the heart beat. It is a horseshoe shaped and is situated at the atriocaval junction in the upper part of the septum. The impulses travel through the arterial wall to reach the AV Node.
2. Atrio-ventricular Node (AV Node) – It is relatively smaller than SA node. It is situated in the lower and dorsal part of atrial septum just above the opening of coronary sinus. It is capable of generating impulses at a rate of about 60 / min.
3. Atrioventricular Bundle (AV Bundle or Bundle of His) – it is, the only muscular connection between the atrial and ventricular musculatures. It begins at the AV Node, crosses the AV ring and descends along the poster inferior border of the membranous part of the ventricular septum. At the upper border of the muscular part of the septum it divides into right and left branches.
4. The Right Branch of AV bundle passes down the right side of inter ventricular septum. Some part of it goes into the anterior wall of right ventricle where it divides into Purkinje fibres.
5. The left branch – It is distributed into the left ventricle after dividing into Purkinje fibres.
6. The Purkinje fibres form a subendocardial plexus. They are large, pale fibres striated only at their margins.

Defects or damage to this system results in cardiac arrhythmias i.e., defects in the normal rhythm of contraction.

The left branch of AV Bundle supplied by coronary artery.

Clinical Correlation:

1. Consciousness of one's own heartbeat is called as palpitation.
2. Inflammation of the heart can involve more than one layer of the heart. Inflammation of the pericardium is called pericarditis; of the myocardium is myocarditis; and of the endocardium is endocarditis.
3. Rapid heart rate more than 100 / minute is called as tachycardia.
4. Slow heart rate less than 60 / minute is called as bradycardia.
5. Any one of the four chambers of the heart can fail separately, but ultimately the rising backpressure causes right-sided failure (Congestive Cardiac failure or CCF), which is associated with increased venous pressure, Oedema on feet, and breathlessness on exertion. Heart failure (right sided) due to lung disease is known as Cor Pulmonale.
6. Normally the cardiac apex (apex beat) is on the left side. In the condition called dextrocardia the apex beat is on the right side.

Muscular System पेशीशरीरम् (Myology)

It is a structure where the blood vessels ligaments, Dhamani (arteries and veins) and channels are spread over.

वायुःअनुप्रविश्य पिशितं पेशीवीभजते तथा ॥ (Su.Sha.4/29)

When Vayu enters into the fleshy materials it separates to form the different type of muscles.

मांसावयवसंघातःपरस्पर विभक्तःपेशिइतिउच्यते ।

Pesi is a structure produced by the dividadion of fleshy organs.

सिरास्त्राय्वस्थिपर्वाणि सन्ध्यश्च शरीरिणाम् ॥

पेशीभिः संवृतान्यत्र बलवन्ति भवन्त्यतः ॥ (Su.Sha.5/38)

In the body, blood vessels, ligaments, bones, small and big joints- all are covered with muscles that is why they are strong.

तासां बहलपेलवस्थूलाणुपृथुवृत्तह्रस्वदीर्घस्थिरमृदुश् लक्षणकर्कश भावाः

सन्ध्यस्थिसिरास्त्रायुप्रच्छादका यथाप्रदेशं स्वभावत एव भवन्ति ॥ (Su.Sha.5/40)

While covering joints, bones, blood vessels and ligaments they (muscles) become naturally, according to place, abundant, scanty, large, small, flat, round, short, long, hard, soft, smooth and rough.

पञ्च पेशीशतानि भवन्ति । तासां चत्वारि शतानि शाखासु, कोष्ठे षट्षष्टिः, ग्रीवां प्रत्यूर्ध्वं चतुर्त्रिंशत् ॥ (Su.Sha.5/37)

The total numbers of muscles are 500. Out of them, 400 are in extremities, 66 in trunk and 34 in neck and above.

स्त्रीणां तु विंशतिरधिका । दश तासां स्तनयोरेकैकस्मिन् पञ्च पञ्चेति, यौवने तासां परिवृद्धिः,

अपत्यथे चतस्रः- तासां प्रसृते अभ्यन्तरतो द्वे, मुखाश्रिते बाह्ये च वृत्ते द्वे,

गर्भच्छिद्रसंश्रितास्तिस्त्रः, शुक्रार्तवप्रवेशिन्यस्तिस्त्र एव । पित्तपक्वाशययोर्मध्ये गर्भशय्या, यत्र

गर्भतिष्ठति ॥ (Su.Sha.5/39).

In adult females 20 muscles are additional.

The 20 muscles are arranged in the following manner,

1.5 in each breast – $5 \times 2 = 10$ muscles (which develops at the time of puberty).

2. 4 in vaginal introtus – externally – 2.

internally – 2.

3. 3 in uterine tract.

4. 3 muscles are present where sukra and artava enter inside.

In the males, the pesi of scrotum and penis are on the outer side, while the corresponding ones in the females, lie in the interior and cover the ovaries.

Although bones provide leverage and form the framework they cannot move the body by themselves. Motion results from alter of muscles, which constitute 40-50% of total body weight.

The three kinds of muscle tissue- a. Skeletal- Voluntary in nature

b. Cardiac

c. Smooth

Skeletal Muscle:

It is primarily attached to bones and it moves parts of the skeleton. It is striated because when it is examined under microscope it presents with alternating light and dark bands. It is a voluntary muscle tissue because it can be made to contract and relax by conscious control.

Cardiac Muscle:

It forms most of the heart. It is also striated but it is involuntary because contraction is usually not under conscious control. Cardiac muscle includes a pacemaker system that causes the heart to beat.

Smooth Muscle:

It is located in the walls of hollow internal structures such as blood vessels, the stomach and the intestines as well as most other abdominal organs. It is also found in the skin attached to hair follicles. Under the microscope this tissue looks nonstriated and smooth. The action of smooth muscle is usually involuntary.

Both cardiac muscle and smooth muscle are regulated by neurons that are part of the autonomic (involuntary) division of the nervous system and by hormones released by endocrine glands.

Functions of the muscle tissue

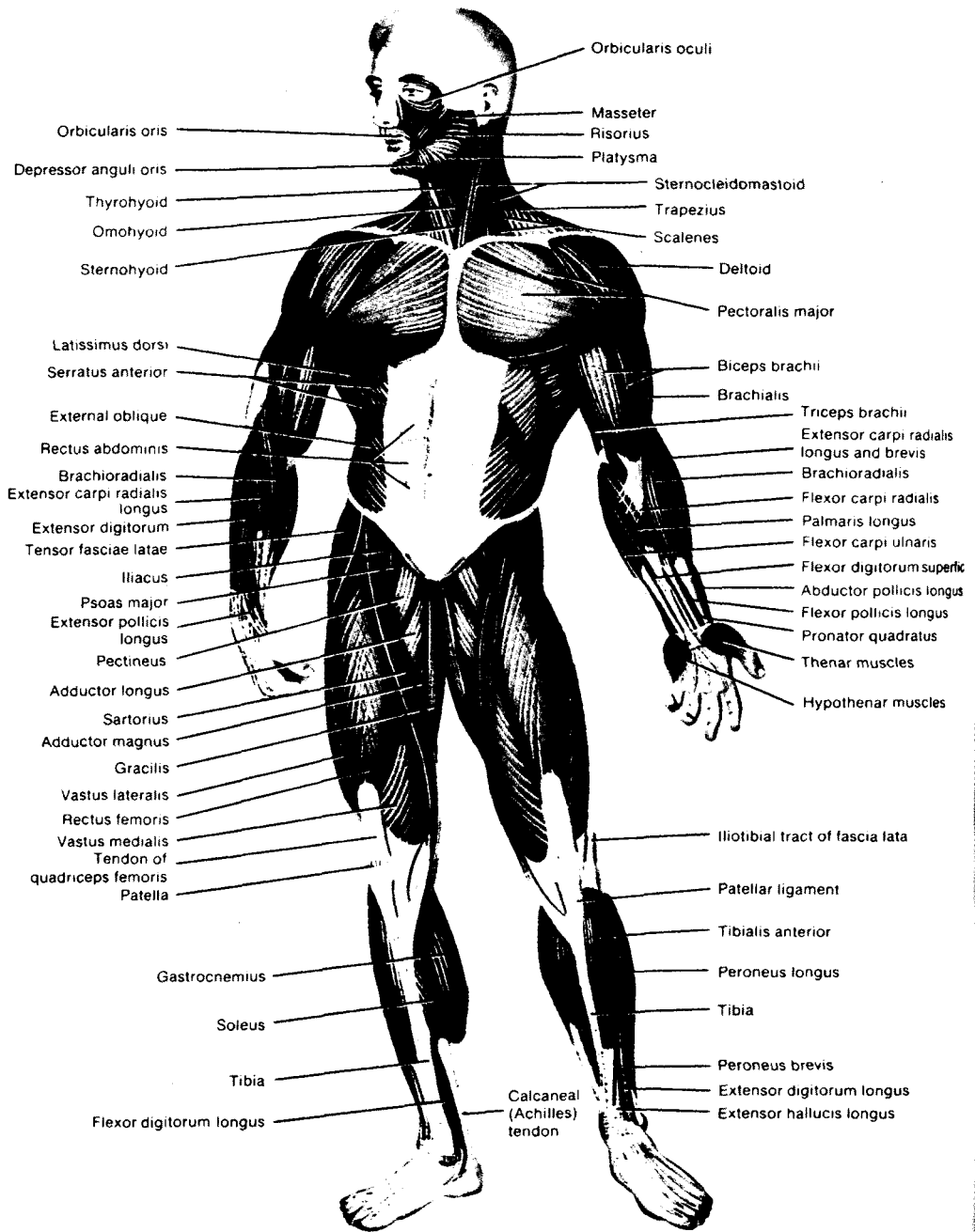
1. By the integrated function of bones, joints and skeletal muscles, the body is able to walk, run, etc.

2. Skeletal muscle contractions stabilize joints and help to maintain body positions such as standing and sitting.

Naming Of Skeletal Muscles

Muscles are named according to the following characteristics.

Muscles of human body - Anterior View



Size - Relative size of the muscle.

Maximum means largest - Gluteus maximus.

Minimum means smallest - Gluteus minimus.

Longus means longest - Adductor longus.

Brevis means short - Peroneus brevis.

Shape - Relative shape of the muscle.

Deltoid means having a triangular shape - Deltoid.

Trapezius means having a trapezoid shape - Trapezius. Serratus means having a saw-toothed shape - Serratus anterior.

Rhomboideus means having a rhomboid (diamond) shape - Rhomboideus major.

Location - Muscle is found near to a structure.

A muscle near the frontal bone - Frontalis

A muscle near the tibia - Tibialis anterior

Number Of Origins - Number of tendons of origin.

Biceps means two origins - Biceps brachii.

Triceps means three origins - Triceps brachii.

Quadriceps means four origins - Quadriceps femoris.

Origin And Insertion- Sites where muscle originates and inserts.

Sternocleidomastoid originates on sternum and clavicle and inserts on mastoid process of temporal bone.

Direction Of Muscle Fibres - Direction of muscle fibres relative to the midline of the body.

Rectus means the fibres run parallel to the midline - Rectus abdominis.

Transverse means the fibres run perpendicular to the midline - Transverse abdominis.

Oblique means the fibres run diagonally to the midline - External oblique.

Actions:

Flexor - Decreases a joint angle - flexor carpi radialis.

Extensor - Increases a joint angle - extensor carpi ulnaris.

Abductor - moves a bone away from the midline - Abductor pollicis longus.

Adductor - moves a bone closer to the midline - Adductor longus.

Levator - Raises or elevates a body part - Levator scapulae.

Depressor - Lowers or depresses a body part - Depressor labii inferioris.

Supinator - Turns palm superiorly and anteriorly - Supinator.

Pronator - Turns palm inferiorly or posteriorly - Pronator teres.

Sphincter - Decreases the size of an opening - External anal sphincter.

Tensor - makes a body part rigid - Tensor fascia latae.

Rotator - Rotates a bone around its longitudinal axis - Obturator externus.

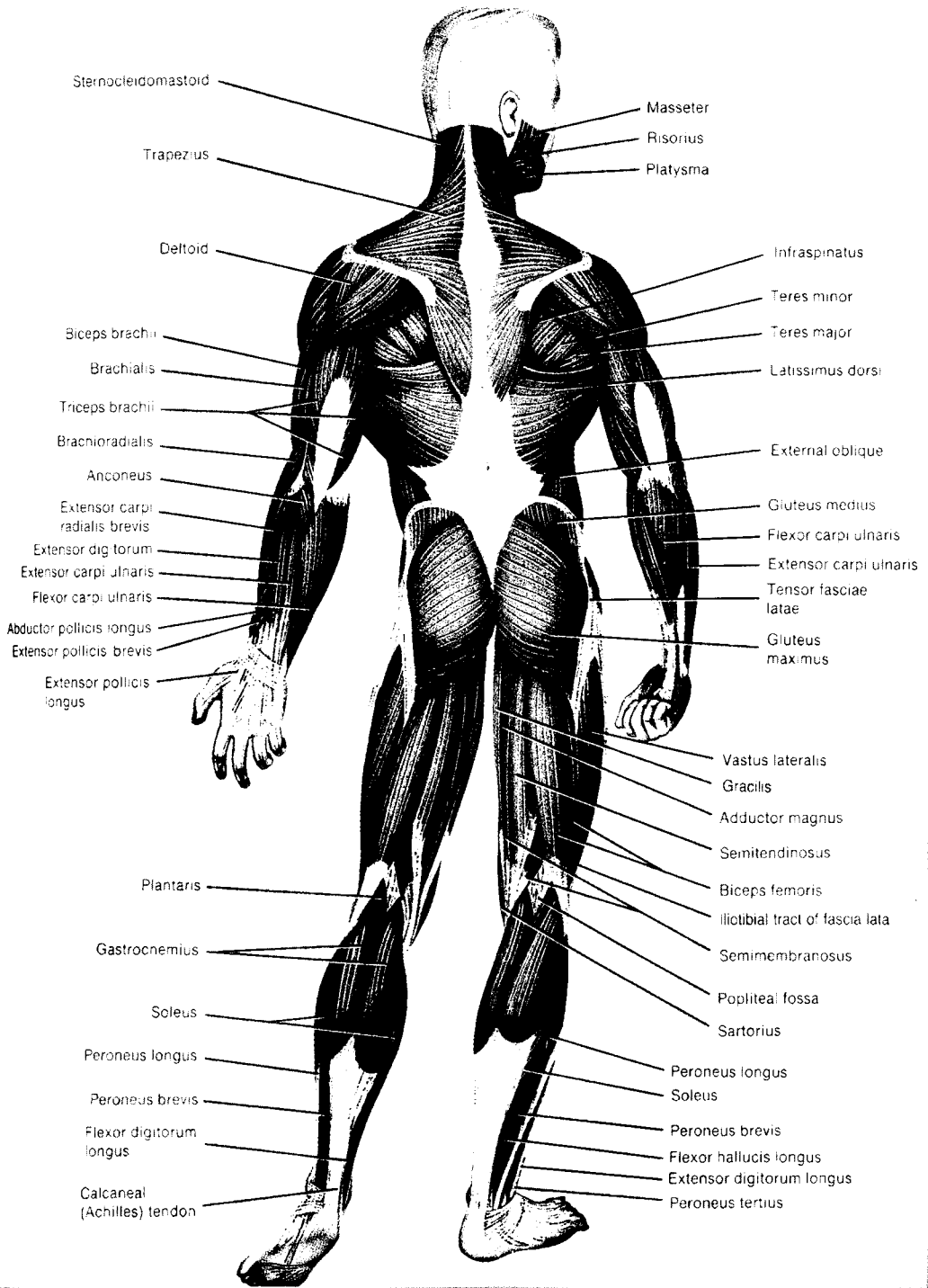
Muscles Of The Leg :

Muscles of the lower limbs are larger and more powerful than those of the upper limbs since lower limb muscles function in stability, locomotion and maintenance of posture. Upper limb muscles characterized by versatility of movement. In addition, muscle of the lower limb often crosses two joints and act equally on both.

The anterior muscles are the Psoas major and Iliacus, together referred to as Iliopsoas. The remaining muscles (except for the Pectineus, Adductors and Tensor Fascia Latae are the posterior muscles. Technically Pectineus and Adductors are component of medial compartment of the thigh, but they are included in this exhibit because they act on thigh. The Fascia lata is a deep fascia of the thigh that encircles the entire thigh

Muscle	Origin	Insertion	Action	Innervations
Psoas major (Psoas=muscle of loin)	Transverse processes and bodies of lumbar vertebra.	Lesser trochanter of femur.	Flexes and rotates the thigh laterally.	Lumbar nerves. L2-L3.
Iliacus.	Iliac fossa.	Tendon of Psoas major.	Flexes and rotates the thigh and flexes the vertebral column.	Femoral nerve.
Gluteus maximus. (Largest and strongest muscle in the body).	Iliac crest, sacrum, coccyx and aponeurosis of sacrospinalis.	Iliotibial tract of fascia lata and lateral part of linea aspera inferior to Greater trochanter.	Extends and rotates thigh laterally.	Inferior gluteal nerve.
Gluteus Medius.	Ilium.	Greater trochanter of femur	Abducts and rotates thigh medially	Superior gluteal nerve.
Gluteus Minimus	Ilium	Greater trochanter of femur	Abduct and rotates thigh medially	Superior gluteal nerve.
Tensor fasciae latae	Iliac crest	Tibia by way of the iliotibial tract	Flexes and abducts thigh	Superior gluteal nerve.

Muscles of human body - Posterior view



Piriformis	Anterior Sacrum	Superior border of greater trochanter of femur	Rotates thigh laterally and abducts it.	S1-S2
Obturator internus	Inner surface of Obturator foramen, Pubis and Ischium	Greater trochanter of femur	Rotates thigh and abducts it	Nerve to Obturator Internus.
Obturator externus	Outer surface of Obturator membrane	Deep depression inferior to greater trochanter of femur	Rotates thigh laterally	Obturator nerve.
Superior gamellus	Ischial spine	Greater trochanter of femur	Rotates thigh laterally and abducts it.	Nerve to Obturator internus.
Inferior gamellus	Ischial tuberosity	Greater trochanter of femur	Rotates thigh laterally and abducts it	Nerve to Quadratus femoris.
Quadratus femoris	Ischial tuberosity	Elevation superior to mid portion of inter trochantric crest (quadrate tubercle) on posterior femur.	Laterally rotates and abducts the thigh.	Nerve to Quadratus femoris.
Adductor longus	Pubic crest and Pubic symphysis	Linea aspera of femur	Adducts, medially rotates and flexes the thigh	Obturator nerve.
Adductor brevis	Inferior ramus of Pubis	Superior half of linea aspera	Adducts, medially and flexes thigh.	Obturator nerve.

Adductor magnus.	Inferior ramus of pubis and ischium to ischial tuberosity.	Linea aspera of femur	Adducts and medially rotates thigh. Anterior part flexes and posterior part extends it.	Obturator and Sacral nerves.
Pectineus	Superior ramus of Pubis	Pectineal line of femur between lesser trochanter and linea aspera	Flexes and adducts thigh	Femoral nerve.

The muscles that act on the Tibia and Fibula are separated into compartments by deep fascia. The medial (adductor) compartment is so named because its muscle adducts the thigh. The Obturator nerve innervates it. Adductor magnus, Adductor longus, Adductor brevis and Pectineus muscle components of the medial compartment are included because they act on the femur.

The anterior (extensor) compartment is designated so because its muscles act to extend the leg, and some also flex the thigh. It is composed of the Quadriceps femoris and Sartorius muscle and is innervated by the femoral nerve.

The Quadriceps femoris muscle is a composite muscle that includes four distinct parts, usually described as four separate muscles (Rectus femoris, Vastus lateralis, Vastus intermedius and Vastus medialis). The common tendon for the four muscles is known as quadriceps tendon, which attaches to the patella. The tendon continues inferior to the patella as the patellar ligament, which attaches to the Tibial tuberosity. The Rectus femoris and Sartorius muscle are also flexes of the thigh.

The Posterior (flexor) compartment is named so because its muscle flexes the leg but also extend the thigh. The branches of the sciatic nerve innervate it. Included are the Hamstrings (Biceps femoris, Semitendinosus and Semimembranosus). The Hamstrings are named because their tendons are long and string like in the popliteal area and from an old practice of butchers in which they hung.

The Popliteal fossa is a diamond shaped space on the posterior aspect of the knee bordered laterally by the tendon of Biceps femoris and medially by the Semitendinosus and semimembranosus muscles.

Anterior Compartment (extensor) compartment

<i>Muscle</i>	<i>Origin</i>	<i>Insertion</i>	<i>Action</i>	<i>Innervations</i>
Quadriceps femoris		Patella via quadriceps tendon and then tibial tuberosity via patellar ligament.	All four heads extends leg; rectus portion alone also flexes thigh.	Femoral nerve.
1. Rectus femoris	Anterior inferior iliac spine.			
2. Vastus lateralis	Greater trochanter & linea aspera of femur.			
3. vastus medialis	Linea aspera of femur.			
4. Vastus intermedius	Anterior and lateral surfaces of body of femur.			
<i>Sartorius</i> (Sartor = tailor; contracts when you sit in the cross legged position of a tailor; longest muscle in the body)	Anterior superior iliac spine	Medial surface of body of tibia	Flexes leg; flexes thigh and rotates it laterally, thus crossing leg.	Femoral nerve.

Posterior (flexor) compartment

Muscles of facial expression:

Muscle	Origin	Insertion	Action	Innervation
Frontalis	Galea aponeurotica	Skin superior to supraorbital margin	Draws scalp anteriorly, elevates eyebrows and wrinkles, forehead horizontally	Facial nerve(VII).
Occipitalis	Occipital bone and mastoid process of temporal bone	Galea aponeurotica	Draws scalp posteriorly	Facial nerve(VII).
Orbicularis oris	Muscle fibres surrounding opening of the mouth	Skin at corner of the mouth	Close lips, compresses lips against teeth, protruded lips and shapes lips during speech.	Facial nerve(VII).
Zygomaticus major	Zygomatic bone	Skin at angle of mouth and orbicularis oris	Draw angle of mouth upward and outward as in smiling and laughing	Facial nerve(VII).
Levator lasii superioris	Superior to infra orbital foramen of maxilla	Skin at angle and orbicularis oris	Elevates upper lip	Facial nerve(VII).
Depressor labii inferioris	Mandible	Skin of lower lip	Depressor lower lip	Facial nerve(VII).

Buccinator	Alveolar processes of maxilla and mandible and pterygomandibular rephe	Orbicularis oris	Major cheek muscle compresses cheek as in blowing air out of mouth and causes cheek to cave in, producing the action of sucking	Facial nerve (VII).
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Muscles That Move The Mandible (Lower Jaw):

The muscles that move the mandible (lower jaw) are also known as muscles of mastication because they are involved in biting and chewing.

Muscle	Origin	Insertion	Action	Innervation
Masseter (masseter=chew)	Maxilla and zygomatic arch	Angle and ramus of mandible	Assists to close the mouth by elevating mandible side to side movement of mandible protracts mandible	Mandibular division of trigeminal nerve.
Temporalis	Parietal bone	Coronoid process and ramus of mandible	Elevates and retracts mandible and assists in side to side movement of mandible	Mandibular division of trigeminal nerve.
Medial pterygoid	Medial surface of lateral portion of pterygoid process of sphenoid-maxilla	Angle and ramus of mandible	Elevates and protracts mandible and moves mandible from side to side	Mandibular division of trigeminal nerve.

Lateral pterygoid	Greater wing and lateral surface of lateral portion of pterygoid process of sphenoid	Condyle of mandible, tempero-mandibular articulation	Protracts mandible opens mouth and moves mandible from side to side	Mandibular division of trigeminal nerve.
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Muscles That Move The Eye Balls-Extrinsic Muscles:

Muscles associated with the eyeball are of two principal types: Extrinsic and Intrinsic. Extrinsic muscles originate outside the eyeballs and insert on their outer surface (sclera). They move the eyeballs in various directions. Intrinsic muscles originate and insert entirely within the eyeballs. They move structures within the eyeballs. Three pairs of extrinsic muscles control movements of the eyeballs. Two pairs of Rectus muscle move the eyeballs in the direction indicated by their respective names- superior, inferior, lateral and medial. One pair of muscles, the oblique muscles-superior and inferior-rotates the eyeballs on their axes. The extrinsic muscles of the eyeballs are between the fastest contracting and most precisely controlled skeletal muscles of the body.

Muscle	Origin	Insertion	Action	Innervations
Superior rectus	Tendinous ring attached to bony orbit around optic foramen	Superior and central part of eyeball	Rolls eyeball superiorly	Oculomotor nerve (II).
Inferior rectus	Tendinous ring attached to bony orbit around optic foramen	Inferior and central part of eyeball	Rolls eyeball inferiorly	Oculomotor nerve (II).
Lateral rectus	Tendinous ring attached to bony orbit around optic foramen	Lateral side of eyeball	Rolls eyeball laterally	Abducens nerve (VI)
Medial rectus	Tendinous ring attached to bony orbit around optic foramen	Medial side of eyeball	Rolls eyeball medially	Oculomotor nerve (III)

Superior oblique	Tendinous ring attached to bony orbit around optic foramen	Eyeball between superior and lateral rectus. The muscle inserts in a round tendon that moves through a ring of fibrocartilagenous tissue called trochlea	Rotates eyeball on its axis directs cornea inferiorly and laterally	Trochlear nerve (IV).
Inferior oblique	Maxilla(anterior orbital cavity)	Eyeball between inferior and lateral rectus	Rotates eyeball on its axis directus cornea superior and laterally	Oculomotor nerve (III).

Muscles That Move The Tongue:

The tongue is divided into lateral halves by a median fibrous septum. The septum extends throughout the length of tongue and is attached inferiorly to the hyoid bone. Like the muscles of eyeballs, muscles of the tongue are of two principal types- extrinsic and intrinsic. Extrinsic muscles originate outside the tongue and insert into it. They move the entire tongue in various directions such as anteriorly, posteriorly and laterally. Intrinsic muscles originate and insert within the tongue. The muscles alter the shape of tongue rather than moving the entire tongue. The extrinsic and intrinsic muscles of the tongue arranged in both lateral halves of the tongue.

Muscle	Origin	Insertion	Action	Innervation
Genioglossus	Mandible	Under surface of tongue and hyoid bone	Depresses tongue and thrusts it anteriorly	Hypoglossal nerve (xii)
Styloglossus	Styloid process of temporal bone	Side and undersurface of tongue	Elevates tongue and draws it posteriorly	Hypoglossal nerve (xii)

Muscle	Origin	Insertion	Action	Innervation
Palatoglossus	Anterior surface of soft palate	Side of tongue	Elevates posterior portion of tongue and draws soft palate inferiorly on tongue	Pharyngeal branch of vagus nerve
Hyoglossus	Body of tongue	Side of tongue	Depresses tongue and draws its sides inferiorly	Hypoglossal nerve (xii)

MUSCLES OF THE FLOOR OF ORAL CAVITY (MOUTH)

The muscles are referred as suprahyoid muscles because they lie superior to the hyoid bone.

Digastric	Anterior belly from inner side of the lower border of mandible; posterior belly from mastoid process of temporal bone.	Body of hyoid bone	Elevates hyoid and depresses mandible	Anterior belly from trigeminal nerve, from facial nerve
Stylohyoid	Stylohyoid process of temporal bone	Body of hyoid bone	Elevates hyoid bone and draws its posteriorly	Facial Nerve(vii)
Mylohyoid	Inner surface of mandible	Body of hyoid bone	Elevates hyoid bone and floor of mouth and depresses mandible	Mandibular division of trigeminal nerve.
Geniohyoid	Inner surface of mandible	Body of hyoid bone	Elevates hyoid bone and draws hyoid bone and tongue anteriorly and depresses mandible	Cervical nerve (C1)

MUSCLES OF THE ABDOMINAL WALL

The anterolateral abdominal wall is composed of skin, fascia and four pairs of flat, sheet like muscles; rectus abdominis, external oblique, internal oblique, and transeversus abdominis. Three transverse fibrous bands of tissue called tendinous intersections interrupt the anterior surfaces of the rectus abdominis muscles.

The aponeuroses of the external oblique, internal oblique and transeverse abdominis muscles form the rectus sheath which encloses the rectus abdominis muscle, and meet at the midline to form the linea alba (WHITE LINE), a tough, fibrous band that extends from the xiphoid process of the sternum to the pubic symphysis.

The inferior free border of the external oblique aponeurosis, plus some collagen fibres, forms the inguinal ligament, which runs from the anterior superior iliac spine to the pubic tubercle.

Just superior to the medial end of the inguinal ligament is a triangular slit in the aponeurosis referred to as the superficial inguinal ring, the outer opening of the inguinal canal. The canal contains the spermatic cord and ilioinguinal nerve in males and round ligament of the uterus and ilioinguinal nerve in females.

The lumbar vertebrae, parts of the ilia of the hip bones, psoas major muscle, quadratus lumborum muscle, and iliacus muscle, form the posterior abdominal wall. Whereas the anterolateral abdominal wall is contractile and distensible, the posterior abdominal wall is bulky and stable by comparison.

Muscle	Origin	Insertion	Action	Innervation
Rectus abdominis	Pubic crest and pubic symphysis	Cartilages of fifth to seventh ribs and xiphoid process	Flexes vertebral column and compresses abdomen to aid in defaecation, urination, forced expiration and child birth	Branches of thoracic nerves T7-T12
External oblique	Inferior eight ribs	Iliac crest and linea alba	Contraction of both compresses abdomen, contraction of one side alone bends vertebral column laterally rotates the vertebral column	T7-T12 thoracic nerves & iliohypogastric nerves

Muscle	Origin	Insertion	Action	Innervation
Internal oblique	Iliac crest, inguinal ligament & thoraco lumbar fascia	Cartilages of inferior three or four ribs & linea alba	Compresses abdomen laterally rotates vertebral column	Thoracic nerves T8-T12, ilio hypogastric & ilio inguinal nerves
Transversus abdominis	Iliac crest, inguinal ligament, lumbar fascia & cartilages of inferior six ribs	Xiphoid process, linea alba & pubis	Compresses abdomen	Branches of thoracic nerves T8-T12 ilio hypo gastric & ilio inguinal nerves
Quadratus lumborum	Iliac crest & ilio lumbar ligament	Inferior border of twelfth rib & transverse processes of first four lumbar vertebra	During forced expiration, it pulls inferiorly on the twelfth rib; during deep inspiration, it fixes the twelfth rib to prevent its elevation & contraction of one side bends vertebral column laterally	Branches of thoracic nerve T12 & lumbar nerves L1-L4

MUSCLES USED IN BREATHING

The Muscles, which are helping for respiration they are attached to the ribs and by their contraction and relaxation after the size of the thoracic cavity during breathing. Essentially inspiration occurs when the thoracic cavity increases in size. Expiration occurs when the thoracic cavity decreases in size.

The principal muscles of inspiration during normal breathing are the diaphragm and external intercostals. During forced inspiration, accessory muscles such as sternocleidomastoid, scalenes and pectoralis minor are also used.

The principal muscles of expiration during normal breathing are also the diaphragm and external intercostals. During expiration accessory muscles such as internal intercostals and abdominal muscles (external oblique, internal oblique, transversus abdominis and rectus abdominis) are also used.

The diaphragm one of the muscles used in breathing is dome-shaped and has three major openings through which various structures pass between the thorax and abdomen. The structures include the aorta along with the thoracic duct and azygos vein, which passes through the aortic hiatus, oesophagus with accompanying vagus (X) nerves which pass through the oesophageal hiatus and the inferior venacava, which passes through the foramen for the venacava.

Muscle	Origin	Insertion	Action	Innervation
Diaphragm	Xiphoid process, costal cartilages of inferior six ribs and lumbar vertebra	Central tendon aponeurosis that serves as the tendon of insertion for all muscular fibres	Forms floor of thoracic cavity and pulls central tendon inferiorly during inspiration	Phrenic nerve (C3, C4 & C5)
External intercostals	Inferior border of rib above	Superior border of rib below	Elevates ribs during inspiration and thus increases lateral and anteroposterior dimensions of thorax.	Intercostal nerve
Internal intercostals	Superior border of rib below	Inferior border of rib above	Draw adjacent ribs together during forced expiration and thus decreases lateral and anteroposterior dimensions of thorax.	Intercostal nerve

MUSCLES THAT MOVE THE HUMERUS

Of the nine muscles that cross the shoulder joint, only two of them (pectoralis major and latissimus dorsi) do not originate on the scapula. These two muscles are thus designated as axial muscles, since they originate on the axial skeleton. The remaining seven muscles arise from the scapula. The shape of the articulating bones or its ligaments does not provide the strength and stability of the shoulder joint. Instead four deep muscles of the shoulder, subscapularis, supraspinatus, infraspinatus & teres minor- strengthen and stabilize the shoulder joint. The muscles join the scapula to the humerus.

Their tendons are arranged to form a nearly complete circle around the joint, an arrangement referred as the rotator (musculotendinous) cuff.

Muscle	Origin	Insertion	Action	Innervation
Pectoralis major	Clavicle, sternum cartilages of 2 nd to 6 th ribs	Greater tubercle and intertubercular sulcus of humerus	Flexes, adducts and rotates arm medially	Medial and lateral pectoral nerve
Latissimus dorsi	Spines of inferior six thoracic vertebra, lumbar vertebra, crests of sacrum and ilium, inferior four ribs	Intertubercular sulcus of humerus	Extends, adducts and rotates arm medially, draws arm inferiorly and posteriorly	Thoraco-dorsal nerve

SCAPULAR

Muscle	Origin	Insertion	Action	Innervation
Deltoid	Acromial extremity of clavicle and acromion and spine of scapula	Deltoid tuberosity of humerus	Abducts, flexes, extends medially and laterally rotates arm	Axillary nerve
Subscapularis	Subscapular fossa of scapula	Lesser tubercle of humerus	Rotates arm medially	Upper end – lower scapular nerve
Supra spinatus	Supra spinus fossa of scapula	Greater tubercle of humerus	Assists deltoid muscle in abducting arm	Supra scapular nerve
Infra spinatus	Infra spinus fossa of scapula	Greater tubercle of humerus	Rotates arm laterally; adducts arm	Supra scapular nerve

Teres major	Inferior angle of scapula	Intertubercular sulcus of humerus	Extends arm, assists in adduction and medial rotation of arm	Lower subscapular nerve
Teres minor	Inferior lateral border of scapula	Greater tubercle of humerus	Rotates arm laterally extends and adducts arm	Axillary nerve
Coracobrachialis	Coracoid process of scapula	Middle of medial surface of shaft of humerus	Flexes and adducts arm	Musculo-cutaneous nerve

MUSCLES THAT MOVE THE PECTORAL (SHOULDER) GIRDLE

Muscles that move the pectoral (shoulder) girdle can be divided into anterior and posterior groups. The principal action of the muscles is to stabilize the scapula so that it can function as a stable point of origin for most of the muscles that move the humerus (arm)

ANTERIOR

Muscle	Origin	Insertion	Action	Innervation
Subclavius	First rib	Clavicle	Depresses clavicle	Nerve to subclavius
Pectoralis minor	Third through fifth ribs	Coracoid process of scapula	Depresses and moves scapula anteriorly and elevates third through fifth ribs during forced inspiration when scapula is fixed	Medial pectoral nerve
Serratus anterior	Superior eight or nine ribs	Vertebral border and inferior angle of scapula	Rotates scapula superiorly and laterally abducts scapula, and elevates ribs when scapula is fixed	Long thoracic nerve

POSTERIOR

Muscle	Origin	INSERTION	Action	Innervation
Trapezius	Occipital bone, ligamentum nuchae and spines of 7 th cervicle and all thoracic vertebra	Clavicle and acromion and spine of scapula	Elevates clavicle adducts scapula, rotates scapula superiorly, elevates or depresses scapula and extends head	Accessory (XI) nerve and cervical nerves (C3 – C4)
Levator scapulae	Superior four or five cervical vertebra	Superior vertebral border of scapula	Elevates scapula and slightly rotates it inferiorly	Dorsal scapular nerve and cervical nerves C3 –C5
Rhomboideus major	Spines of second to fifth thoracic vertebra	Vertebral border of scapula inferior to spine	Adducts scapula and slightly rotates it inferiorly	Dorsal scapular nerve
Rhomboideus minor	Spines of seventh cervical and first thoracic vertebra	Vertebral border of scapula superior to spine	Adducts scapula and slightly rotates it inferiorly	Dorsal scapular nerve

LYMPHATIC SYSTEM

तद्यथा- दशोदकस्याञ्जलयः शरीरे स्वेनाञ्जली प्रमाणेन, यन्तु प्रच्यवमानं पुरीषमनुबधान्यतियोगेन तथा मूत्रं रुधिरमन्यांश्च शरीरधातुन्, यन्तु सर्वशरिरचरं बाह्य त्वग्बिभवति, यन्तु त्वगान्तरे व्रणगतं लसिकाशब्दं लभते । (Ch.Sha.7/15)

Udaka, an aqueous element is a substance which is seen mixed with faeces during the occurrence of diarrhoea; it is also found in association with urine, blood and other tissue elements of the body it is spread all over the body with its site in the external skin. Inside the skin, it is known as *lasika* (lymph), which exudes through ulcers.

The lymphatic system is consists of fluid called lymph flowing within lymphatic vessels (lymphatics), several structures and organs that contain lymphatic tissues, and red bone marrow, which houses stem cells that develop into lymphocytes. Interstitial (tissue) fluid and lymph are basically the same. The major difference between the two is location. After fluid passes from interstitial spaces into lymphatic vessels, it is called *lymph* (lympa =clear water).

Lymphatic tissue is a specialized form of reticular connective tissue that contains large number of lymphocytes.

The lymphatic vessels at the periphery are microscopic blind (closed) end vessels, spoken of lymphatic capillaries. These tiny vessels are situated in the inter cellular spaces and their walls formed by endothelial cells supported by the fibrous connective tissue. These capillaries repeatedly join together to form bigger lymphatic vessels, which pass through the lymph nodes, receive more tributaries and gradually increase in size. All the lymph from the body is finally collected into two big channels-the right lymphatic duct and the thoracic duct (left lymphatic duct), which opens into the right and left sub clavian veins respectively.

Lymphatic vessels resemble veins in structure but have thinner walls and more valves. At intervals along the lymphatic vessels, lymph flows through lymphatic tissue structures called lymph nodes. In the skin lymphatic vessels lie subcutaneous tissue and generally follow veins. Lymphatic vessels of the viscera generally follow arteries, forming plexuses around them.

Functions Of Lymphatic System:

- 1.Draining interstitial fluid – lymphatic vessels drain tissue spaces of excess interstitial fluid.
- 2.Transporting dietary lipids-lymphatic vessels carry lipids and lipid – soluble vitamins (A, D, E and K) absorbed by the gastro intestinal tract to the blood.
- 3.Protecting against invasion-lymphatic tissue carries out immune responses. These rare highly specific responses targeted to particular invaders or abnormal cells. Lymphocyte, aided by macrophages, recognizes foreign cells and substances, microbes (bacteria, viruses and so on), and cancer cells and responds to them in two basic ways.

Some lymphocytes (T-cells) destroy the intruders by causing them to rupture or by releasing cytotoxic (cell killing) substances. Other lymphocytes (B cells) differentiate into plasma cells that secrete antibodies. These are proteins that combine with and cause destruction of specific foreign substances. In carrying out immune responses, the lymphatic system concentrates foreign substances in certain lymphatic organs, circulates lymphocytes through the organs to make contact with the foreign substances, destroys the foreign substances, and eliminates them from the body.

Properties Of Lymph:

Lymph should be regarded as the modified tissue fluid. Lymph is the clear watery – appearing fluid found in lymphatic vessels and is formed by the passage of substances from blood capillaries into tissue spaces. This process is known as transudation, which involves the process of diffusion and filtration. Lymph, collected from the thoracic duct during fasting is transparent, yellowish in color, faintly alkaline in reaction and clots slowly.

After a fatty food, the lymph of the thoracic duct appears milky due to the presence of emulsified fat absorbed through alimentary canal.

Composition Of Lymph:

Microscopic examination of lymph depicts that it contains a large amount of leucocytes (mostly lymphocytes) ranging from 500 to 75,000 per cu mm. No blood platelets are present.

It contains. 1. Water-94%

2. Solid-6%

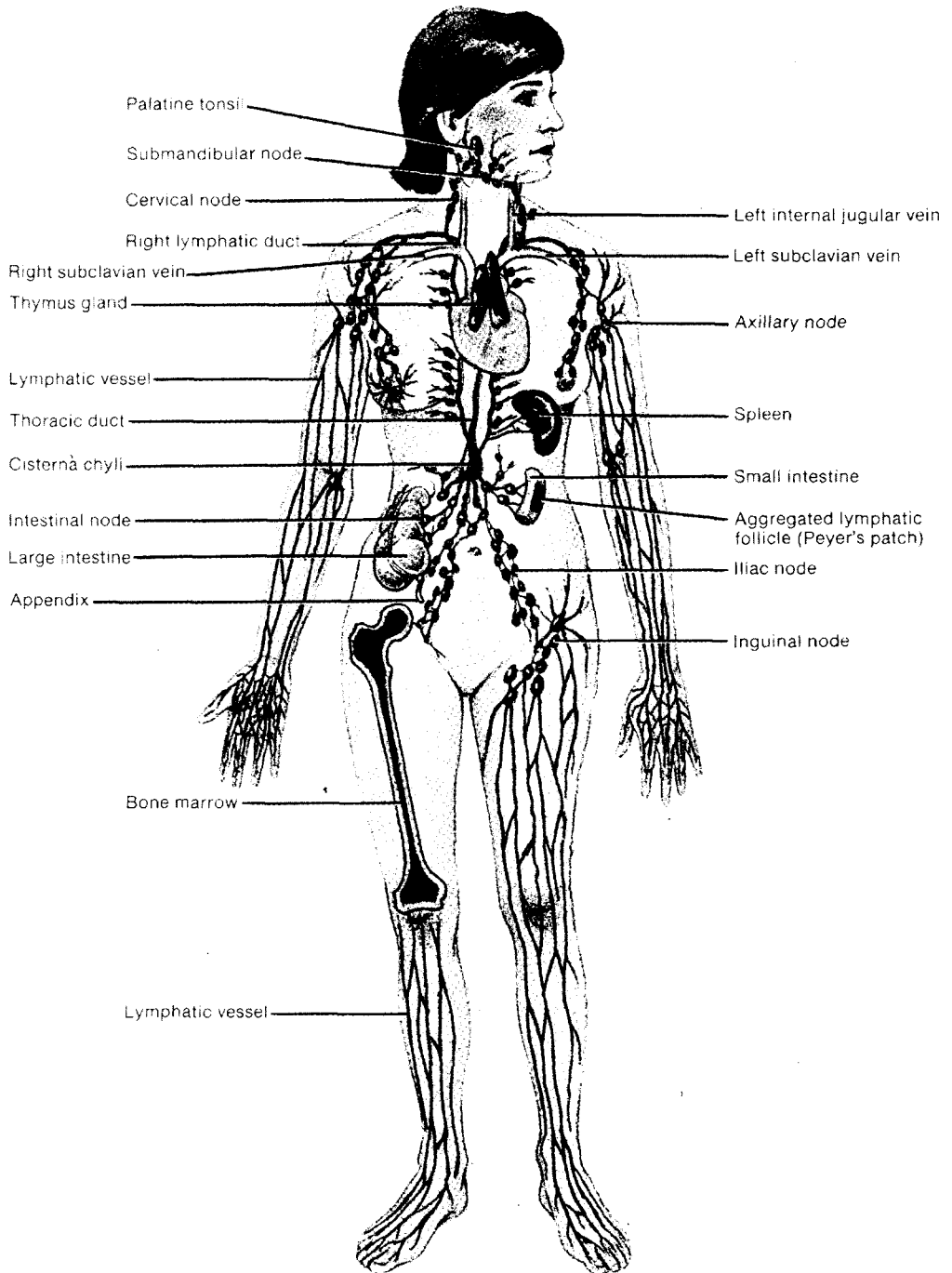
It includes proteins, fats, carbohydrates, urea, creatinine, phosphorus, non-protein nitrogenous substances, enzymes and antibodies are present.

Formation Of Lymph:

Most components of blood plasma freely filter through the capillary walls to form interstitial fluid. More fluid seeps out of blood capillaries by filtration than returns to them by re-absorption. The excess fluid, about 3litres per day, drains into lymphatic vessels and becomes lymph. Ultimately, lymph drains into venous blood through the right lymphatic duct and thoracic duct (left lymphatic duct) at the junction of the internal jugular and sub clavian veins.

Since lymph is formed from tissue fluid, anything that increases the amount of tissue fluid will increase the rate of lymph formation. Lymph formation depends upon physical factors. There is no vital secretory process involved in it. The following factors are responsible for lymph formation.

Lymphatic system



1. Capillary pressure-If the capillary pressure is raised the rate of lymph formation increases. This is seen in venous obstruction.

2. Permeability of the capillary wall-Under any condition where the permeability of the capillary wall is increased, more tissue fluid will be formed and consequently more lymph. These factors increase capillary permeability

a. Rise in temperature.

b. Reduced oxygen supply.

c. Alternation of the osmotic pressure-Anything that reduces the colloidal osmotic pressure of blood will increase formation of tissue fluid and lymph.

d. Increased metabolic activity of an organ-Increased activity of a particular area increases the flow of lymph in the locality.

e. Massage and passive movements- these increase lymphatic flow to some extent just like active muscular contraction.

Circulation Of Lymph:

The sequence of lymph flow is Arteries (blood plasma)

(blood plasma) Interstitial spaces (interstitial fluid)

capillaries (lymph) Lymphatic vessels (lymph)

(lymph) Sub clavian veins (blood plasma).

Blood capillaries

Lymphatic

lymphatic ducts

Rate Of Flow Of Lymph:

Rate of flow of lymph along the human thoracic duct is from 1-1.5ml per minute.

Regulation of the rate of lymph flow depends upon

a. Interstitial pressure.

b. Arterial pulsation.

c. Intra thoracic pressure.

d. Muscular massage.

Functions Of Lymph:

It has the following functions

1. Nutritive-It supplies nutrition and oxygen to those parts where blood cannot reach.

2. Drainage- it drains away excessive tissue fluid and the metabolites and it tries to maintain the volume and composition of tissue fluid constant.

3. Transmission of proteins- Lymph returns proteins to the blood from the tissue spaces.

4. Absorption of fats-Fats from the intestines is also absorbed through the lymphatics.

5. Defensive- the lymphocytes and monocytes of lymph act as defensive cells of the body. It also removes bacteria from the body.

Lymph Trunks And Ducts:

Lymph passes from lymphatic capillaries into lymphatic vessels and through lymph nodes. The existing lymphatic vessels unite to form lymph trunks. The principal trunks are the lumbar, intestinal, broncho mediastinal sub clavian and jugular trunks.

The principal trunks pass their lymph into two main channels, the thoracic duct and the right lymphatic duct. From these ducts, lymph passes into the venous blood.

Thoracic (Left Lymphatic) Duct:

It is about 38-45 cm in length and begins as a dilation called the cisterna chyli, which is anterior to the second lumbar vertebra. The thoracic duct is the main collecting duct of the lymphatic system. It receives lymph from the left side of the head, neck and chest, the left upper limb and the entire body inferior to the ribs.

The cisterna chyli receives lymph from the right and left lumbar trunks from the intestinal trunk. The lumbar trunks drain lymph from lower limbs, visceral of pelvis, kidneys, suprarenal glands and the deep lymphatics from most of the abdominal wall. The intestinal trunk drains lymph from the stomach, intestines, pancreas, spleen and part of the liver.

In the neck, the thoracic duct also receives lymph from the left jugular, left subclavian and left broncho mediastinal trunks. The left jugular trunk drains lymph from the left side of the head and neck and the left subclavian trunk drains lymph from the left upper limb. The left broncho mediastinal trunk drains lymph from the left side of the deeper parts of the anterior thoracic wall, superior part of the anterior abdominal wall, anterior part of the diaphragm, left lung and left side of the heart.

Right Lymphatic Duct:

It is about 1.25 cm long and drains lymph from the upper right side of the body. The right lymphatic duct collects lymph from the right jugular trunk which drains the right side of the head and neck; the right subclavian trunk, which drains the right upper limb and the right broncho mediastinal trunk, which drains the right side of the thorax, right lung, right side of the heart and part of the liver.

Lymphatic Tissues And Organs:

Lymphatic organs and tissues, which are widely distributed throughout the body, are classified into two groups based on their functions. Primary lymphatic organs are the sites where stem cells divide and become immunocompetent, that is capable of mounting

an immune response. The primary lymphatic organs are the red bone marrow (in flat bones and the epiphysis of long bone of adults) and the thymus. Pluripotent stem cells in red bone marrow give rise to mature, immunocompetent B cells and to pre-T cells, which migrate to and become immunocompetent T cells in the thymus. The secondary lymphatic organs and tissues are the sites where most immune responses occur. They include lymph nodes, the spleen and lymphatic nodules (follicles).

Lymph Nodes:

Located along lymphatic vessels are about 600 bean-shaped lymph nodes. They are scattered throughout the body, both superficially and deep, and usually occur in

groups. Large groups of lymph nodes are present near the mammary glands and in the axillae and groin. Lymph nodes are 1-25 mm long and are covered by a capsule of dense connective tissue that extends into the node. The capsular extensions, called trabeculae, divide the node into two compartments, provide support, and provide a route for blood vessels into the interior of a node. Internal to the capsule is a supporting network of reticular fibers and fibroblasts. The capsule, trabeculae, reticular fibers, and fibroblasts constitute the stroma of a lymph node.

The parenchyma of a lymph node is specialized into two regions: cortex and medulla. The outer cortex contains many follicles, which are regions of densely packed lymphocytes arranged in masses that resemble lymphatic nodules. The outer rim of each follicle contains T cells (T lymphocytes) plus macrophages and follicular dendritic cells, which participate in activation of T cells. In the germinal centers where B cells proliferate into antibody-secreting plasma cells.

PARIBASHA SHARIRAM

Jala:

मांससिरास्त्राख्यस्थिजालानि प्रत्येकं चत्वारि, तानि मणिबन्धगुल्फसंश्रितानि परस्परनिबद्धानि परस्परगवाक्षितानि चेति, यैर्गवाक्षितमिदं शरीरम् । (Su. Sh. 5/12)

Bones form Jalas. These are four kinds and complex in structure. Four of each of the fleshly parts, the siras, muscular fibers and bones, comprise 16 and they are found in the wrists and ankles; they are all inter-connected, inter-mingled.

Shanghata:

चतुर्दशांशा संघाताः, तेषां त्रयो गुल्फजानुवङ्क्षणेषु एतेनेतरसक्थि बाहू च व्याख्यातौ, त्रिकशिरसोरेकैकः । (Su. Sh. 5/19)

The groups of bones are fourteen, out of fourteen

Three in each ankle, knee and hip, as also in wrist, elbow and shoulder, one group in the pelvis and one in the skull.

Simanta:

चतुर्दशैव सीमन्ताः, ते चास्थिसङ्घातवद्रणनीयाः, यतस्तैर्युक्ता अस्थिसंघाताः, ये ह्युक्ताः संघातास्ते खल्वष्टादशैकैषाम् (Su. Sh. 5/17)

The simantas are 14; they are counted like the Sanghatas, as the sanghatas, which are already mentioned, possess these simantas.

स्नायुः

स्नायुः चतुर्विधा विद्यात् तास्तु-

प्रकारः

स्थानं

१. प्रतानवत्यः

शाखासु सर्वसन्धिषु च ।

२. वृत्तः

कण्डराः सर्वा विज्ञेयाः ।

३. पृथुलाः

पार्श्वोरसि तथा पृष्ठे शिरसी च ।

४. सुषिराः

आमपक्काशयान्तेषु बस्तौ च । (su.sha.5/30)

There are 4 kinds of snayus.

1. Pratyavanaty (having long tendons) is found in the extremities and the joints.
2. Vrita-This type of kandaras are found in all over the body.
3. Prithula (large and flat) found in two sides of flanks, thorax, back and scalp.
4. Susira (ring like) are found in the end of the stomach, large intestine, and urinary bladder.

Bones mainly support the snayus. Fleshly organs are tied to the bones by snayu and sira. It is because of this protection that organs are not crushed, nor they are displaced.

Kandara:

षोडश कण्डराः - तासां चतस्रः पादयोः, तावत्यो हस्तग्रीवापृष्ठेषु, तत्र हस्तपादगतानां कण्डराणां नखा अग्रप्ररोहाः, ग्रीवाहृदयनिबन्धिनीनामधोभागगतानां मेद्रं, श्रोणिपृष्ठनिबन्धिनीनामधोभागगतानां बिम्बं, मूर्धोरुवक्षो असपिण्डादीनां च

(Su. Sh. 5/11)

There are 16 kandaras. They are distributed over the paada, hastha, greeva and prusta. Each has 4 kandaras. Acc to Dalhana the Kandara is called as Maha Snayu. In hastha and paadha the kandaras are known as agrapraroaha. In greeva the kandara is known as medhra. In prusta it is known as bimba.

Kurcha:

षट् कूर्चाः, ते हस्तपदग्रीवामेद्रेषु, हस्तयोर्द्वौ, ग्रीवामेद्वयोरैकैकः ।(Su. Sh. 5/13)

These are six in number one in each hand and foot, one in the neckandonenearthe penis.

Mamsarajju:

महत्यो मांसरज्जवश्चतस्रः - पृष्ठवंशमुभयतः पेशीनिबन्धनार्थं द्वे बाह्ये, आभ्यन्तरे च द्वे ।

(Su. Sh. 5/14)

Mamsa rajju (fleshy bands) are four in number. They are large and fleshy. Two are on each side of the spinal column to which pesi adhere; two are in the inside and two on the outside.

PART - A

1. Garbha is divided by:
(a) Vayu (c) Jala
(b) Akasa (d) Prithivi
2. Purusha is defined as the combination of:
(a) Pancha mahabhutas and Atma
(b) Manas and Indriyas
(c) Atma and Indriyas
(d) Srotas and Atma
3. The taste of suddha sukra is:
(a) Amla (c) Katu
(b) Madhura (d) Tasteless
4. The incurable sukra dosa is:
(a) kunapa (c) ksina
(b) granthi (d) mutra-purisa
gandhayukta sukra
5. Artava that stains the cloth is:
(a) Suddh (c) Vataja
(b) Asuddha (d) Pittaja
6. The number of factors for the formation of garbha is:
(a) 4 (c) 2
(b) 6 (d) 1
7. kalala is:
(a) Medomala (c) Mamsa sneha
(b) Sukra of sanda (d) garbha without
pitija gunas
8. Rutkala according to Susruta is:
(a) 12 days (c) 3 days
(b) 16 days (d) 5 days
9. A Woman with fourth month pregnancy is known as;
(a) Saugandhika (c) Douhrud
(b) Kunapa (d) Acarana
10. If the embryo during 2nd month of pregnancy is in pinda shape it indicates;
(a) Female (c) Napumsaka
(b) Male (d) Garbhasrava
11. According to Dhanvantari the development of organs in the embryo takes place as follows:
(a) Head develops first
(b) Nabhi develops first
(c) Hridaya develops first
(d) All the organs at a time.
12. The number of pranas of the garbha is:
(a) 11 (b) 10 (c) 8 (d) 4
13. The variety of tvak that contributes for chaya and prabha:
(a) tamra (c) Sveta
(b) Lohita (d) Avabhasini
14. The space between dhatu and asaya is known as:
(a) Kala (c) Vasa
(b) Mala (d) Vapa
15. During embryogenesis the yakrut and pliha are derived from:
(a) Sonita (c) Sonita kitta
(b) sonita phena (d) Sonita & Sleshma
16. The number of pesis in males:
(a) 500 (c) 700
(b) 900 (d) 210
17. The number of pesis in female:
(a) 500 (c) 520
(b) 540 (d) 560
18. According to Susruta the number of bones in the body:
(a) 300 (c) 350
(b) 206 (d) 200
19. The number of joints acc. to Susruta:
(a) 200 (c) 210
(b) 150 (d) 107
20. The number of snayus:
(a) 900 (c) 300
(b) 700 (d) 210
21. Kandara is also known as:
(a) Maha snayu (c) Srotas
(b) Kala (d) Vasa
22. Suddha mamsa sneha is known as :
(a) Kala (c) Kandara
(b) Snayu (d) Vasa
23. In small bones the majja is known as:
(a) Kala (c) Rakta medas
(b) Lasika (d) Rakta
24. In big bones the medas is known as:
(a) Majja (c) Sonita
(b) Sukra (d) Rajas
25. The number of Asayas in Males:
(a) 10 (c) 11
(b) 7 (d) 8

26. The length of intestines in males:
 (a) 3 vyamas (c) 2 vyamas
 (b) 3.5 vyamas (d) 1 vyamas
27. Name of third layer of kala
 (a) medodara (c) sleshmadara
 (b) rakthadara (d) purishadara
28. Mamsarajju is situated in:
 (a) Siras (c) Hrdaya
 (b) Sriva (d) Prstha
29. Joints are covered by:
 (a) Mamsadhara kala (c) Sleshmadhara kala
 (b) Rakthadhara kala (d) Pittadhara kala
30. The number of sivanis in the whole body:
 (a) 7 (c) 5
 (b) 4 (d) 2
31. The category of asthi to which danta belongs:
 (a) Nalaka (c) Valaya
 (b) Ruchaka (d) Kapala
32. Amsa sandhi belongs to:
 (a) Sthira Sandhi (c) Ruchaka
 (b) Cesta snadhi (d) None of the above
33. Number of layers in twacha according to Susruta:
 (a) 7 (b) 8
 (c) 5 (d) 6
34. Janu Sandhi belongs to the following variety:
 (a) Ulukhala (c) Pratar
 (b) Korasandhi (d) Samudga
35. The involvement of the under mentioned structure causes death:
 (a) Asthi (c) Sandhi
 (b) Pesi (d) Snayu
36. The number of marmas:
 (a) 700 (c) 500
 (b) 107 (d) 11
37. The following marmas is included in sadyopranahara marmas:
 (a) Talahrdaya (c) Vitapa
 (b) Gulpha (d) Nabhi
38. The number of kalantara pranahara marmas:
 (a) 19 (c) 33
 (b) 3 (d) 44
39. The number of vaikalyakara marmas:
 (a) 44 (c) 33
 (b) 19 (d) 3
40. The involvement of.....Kalanthara pranahara marma causes instantaneous death:
 (a) Ksipra (c) Talahrdaya
 (b) Simanta (d) Indrabasti
41. The duration for death to occur in case of sadyopranahara marma:
 (a) Within 7 days (c) One month
 (b) within 20 days (d) Two months
42. Susruta suggested amputation of hands and legs in the case of involvement of:
 (a) Ksipra & Talahrdaya marmas (c) Guda
 (b) Hrdaya (d) Vitapa
43. The mula(adhistana) of siras:
 (a) Hrdaya (c) Yakrt
 (b) Nabhi (d) Pliha
44. The number of siras not to be subjected to siravyadha in hands & legs:
 (a) 400 (c) 32
 (b) 50 (d) 16
45. Sensory perception is carried by:
 (a) Sira (c) Dhamani
 (b) Srotas (d) Kala
46. Raktavaha srotas originates from:
 (a) Hrdaya (c) Kloma
 (b) Yakrt-pliha (d) Vrkka
47. The total number of srotas according to Susruta:
 (a) 22 (c) 10
 (b) 9 (d) 8
48. Vrukka is the site of origin for:
 (a) Mutravaha srotas (c) Rasavaha srotas
 (b) Medovaha srotas (d) Purisavaha srotas
49. Names of the dhatuvaha srotas as that have not been included by Susruta:
 (a) Rakta&mamsa (c) Asthi&majja
 (b) Rasa&sukra (d) Both a & b
50. Total number of abedhya sira (should not be punctured)
 (a) 98 (b) 94
 (c) 24 (d) 28
51. The site of kloma as per chakrapani
 (a) Hrdaya (c) Yakrt
 (b) Pleeha (d) Vrkka
52. Charaka divided the whole body into
 (a) 6 parts (c) 4 parts
 (b) 8 parts (d) 10 parts
53. The following dhatus are included under dasapranayatanas except
 (a) Sukra (c) Mamsa
 (b) Raktha (d) Medas
54. Number of garbhasamudayakara bhavas are:
 (a) 5 (c) 6
 (b) 7 (d) 8

55. The month in which ojas remains unstable:
 (a) 4 (c) 8
 (b) 7 (d) 6
56. Sira and dhamani are considered as
 (a) Pitruja bhava (c) Atmaja bhava
 (b) Matruja bhava (d) Satmyaja bhava
57. Smriti, utsaha & krodha are related to
 (a) sattvika bhava (c) Atmaja bhava
 (b) Satmyaja bhava (d) none of the above
58. Pregnant women becomes lean (krusha) during-----month because garbha is nourished by more quality of mamsa and shonita
 (a) 4 (c) 3
 (b) 5 (d) 6
59. The mastika measures:
 (a) 1 anjali (c) 3 anjali
 (b) 2 anjali (d) 1/2 anjali
60. Para ojas measures:
 (a) 8 drops (c) 2 anjali
 (b) 1/2 anjali (d) 2 drops
61. Mutra pramana is
 (a) 7 anjali (c) 1/2 anjali
 (b) 4 anjali (d) 8 anjali
62. Trimarmas are:
 (a) Hrdaya, Kloma & Yakrt
 (b) Siras, Hrdaya & Vasti
 (c) Vasti, Medhra & Guda
 (d) Hrdaya, Pleeha & Yakrt
63. Number of petals of muladhara chakra:
 (a) 4 (c) 8
 (b) 6 (d) 10
64. Sankha is
 (a) Marma (c) Dhatu
 (b) Pranayatana (d) Both a & b
65. The number of valis in guda
 (a) 3 (c) 5
 (b) 4 (d) 6
66. Anatomy deals with:
 (a) Functions (c) Structure
 (b) Synthesis (d) None
67. At birth the normal umbilical cord contains
 (a) 2 umbilical arteries (c) Vitelline duct
 (b) 2 umbilical vein (d) The ductus venosus
68. The chromosomal formula of the normal human ovum is
 (a) 44 autosomes & 2 x chromosomes
 (b) 44 autosomes & 1 x, y chromosomes
 (c) 22 autosomes & 1 x chromosome
 (d) 22 autosomes & 1 y chromosome
69. Developmentally placenta is from:
 (a) Fetal origin
 (b) Material origin
 (c) Both fetal and material origin
 (d) 4/5th of placenta is formed from maternal origin
70. Pelvic organs are
 (a) Extra peritoneal
 (b) Intra peritoneal
 (c) Extra peritoneal except ovary
 (d) None of the above
71. The glands having both endocrine & exocrine functions include
 (a) Pancreas (c) Both a & b
 (b) Testis (d) None
72. Cilia are formed in epithelium of:
 (a) Bronchi (c) Maxillary air sinuses
 (b) Fallopian tube (d) All the above
73. The area of greatest growth activity in the bones is
 (a) Epiphysis (c) Metaphysis
 (b) Diaphysis (d) Epiphysial cartilage
74. The first bone to occify and its epiphysis appears last
 (a) Carpal bone (c) Femur
 (b) Scapula (d) Clavicle
75. Growth continues for a longer period at the:
 (a) Knee (c) Shoulder
 (b) Wrist (d) All the above
76. The atlas vertebra is unique in having
 (a) A third spine
 (b) No body
 (c) Foramen transversarium
 (d) All the above
77. The largest synovial joint in the body
 (a) Knee joint (c) Hip joint
 (b) Elbow joint (d) Shoulder joint
78. The shoulder joint permits
 (a) Flexion & extension
 (b) Abduction & aduction
 (c) Circumduction
 (d) All the above
79. Deep inguinal ring:
 (a) Is situated 1.25 cm above and lateral to the pubic tubercle
 (b) Is an opening in the transverses abdominus muscle
 (c) Transmits ilco-inguinal nerve
 (d) Is a deficiency in the transversalis fascia

80. The number of bones in the middle ear:
 (a)3 (c)5
 (b)4 (d)6
81. The inguinal artery arises from the:
 (a)External carotid artery (c)Subclavian artery
 (b)Internal carotid artery (d)Mandibular artery
82. Uterine artery is a branch of:
 (a)Aorta (c)External iliac artery
 (b)Ovarian artery (d)Internal iliac artery
83. The left ovarian vein terminates at:
 (a)Inferior vena cava (c)Internal iliac vein
 (b)Left renal vein (d)None of the above
84. Wrist drop is seen in:
 (a)Ulnar nerve palsy (c)Median nerve palsy
 (b)Radial nerve palsy (d)Auxillary nerve palsy
85. Injury to ulnar above elbow can produce:
 (a)Ape hand (c)Deputytren's contracture
 (b)Claw hand (d)Volkman's contracture
86. Pain fibres are carried by:
 (a)Ventral spino-thalamic tract
 (b)Spino-cerebellar tract
 (c)Posterior columns
 (d)Lateral spinothalamic tract
87. The general sensory supply to the posterior 1/3 of the tongue is by:
 (a)Hypoglossal nerve
 (b)Glossopharyngeal nerve
 (c)Lingual nerve
 (d)Chorda tympani nerve
88. The following nerve endings are found in the skin:
 (a)Meissner's corpuscle (c)Pecinian corpuscle
 (b)Russal's corpuscle (d)Both a & b
89. The spinal cord extends from foramen magnum to the lower border of the
 (a)First lumbar vertebra
 (b)Fifth lumbar vertebra
 (c)Tenth thoracic vertebra
 (d)Eleventh thoracic vertebra
90. The abductor of vocal cord is:
 (a)Lateral crico-aretenoid (c)Crico-thyroid
 (b)Posterior crico-aretenoid (d)Inter-aretenoid
91. The nasolacrimal duct extends from the lower part of the lacrimal sac of the:
 (a)Maxillary sinus
 (c)Superior meatus of the nose
 (b)Ethmoid sinus
 (d)Inferior meatus of the nose
92. The first permanent tooth to erupt is
 (a)First premolar (c)Canine
 (b)First molar (d)Lateral incisor
93. Eustachian tubal opening is related to the posterior end of the:
 (a)Superior turbinate (c)Inferior turbinate
 (b)Middle turbinate (d)None of the above
94. The heart receives nerves from the
 (a)Parasympathetic system and the phrenics
 (b)Parasympathetic system, the vagi
 (c)Sympathetic system of phrenics
 (d)Sympathetic system, parasympathetic and vagi
95. The blood supply of the lung tissue proper is by:
 (a)Pulmonary veins
 (b)Pulmonary arteries
 (c)Bronchial arteries
 (d)Lower thoracic aorta
96. Male accessory sex glands include:
 (a)Seminal vesicles (c)Bulbus urethra
 (b)Vas deference (d)Prostate
97. Which is the largest gland of the body:
 (a)Liver (c)Adrenal
 (b)Pancreas (d)Pituitary
98. The number of liver lobes:
 (a)2 (c)4
 (b)3 (d)6
99. The longest muscle in the body:
 (a)Trapezius (c)Deltoid
 (b)Sartorius (d)Triceps
100. Bone with long neck;
 (a)Femur (c)Ulna
 (b)Humerus (d)Radius
101. The number of ribs joining the sternum:
 (a)7 (c)11
 (b)9 (d)12
102. Cruciate ligament is seen in:
 (a)Shoulder joint (c)Knee joint
 (b)Wrist joint (d)Hip joint
103. Odontoid process is seen in:
 (a)Second cervical vertebra (c)Humerus
 (b)First thoracic vertebra (d)Tibia
104. which is not a type of snayu
 (a)pratanavati (c)kora
 (b)sushiar (d)pruthu
105. The number of thoracic vertebrae:
 (a)7 (c)5
 (b)4 (d)12

106. The number of carpal bone is :
 (a)6 (c)8
 (b)7 (d)5
107. Total number of bones in upper limbs
 (a)60 (c)30
 (b) 66 (d)40
108. Which tube connects the middle ear with the pharynx
 (a)Fallopian (c)Eustachian
 (b)Wharton's duct (d)Nasolacrimal duct
109. Length of the female urethra:
 (a)2 cm (c)4 cm
 (b)3 cm (d)6 cm
110. Which cranial nerve supplies the lateral rectus muscle:
 (a)Trigeminal (c)Pudendal
 (b)Trochlear (d)Abducent
111. Mamsadhara is:
 (a)5th layer of twak (c) I kala
 (b)7th layer of twak (d)2nd layer of twak
112. Marmas are described in Susruta Samhita:
 (a)Sutra sthana ch 6 (c) Sutra sthana ch 7
 (b) Sarira sthana ch 6 (d) Sarira sthana ch 6
113. Number of yogavaha srotas present in the human body as per Susruta:
 (a)11 pairs (c)13 pairs
 (b)9 pairs (d)22 pairs
114. Stapani comes under:
 (a)Mamsa marma (c)Sira marma
 (b)Snayu marma (d)None of the above
115. Tamra is
 (a)Kala (c)Sira
 (b)Twak (d)Kandara
116. Ruchaka is a kind of:
 (a)Asthi (c)Snayu
 (b)Asthi sandhi (d)Kandara
117. Hypothalamus is situated in :
 (a)Fore brain (c)Hind brain
 (b)Mid brain (d)Third ventricle
118. The valve in between left atrium and left ventricle is:
 (a)Mitral valve (c)Both
 (b)Tricuspid valve (d)None of the above
119. Smallest bone in the body is:
 (a)Maleeus (c)Clavicle
 (b)Incus (d)Stapes
120. Fallopian tubes are derived from:
 (a)Bellini's duct (c)Whartons duct
 (b)Mullerians duct (d)Wolfian duct
121. Reproduction of cells is due to the process of
 (a)Miosis (c)Both a & b
 (b)Mitosis (d) Only b
122. Musician nerve is:
 (a)Median nerve (c)Glossopharyngeal
 (b)Ulnar nerve (d)Radial nerve
123. Foramen of monro is:
 (a) Opening of third ventricle into 4th ventricle
 (b) Opening of lateral ventricles into 3rd ventricle
 (c)Both
 (d)None of the above
124. Bartholin glands are present in:
 (a)Labia majora (c)Bulbous part of urethra
 (b)Labia minora (d)None of the above
125. The length of the spinal cord present in the body:
 (a)45 cm (c)55 cm
 (b)65 cm (d)75 cm
126. Number of spinal nerves present in the body:
 (a)331 pairs (c)31 pairs
 (b)33 pairs (d)29 pairs
127. Total number of astisandhis according to Susruta
 (a) 200 (c) 300
 (b)210 (d) 310
128. The essence part of sonita and kapha together to form
 (a)hrudaya (c)vrukka
 (b)pupphusa (d)dudhara
129. Mental foramina present in:
 (a)Malleus (c)Mandible
 (b)Maxillary bone (d)None of the above
130. Stenson's duct is the duct of:
 (a)Parotid glands (c)Sublingual glands
 (b)Pancreas (d)Submandibular gland
131. Carpus canerosum present in
 (a)Testis (c)vagina
 (b)Uterus (d)Penis
132. Tympanic nerve is the branch of
 (a)Auditory nerve (c)Vagus nerve
 (b)Glossophayngeal nerve (d)Trigeminal nerve
133. Basti is an example of
 (a) sira marma (c) asti marma
 (b) snayu marma (d) Sandhi marma

134. Number of extra pesis present in the female
 (a)2 (b)20 (c)40 (d)50
135. Gastrocnemius is
 (a)Abdomen (c)Calf muscle
 (b)Heart (d)neck
136. Splenic artery is the branch of
 (a)Inferior vena cava (c)Coeliac trunk
 (b)Heart (d)Neck
137. Nitambha belongs to
 (a)Asthi marma (c)Sandhi marma
 (b)Mamsa marma (d)Snayu marma
138. The following tvak is vrihi pramana
 (a)Vidini (c)Lohita
 (b)Avabhashini (d)Rohini
139. The following is not a kind of asthi
 (a)Taruna (c)Kapala
 (b)Nalaka (d)Pratara
140. The following srotas is not mentioned in Susruta
 (a)Majjavaha srotas (c)Svedavaha srotas
 (b)Astivaha srotas (d)All the above
141. Kaksha sandhi comes under
 (a)Samudga (c)Kosa
 (b)Pratara (d)Ululkhala
142. Second layer of twak is
 (a)Tamra (c)Mamsadhara
 (b)Lohita (d)Avabhashini
143. Great saphoneous vein drains into
 (a)Femoral vein (c)External vein
 (b)Popliteal vein (d)None of the above
144. Largest vein in the body
 (a)Inferiotr vena cava
 (c)Great saphoneous vein
 (b)Superior vena cava
 (d)None of the above
145. Nails are derived from
 (a)Snayu (c)Kandara
 (b)Sukra (d)Asthi
146. Insertion of triceps brachi
 (a)Superior to the styloid process of radius
 (c)Tuberosity and colonoid process of ulna
 (b)Oblique line of radius
 (d)Olecranon process of ulna
147. Innervation of gastrocnemius muscle
 (a)Deep peroneal nerve (c)Tibial nerve
 (b)Obturator nerve (d)None of the above
148. The refracture media of the eye are
 (a)Acqueous humour and vitreous humour
 (b)cornea and acqueous humour
 (c)Lens and vitreous humour
 (d)Both b& c
149. Caudate lobe is present in
 (a)Pituitary gland (c)Adrenal gland
 (b)Parathyroid gland (d)Liver
150. Smallest muscle in the body is
 (a)Popliteus (c)Sartorius
 (b)Stapedeus (d)Serratus anterior

ANSWERS FOR PART - A

No		No		No		No		No		No	
1	a	26	b	51	a	76	b	101	b	126	c
2	a	27	a	52	a	77	a	102	c	127	b
3	b	28	d	53	d	78	d	103	a	128	a
4	d	29	c	54	c	79	b	104	c	129	c
5	b	30	a	55	c	80	a	105	d	130	a
6	a	31	b	56	a	81	a	106	c	131	d
7	d	32	b	57	a	82	d	107	a	132	d
8	a	33	b	58	b	83	b	108	c	133	b
9	c	34	b	59	d	84	b	109	c	134	b
10	b	35	d	60	a	85	b	110	d	135	c
11	d	36	b	61	b	86	d	111	b	136	c
12	a	37	d	62	b	87	b	112	b	137	a
13	d	38	c	63	a	88	d	113	a	138	d
14	a	39	a	64	d	89	a	114	c	139	d
15	a	40	a	65	a	90	b	115	b	140	d
16	a	41	a	66	c	91	d	116	a	141	d
17	c	42	a	67	a	92	b	117	a	142	b
18	a	43	b	68	a	93	c	118	a	143	a
19	c	44	d	69	c	94	d	119	d	144	a
20	a	45	c	70	a	95	c	120	b	145	c
21	a	46	b	71	a	96	d	121	b	146	d
22	d	47	a	72	d	97	a	122	b	147	c
23	c	48	b	73	c	98	a	123	b	148	d
24	a	49	c	74	d	99	b	124	a	149	d
25	b	50	a	75	d	100	a	125	a	150	b

PART - B

151. According to ayurveda, lower part of stomach to the end of small intestine is called as
(a)Grahani (c)Kshudrantra
(b)Amasaya (d)Koshta
152. A vein which divides like an artery is
(a)Pulmonary vein (c)Coronary vein
(b)Portal vein (d)Renal vein
153. Colour of the vitiated blood is:
(a)Indra kopha sankasa
(b)Sphatika sannibha
(c)Kusumbha puspha
(d)Gunja sannibha
154. The pramana used to measure drava rupa chatus
(a)Anjali (c)Anguli
(b)Bindu (d)Both a & c
155. The hardest substance in the human body:
(a)Enamel (c)Osteocytes
(b)Bone (d)Hair follicle
156. Total number of angapratyangas in human body in garbhavastha:
(a)35 (c)84
(b)29 (d)11
157. The kala which is present between Tarunasthis is:
(a)Medo dhara (c)Sleshma dhara
(b)Asthi dhara (d)Sukra dhara
158. Greater omentum may be compared to----
----- in Ayurveda
(a)Vapa vahana (c)Sleshma dhara
(b)Medo dhara (d)None
159. The tongue muscle is:
(a)Involuntary (c)Specialized
(b)Voluntary (d)None
160. Smsru(mustash) is the mala of:
(a)Ojus (c)Anda kosha
(b)Asthi (d)Sukra
161. The kala which is present all over the body:
(a)Yakrit-plecha dhara (c) Sleshma dhara
(b)Sukra dhara (d) Rakta dhara
162. The kala which is spread all over the body:
(a)Vata dhara (c)Sleshma dhara
(b)Sukra dhara (d)Rakta dhara
163. All the kalas have one of the following doshas in them:
(a)Vata (c)Sleshma
(b)Pitta (d)Rakta
164. Melanin is present in-----layer of skin
(a)Tamra (c)Udaka dhara
(b)Lohita (d)Asrigdhara
165. Vagbhata quated that skin forms from-
dhatu
(a)Rasa (c)Mamsa
(b)rakta (d)Ojus
166. According to Susruta skin forms from-
dhatu
(a)Rasa (c)Mamsa
(b)Rakta (d)Sukra
167. Skin(twak) is the upadhatu of-----
dhatu
(a)Rasa (c)Rakta
(b)Mamsa (d)Medas
168. Udaka vaha dhamanis are originated
(a)Kloma (c)Tala
(b)Antra (d)both a & c
169. Anna vaha dhamanis are present in
(a)Amasaya (c)Parswa
(b)both a & b (d)Pittasaya
170. Malavisarjana dhamanis are present in
(a)Sthulantara (c)Pittasaya
(b)Grahani (d)Adhara guda
171. The 24 varieties of main dhamanis
are further divided into-types
(a)30 (c)80
(b)64 (d)72
172. The siras are mainly divided into-
types
(a)24 (c)44
(b)64 (d)84
173. Vapa vahana is otherwise known as
(a)Taila vartika (c)Apara
(b)Garbhasaya (d)None

174. Number of koshtangas according to Susruta
 (a)8 (c)15
 (b)12 (d)9
175. Total number of sadhya prana hara marma are
 (a) 57 (c)19
 (b)4 (d)3
176. Total pratyangas according to charaka
 (a)8 (c)15
 (b)56 (d)54
177. Sarangadhara considered as the 10th Bahirmukha srotas in males
 (a)Sthana (c)Nabhi randhra
 (b)Brahma randhra (d)None
178. Rakta vaha dhamanis are among the mula sthana of -srotas
 (a)Rakta vaha (c)Mamsa vaha
 (b)Prana vaha (d)both a & b
179. Rasa vaha dhamanis and hridayam are the mula sthana of srotas
 (a)Rasa vaha (c)Prana vaha
 (b)both a & c (d)Udaka vaha
180. According to vagbhata, there are ----- categories of marmas
 (a)5 (c)4
 (b)7 (d)6
181. Yoga vaha srotas are in number
 (a)13 (c)22
 (b)9 (d)10
182. According to Dalhana, purisha dhara kala is also known as
 (a)Asthi dhara (c)anna dhara
 (b)Rasa dhara (d)Mala dhara
183. In the genito-urinary system, pourusha means
 (a)Sukra vaha nadi (c)Prostate
 (b)Vrishana (d)Penis
184. Number of pupphusa according to charaka
 (a)1 (c)2
 (b)3 (d) none
185. Guda is -angulis in size
 (a)4 ½ (c)5 ½
 (b)6 ½ (d)5
186. The only asthi marma which is ranahara is
 (a)Adhipati (c)Sankha
 (b)Afanga (d)Sringataka
187. Number of marmas in head
 (a)12 (c)14
 (b)44 (d)37
188. The marma specially mentioned by vagbhata
 (a)Snayu (c)Twak
 (b)Dhamani (d)Kandara
189. Which of the following marmas will be 3 angulis in size?
 (a)Janu (c)Kurpara
 (b)both a & c (d)Kshipra
190. Which one of the following is an end artery?
 (a)Renal artery (c)Cerebral artery
 (b)Coronary artery (d)all the above
191. Water-shed line indicates-marma
 (a)Guda (c)Hridaya
 (b)Sirah (d)Nabhi
192. The thickness of rohini layer is
 (a)1/2 yava (c) 1 yava
 (b)1 ½ yava (d)2 ½ yava
193. Nakha develops from
 (a)Asthi (c)Snayu
 (b)Roma (d)Kandara
194. The muscle of urinary bladder is
 (a)Erector (c)Detrusor
 (b)Dortus (d)None
195. Which organ is reservoir of blood?
 (a)Heart (c)Spleen
 (b)Liver (d)Kidney
196. The largest digestive gland is
 (a)Spleen (c)Stomach
 (b)Liver (d)Pancreas
197. Pancreatic duct is known as
 (a)Duct of wirsung (c)Both a & b
 (b)Silvius aequeduct (d)None
198. Which one of the following is a pranayatana according to vagbhata?
 (a)Kanta (c)Yakrit
 (b)Urah (d)Nasika
199. The organ, which performs both exocrinal as well as endocrinal activity, is
 (a)Liver (c) Pancreas
 (b)Pituitary (d)Kidney
200. Susruta calls ----- as Antarmukha srotas
 (a)Yoga vaha (c)Sukshma Srotas
 (b)Sthula srotas (d)None
201. The srotas which is not described by Susruta is
 (a)Sweda vaha (c)Majja vaha
 (b)Asthi vaha (d)All the above

202. Asthi marma are absent in the
 (a) Neck (c) Limb
 (b) Head (d) All the above
203. Maximum number of marmas in the body are
 (a) Sira marma (c) Snayu marma
 (b) Asthi marma (d) Sandhi marma
204. Rujakara marma are absent in
 (a) Limbs (c) Thorax
 (b) Head & neck (d) Abdomen
205. The adjoining part of udara & uras is known as
 (a) vankshana (c) kati
 (b) sphika (d) jaghana
206. The average weight of spinal cord is
 (a) 45 gm (c) 50 gm
 (b) 35 gm (d) 55 gm
207. The lateral ventricles of cerebral hemispheres will open into a common central cavity (3rd ventricle) through
 (a) Foramen of monro (c) Foramen of magnum
 (b) Foramen centralis (d) Foramen ovalis
208. Average length of spinal cord is
 (a) 45 cm (c) 60 cm
 (b) 55 cm (d) 65 cm
209. Normal quantity of CSF in adult is
 (a) 100 ml (c) 200 ml
 (b) 150 ml (d) 50 ml
210. Number of joints according to charaka
 (a) 210 (c) 250
 (b) 260 (d) 200
211. number of peshis according to charaka
 (a) 700 (c) 500
 (b) 900 (d) 400
212. Total number of bones in human body
 (a) 210 (c) 204
 (b) 206 (d) 200
213. Ghrana, Greeva & Karna possess type of bones
 (a) Valaya (c) Taruna
 (b) Nalaka (d) Ruchaka
214. Number of sandhis in the head & neck are
 (a) 53 (c) 47
 (b) 61 (d) 61
215. "Sushira" type of snayu are present in – place
 (a) Amashaya (c) Vasthi
 (b) Pakwashaya (d) All the above
216. Vasa is in quantity in the body
 (a) 2 anjali (c) 4 anjali
 (b) 3 anjali (d) 7 anjali
217. How many malayanas are here in the body?
 (a) 2 (guda & sisna)
 (b) 2 (guda & mukha)
 (c) 3 (guda, sisna & romakupa)
 (d) 3 (trimalas)
218. jeeva rakthsasyam urah indicates – organ
 (a) Liver (c) Heart
 (b) Spleen (d) Lungs
219. "Mahat" is the synonym of
 (a) Paramanu (c) heart
 (b) brain (d) atom
220. The length of antras is
 (a) 2 ½ vyama (c) 3 ½ vyama
 (b) 3 vyama (d) 4 ½ vyama
221. The length of eyeball is
 (a) 1 ½ anguli (c) 2 ½ anguli
 (b) 2 anguli (d) 2 anguli
222. The impacted foreign body should not be removed in case of
 (a) Sadhyah pranahara (c) Vishalyaghna
 (b) Riji kara (d) Vaikalya kara
223. Amsa marma abhighata leads to
 (a) Raktapyrana koshta
 (b) Vata purana koshta
 (c) Kapha purana koshta
 (d) Pitta purana koshta
224. Watershed line is indicated by
 (a) Vasthi (c) Nabhi
 (b) Hridaya (d) Sirah
225. "peripheral heart" may be compared to
 (a) Indra vasthi (c) Janu
 (b) Kurcha (d) Gulpha
226. Charaka measured human body on the basis of pramana
 (a) Anjali (c) Bindu
 (b) Anguli (d) Bhara
227. Jnana-vijnana and sukha dukha are bhavas
 (a) Matrija (c) Atmaja
 (b) Pitruja (d) Sattwaja
228. The largest muscle in the body
 (a) Stapedeus (c) Deltoid
 (b) Scalenus (d) Sartorius
229. Hrudya is an example of
 (a) mamsa marma (c) snayu marma
 (b) sira marma (d) asthi marma

230. The largest vein in the human body is
 (a) Great saphenous vein
 (b) Portal vein
 (c) Superior vena cava
 (d) Inferior vena cava
231. Anatomical & physiological aspects of genito-urinary system are well explained by
 (a) Charaka (c) Vagbhata
 (b) Sushruta (d) Sarangadhara
232. Which one of the following Mannas is soumya as well as Agneya?
 (a) Sadhyah pranahara (c) Vishalyaghna
 (b) Kalantara pranahara (d) Vaikalyakara
233. Which is known as the "muscle of laughter" ?
 (a) Frontalis (c) Risorius
 (b) Triangularis (d) Buccinator
234. Morrison's pouch is known as
 (a) Recto vesicle pouch (c) Duodenum
 (b) Stomach (d) Hepato renal pouch
235. Brunner's glands are present in the
 (a) Oesophagus (c) Duodenum
 (b) Stomach (d) Small intestine
236. Which is the shortest branch of the abdominal aorta?
 (a) Rt. renal artery (c) Carotid artery
 (b) Lt. renal artery (d) External iliac artery
237. is a famous as musician's nerve
 (a) Ulnar nerve (c) Median nerve
 (b) Radial nerve (d) Femoral nerve
238. What is the normal weight of human brain?
 (a) 1200-1500 gm (c) 500-750 gm
 (b) 800-1000 gm (d) none
239. Pancreatic duct is also called as
 (a) Duct of bellini (c) Mullarian duct
 (b) Duct of wirsung (d) Wolffian duct
240. Which of the following organs is divided into head, body & tail?
 (a) Pancreas (c) Gall bladder
 (b) Liver (d) Spleen
241. Islets of Langerhans are present in
 (a) Spleen (c) Supra renal glands
 (b) Kidney (d) Pancreas
242. The first bone to start ossification in intrauterine life
 (a) Scapula (c) Femur
 (b) Clavicle (d) Humerus
243. Amsa is a
 (a) Sandhi (b) Asthi (c) Marma (d) all the above
244. Sushruta consider the following as the mula of sukra vaha srotas
 (a) Sthana (c) Sepha
 (b) Vrishana (d) Both b & c
245. Which forms the base of femoral triangle?
 (a) External iliac artery (c) Round ligament
 (b) Inguinal ligament (d) Femoral artery
246. Cervical part of internal carotid artery have..... number of branches
 (a) 1 (b) 2 (c) 3 (d) nil
247. is the largest sesmoid bone
 (a) Scapula (c) Pisiform
 (b) Hip bone (d) Patella
248. Nabhi is marma
 (a) Snayu (b) Sira (c) Mamsa (d) Dhamani
249. The length of human body according to charaka is
 (a) 124 anguli (c) 84 anguli
 (b) 104 anguli (d) 64 anguli
250. "sarira vichya sariropakaratham ishyate....." is the statement of
 (a) Charaka (c) Vagbhata
 (b) Sushruta (d) Gananathsen

ANSWERS FOR PART - B

No	Ans	No	Ans	No	Ans	No	Ans
151	a	176	b	201	d	226	b
152	b	177	c	202	c	227	c
153	c	178	d	203	a	228	d
154	a	179	b	204	b	229	b
155	a	180	d	205	a	230	d
156	b	181	c	206	b	231	b
157	a	182	d	207	a	232	b
158	a	183	a	208	a	233	c
159	b	184	c	209	b	234	d
160	b	185	a	210	d	235	b
161	a	186	c	211	d	236	b
162	b	187	d	212	b	237	a
163	c	188	c	213	c	238	a
164	a	189	b	214	a	239	b
165	a	190	d	215	d	240	a
166	a	191	d	216	b	241	d
167	b	192	c	217	a	242	b
168	d	193	c	218	c	243	d
169	d	194	c	219	c	244	d
170	b	195	c	220	c	245	b
171	c	196	b	221	c	246	d
172	b	197	a	222	c	247	d
173	a	198	a	223	c	248	b
174	a	199	c	224	c	249	c
175	c	200	a	225	a	250	a

PART - C

251. As per Charaka the total body is divided into
(a) dwianga (c) Panchanga
(b) Trianga (d) Sadanga
252. Number of extra pesis in the female
(a) 50 (c) 20
(b) 2 (d) 40
253. Apanga marma belongs to
(a) Jatru rdhvagata marma (c) Vaikalyakara marmas
(b) Sira marmas (d) All the above
254. Garbhāsaya is situated in
(a) First avarta of yoni (c) Third avarta of yoni
(b) Second avarta of yoni (d) Fourth avarta of yoni
255. Number of simanta present in the body
(a) 4 (c) 18
(b) 14 (d) 20
256. Charaka has given the detailed description of srotas in
(a) Sutra sthana (c) Vimana sthana
(b) Shareera sthana (d) Siddhi sthana
257. Which of the following bhavas are derived from mother to foetus
(a) Hridaya, nabhi, yakrt, rakta (c) Jnana, vignana, ayus
(b) Bala, varna, sthithi, hani (d) Veerya, arogya, medha
258. Atmaja bhavas of Garbha as per Susruta
(a) Indriyani, Ayushya (c) Sukha & dukha
(b) Jnana & Vijnana (d) All of the above
259. Number of bones present in human body as per Charaka
(a) 300 (c) 365
(b) 360 (d) 372
260. Nitamba marma belongs to
(a) Snayu marma (c) Mamsa marma
(b) Sandhi marma (d) Asthi marma
261. Number of pesis and Asayas present in female
(a) 500 pesis & 7 asayas (c) 500 pesis & 8 asayas
(b) 520 pesis & 7 asayas (d) 520 pesis & 8 asayas
262. According to Susruta number of mutra vaha srotas are
(a) 9 (c) 22
(b) 11 (d) 2
263. Find out the false in case of marmas and their number
(a) Mamsa marmas are 11 (c) Snayu marmas are 27
(b) Sira marmas are 41 (d) Asthi marmas are 18
264. Asthis of nose and ear are included in
(a) Kapalasthies (c) Nalakasthies
(b) Valayashties (d) Tarunasthies
265. Which of the following is not 8 in number
(a) Rujakara marmas (c) Asthi marmas
(b) Asyas in female (d) None of the above
266. Number of valies in Guda
(a) 2 (c) 4
(b) 3 (d) 5
267. Which of the following is the variety of snayu
(a) Sankhavarta (c) Pradhara
(b) Vritta (d) Valaya
268. Find out Vasa in the following
(a) Mamsa sneha (c) Rakta medas
(b) A type of majja (d) None of the above
269. Naitas are derived from
(a) Sukra (c) Asthi
(b) Snayu (d) Kandara
270. According to Susruta sankha comes under
(a) Jatru dvagata marmas (c) Asthi marmas
(b) Sadhyah pranahara marmas (d) All the above
271. Which of the following is not pranayataka
(a) Hridaya (c) Sankha
(b) Nabhi (d) None of the above
272. According to Charaka Samhitha, Mutravaha srotas have their root in
(a) Vrikka & vapavahanam
(b) Vasti & vamksana
(c) Amashya & vamaparshvam
(d) None of the above
273. Feto – placental ratio at the time of birth
(a) 6 : 1 (c) 3 : 6
(b) 1 : 6 (d) 6 : 3
274. Sira, snayu, sukra and Dhamani are included in
(a) Matruja bhava (c) Rasaja bhava
(b) Pitruja bhava (d) Satmyaja bhava
275. Which of the following is not true as per Susruta
(a) Total number of marmas are 107
(b) Total number of siras are 700
(c) Total number of yogavaha srotas are 9
(d) Total number of samghatas are 14
276. All of the following are padagata marmas except
(a) Ksipra marmas (c) Kurcha marma
(b) Talahridaya marma (d) Kaksa dhara

277. According to charaka, vrikka and vapavahanam are the site of origin for
 (a) Mamsavaha srotas (c) Medovaha srotas
 (b) Mutravaha srotas (d) Majjavaha srotas
278. All of the following are Rasaja bhavas except
 (a) Sariropacaya (c) Sthita & hani
 (b) Bala & varna (d) Viryam & arogyam
279. According to Susruta sukrovaha Sroto mulam are
 (a) Vasti & medhra (c) Stanas & vrishana
 (b) Medhra & vrishana (d) Vasti & vrishana
280. All of the following are Sadyo pranahara marmas except
 (a) Kantha sira, sringataka (c) Stanarohita, stanamula
 (b) Adhipati, sankham (d) Guda, vasthi, nabhi
281. Number of types of asthi sandhis as per Susruta
 (a) 7 types (c) 9 types
 (b) 8 type (d) 10 types
282. Injury to urvi marma leads to
 (a) Aksepa vata (c) Rakta ksaya
 (b) Sakti sosa (d) Paksaghata
283. Mula of medovaha srotas as per Susruta
 (a) Kati & vrikka (c) Kati & udara
 (b) Udara & vrikka (d) All of the above
284. Raktavahini dhamani's are the mula of
 (a) Rakta vaha srotas
 (b) Mamsa vaha srotas
 (c) Mamsavaha & raktavaha srotas
 (d) Pranavaha srotas
285. Adhipati marma comes under
 (a) Sadhyah pranahara marmas
 (b) Sandhi marmas
 (c) Jatrurdvagata marmas
 (d) All the above
286. The term kala means the space between
 (a) Dhatu & asaya (c) Dhatu & upadhatu
 (b) Dhatu & mala (d) Mala & twak
287. Which of the following srotas is not mentioned by Susruta
 (a) Asthivaha srotas
 (b) Majjavaha srota
 (c) Asthivaha & majjavaha srotas
 (d) None of the above
288. Vedhani twak is adhistana of
 (a) Kilasa & kusta rogas
 (b) Kusta & visarpa rogas
 (c) Bhagandharam & vidradi
 (d) Granthi, apachi & arbuda
289. The extra asaya present in the female
 (a) Mutasaya (c) Garbhasaya
 (b) Raktasaya (d) Pachyamanasaya
290. Which of the following are 7 in number as per Susruta
 (a) Twak & kala (c) Both the above
 (b) Asaya, dhatu & sevani (d) Sanghata & simantas
291. Injury to vitapa marma leads to
 (a) Paksha ghata (c) Sandatva
 (b) Akshepa ghata (d) All the above
292. According to Susruta Hridaya is the mula of
 (a) Rasavaha srotas
 (b) Pranavaha srotas
 (c) Rasavaha & pranavaha srotas
 (d) All the above
293. Number of twak according to charaka Samhitha
 (a) 7 (c) 6
 (b) 8 (d) 10
294. Hanu Sandhi belongs to
 (a) Tunna sevani type of asthi Sandhi
 (b) Sankhavarta type of asthi Sandhi
 (c) Vayasatunda type of asthi sandhi
 (d) Mandala type of asthi Sandhi
295. Janu asthi comes under
 (a) Kapala type of asthi (c) Nalaka type of asthi
 (b) Valaya type of asthi (d) All the above
296. Numbers of bahirmukha srotas are present in females as per Susruta
 (a) 9 (c) 13
 (b) 12 (d) 11
297. Third layer of twak as per Susruta
 (a) Avabhashini (c) Lohitha
 (b) sweta (d) Mamsadhara
298. Common type of twak and kala as per Susruta
 (a) Raktadhara (c) Lohitha
 (b) Mamsadhara (d) Vedini
299. In intrauterine life yakrit & pliha are developed from
 (a) Rasaja bhavas (c) Raktaja bhavas
 (b) Matrija bhavas (d) Atmaja bhavas
300. The following twak is 2 vrihi pramana
 (a) Avabhashini twak (c) Vedini twak
 (b) Lohita twak (d) mamsa dhara
301. Injury to vitapa marma leads to
 (a) Sandatva & alpa sukrata
 (b) Khanjatva & stabdatva
 (c) Pakhaghata & sakthisosa
 (d) Sadhyah pranahara
302. Number of siras present in the body
 (a) 30 (c) 32
 (b) 31 (d) 33

303. The name of 7th layer of kala
 (a)purisha dara (c)pitta dara
 (b)sukra dara (d)rakta dara
- 304.Unduka is derived from
 (a)Sonita phena (c)Sonita sarah
 (b)Sonita kitta (d)None of the above
- 305.Apalaapa marma comes under
 (a)Sira & kalantara pranahara marmas
 (b)Kalantara pranahara & mamasa marmas
 (c)Sandhi & rujakara marmas
 (d)Snayu & vishalyaghna marmas
- 306.Hridaya & rasavahini dhamanies are the mula of
 (a)Pranavaha srotas
 (b)Rasavaha srotas
 (c)Pranavaha & raktavaha srotas
 (d)Pranavaha & rasavaha srotas
- 307.Tunna savani is a variety of
 (a)Asthi (c)Yogavaha srotas
 (b)Asthi sandhi (d)Snayu
- 308.Tala hridaya comes under
 (a)Kalantarab pranahara marmas
 (b)Hasta gata marma
 (c)Pada gata marmas
 (d)All of the above
- 309.Name of the sixth layer of kala as per susrutha
 (a)Sveta (c)Udhakadhara
 (b)pitta dhara (d)Rakta dhara
- 310.Stanamula marma comes under
 (a)Kalantara pranahara marma
 (b)Hasta gata marmas
 (c)Pada gata marmas
 (d)Mamsa gata marmas
- 311.Which of the following is 1/18th vrihi dvaya pramana
 (a)Avabhashini twak (c)Rohini twak
 (b)Lohita twak (d)Mamasadhara twak
- 312.In fetus Caksu & rupa are derived from
 (a)Prithvi bhuta (c)Vayu bhuta
 (b)Jala bhuta (d)Agni bhuta
- 313.Trimarmas are included in
 (a)Sadyah pranahara marmas
 (b)Kalantara pranahara marmas
 (c)Visalyaghna marmas
 (d)Rujakara marmas
- 314.Kaksha, Vankshana, Dansana sandhies are included in
 (a)Kosa type of asthi sandhies
 (b)Samudga type of asthi sandhies
 (c)Ulukhala type of asthi sandhies
 (d)Pratara type of asthi sandhies
- 315.Stanya vaha srotas was not described by
 (a)Charaka (c)Vagbhata
 (b)Susruta (d)Saranghadhara
- 316.The part that will grow even the body is emaciating
 (a)Nakha & danta (c)Siras,dhamanis & srotas
 (b)Roma & Nakha (d)Sweda,Mutra & purisha
- 317.Injury to simanta ,Sringhataka & Adhipathi leads to
 (a)Sadyo pranahara (c)VAikalyakara
 (b)Kalantara pranahara(d)Rujakara
- 318.Number of kandaras present in the human body as per susruta
 (a)6 (b)60 (c)16 (d)66
- 319.Nitambha belongs to
 (a)Kalantara pranahara marmas
 (b)Asthigata marmas
 (c)Pristhagata marmas
 (d)All the above
- 320.Jagritastadvikasati svapatascha nilimati is
 (a)Klomam (c)Vrikkam
 (b)Hridayam (d)Annavaha srotas
- 321.The following is not having 14 in number as per Susruta
 (a)Samghatah (c)Simanta
 (b)Sevaniyah (d)None of the above
- 322.According to susruta Talu & kloma are mula of
 (a)Rasavaha srotas (c)Udakavaha srotas
 (b)Raktavaha srotas (d)Swedovaha srotas
- 323.Avarta marmabhighata leads to
 (a)Sadhya pranahara (c)Badhiryam
 (b)Andhatvam (d)Mukatvam
- 324.Which of the following as per Susruta samhitha
 (a)Total number of asthies are 300
 (b)Total number of dhamanies are 24
 (c)Total number of srotas are 9
 (d)None of the above
- 325.Rasi purusha is other wise known as
 (a)sad dhatuja purusha
 (b)chatur vimsati purusha
 (c)pancha vimsati purusha
 (d)eka dhatwatmaka purusha
- 326.Mamsa dhara twak adhistana rogas are
 (a)Bhaganthara,vidradhi,arsas
 (b)Kusta,visarpa
 (c)Charmadala,ajagallika,masaka
 (d)Sidma,padma,kantaka

327. Marmas are found described in Susruta samhita
 (a) Sutra sthana 6th chapter
 (b) Sarira sthana 6th chapter
 (c) Sarira sthana 10th chapter
 (d) Sutra sthana 10th chapter
328. Which of the following is wrong as per susruta
 (a) Marmas are 107 (c) Asthies are 360
 (b) Sevanyas are 7 (d) Kandaras are 16
329. Measurement of lohita twak
 (a) 1/18th part of vrihi (c) 1/12th part of vrihi
 (b) 1/16th part of vrihi (d) 1/8th part of vrihi
330. Which of the following are 22 in number as per Susruta
 (a) Srotas (c) Yogavaha srotas
 (b) Kandaras & jalas (d) Sanghatas
331. Sthapani comes under
 (a) visalyaghna marmas (c) Sira marmas
 (b) Jatrurdhvagata marmas (d) All the above
332. Raktavaha sroto mulam as per Susruta
 (a) Siras & hrdaya
 (b) Yakrit & pliha
 (c) Talu & kloma
 (d) Rasavahini dhamanis & hridayam
333. Find out asthi types in the following as per Susruta
 (a) Kapala, Ruchaka, Taruna
 (b) Kora, ulukhala, Samudga
 (c) Tunnasevani, Pratara, Vayasa tunda
 (d) None of the above
334. According to caraka number of asthi sandhies are
 (a) 200 (c) 260
 (b) 360 (d) 210
335. Quantity of rakta according to caraka
 (a) Ten anjali (c) Eight anjali
 (b) Nine anjali (d) Seven anjali
336. Trimarmas are described by
 (a) Caraka (c) vagbhata
 (b) Susruta (d) indu
337. Pancha dasa kostangas are found mentioned in
 (a) Caraka samhita sarirastanam
 (b) Susruta samhita sarira sthana
 (c) Astanga hridaya sarira sthana
 (d) None of the above
338. The length of Guda as per Susruta
 (a) 2.5 angulis (c) 4 angulis
 (b) 3.5 angulis (d) 5.5 angulis
339. Sukra dhara kala is located in
 (a) Sarva sandhis (c) Udara & Traunasthi
 (b) Snayu, Dhamanis & srotas (d) Sarva sarira
340. Name of the seventh layer of twak as per Saranghadhara
 (a) Rohini (c) Sthula
 (b) Mamasadhara (d) Vedini
341. Development of buddhi in fetus occurs in
 (a) 5th month (c) 7th month
 (b) 6th month (d) 8th month
342. Janu marma abhigata leads to
 (a) Khanjata (c) Sosa
 (b) Stabdghata (d) Pakshagata
343. The colour of vata vahini sira
 (a) Nila varna (c) Sukla varna
 (b) Aruna varna (d) Gaura varna
344. The mula of mamsavaha srotas
 (a) Snayu (c) Raktavaha dhamanias
 (b) Twak (d) All the above
345. If the semen falls directly on samiranadi the results will be
 (a) Male conception (c) Abortion
 (b) Female conception (d) None of the above
346. The organ having the shape of inverted lotus, which opens and closes during wake and sleep respectively is
 (a) Yakrit (liver) (c) Hridaya (heart)
 (b) Pliha (spleen) (d) Puppusa (lung)
347. Niketamula is the synonym of
 (a) Dhamani (c) Srotas
 (b) Sira (d) Snayu
348. Which of the following are not the types of asthi
 (a) Kapala & ruchaka (c) Valaya & taruna
 (b) Ulukhala & samudgha (d) None of the above
349. According to susruta Pratara is a type of
 (a) Asthi (c) Snayu
 (b) Asthisandhi (d) Jala
350. All the following are the types of snayu except
 (a) Susira (c) Vritta
 (b) Pratanvati (d) Nalaka
351. Nabhi marma comes under
 (a) Sadyah pranahara & mamsa marmas
 (b) Sadyah pranahara & sira marmas
 (c) Kalantara pranahara & sandhi marmas
 (d) Rujakara & snayu marmas
352. Find out the Ruchakasthies in the following
 (a) Janu, nitamba, Sankha (c) Dasana
 (b) Ghrana, Karna, (d) None of the above

353. Number of sevani present in siras
(a)2 (b)3 (c)4 (d)5
354. The normal quantity of mutra as per Charaka
(a)3 anjalis (c)5 anjalis
(b)4 anjalis (d)7 anjalis
355. Sringatakas comes under
(a)Sadyah pranahara marmas
(b)Jatrurdhva sata marmas
(c)Sira marmas
(d)All the above
356. The shape of yoni as per Susruta
(a)Sankhanabhi (c)Asvattha patra
(b)Rohitamatsya mukha (d)None of the above
357. Find out the Rujakara marmas in the following
(a)Hridaya, Vasti, Gudam
(b)Adhipati, Nabhi, Vasti
(c)Sthapani, Indravasti
(d)Gulpha, Manibandha, Kurcha siras
358. The Location of sleshma dhara kala
(a)Snayu, Dhamani, Srotas (c)Sarva sandhis
(b)All sandhis (d)Inbetween Amasaya & pakvasaya
359. Teeth are included in
(a)Kapalasthis (c)Ruchakasthis
(b)Tarunasthis (d)Nalakasthis
360. Largest lymphatic gland is
(a)heart (c)liver
(b)spleen (d)pancreas
361. Injury to vidhura marma causes
(a)Death (c)Dumbness
(b)Deafness (d)Blindness
362. The normal quantity of majja, as per Charaka
(a)1 anjali (c)3 anjalis
(b)2 anjalis (d)4 anjalis
363. Sadyopranahara marmabghata leads to death within
(a)7 days (b)21 days (c)1 month (d)15 days
364. Dhatvasyantara maryaadah is
(a)Twak (c)Raktasaya
(b)Garbhasaya (d)Kala
365. Find out one angula pramana marmas in the following
(a)Urvi, kurcha sira, vitapa, kaksa dhara
(b)Manibanha, gulpha, stana mulas
(c)Janu, kurpara, kurcha
(d)Simanta, maatrika, Manya
366. Normal quantity of Artava as per Astanga hridaya
(a)4 anjalis (c)6 anjalis
(b)5 anjalis (d) None of the above
367. AS per Vagbhata "Prithak svaprasritam" is the quantity of
(a)Ojas, Mastiska & Sukra (c)All the above
(b)Vasa, Majja & para ojas (d)None of the above.
368. Number of Dhamanis as per susruta
(a)22 (c)24
(b)23 (d)26
369. Pranas of garbha according to Susruta are
(a)Agni, Soma, Vayu
(b)Satva, Rajas, Tamas
(c)Panchendriyas & Bhutatma
(d)All the above
370. Susira type of snayus present in
(a)End portion of amasaya
(b)End portion of pakvasaya
(c)Vasti
(d)All the above
371. Puppusa is derived from
(a)Sonita phena prabhaava
(b)Sonita kitta prabhava
(c)Rakta meda prasada
(d)Sonita kapha prasadajam.
372. Dhamani marmas are found mentioned in
(a)Charaka samhita sarira sthana
(b)Susruta samhita sarira sthana
(c)Astanga hridaya sarira sthana
(d)None of the above
373. Which of the following is marma lakshana
(a)Visama toda on pressure
(b)Visama spandana on pressure
(c)Visama ruk on pressure
(d)Visama spandana and ruk on pressure
374. Murdha, Kantha, Hridaya, Nabhi, Gudam, Vasti are included in
(a)Marmas (c)Marmas & pranayatanas
(b)Pranayatanas (d)None of the above
375. Kati Sandhi is an example of
(a)Sthira (c)Kora
(b)Chestavanta (d)Ullukhala
376. Number of manasa prakruthi
(a)3 (c)6
(b)11 (d)16
377. Total number of mula prakruthi
(a)7 (c)8
(b)3 (d)1
378. Which is not included in kostanga-by Charaka
(a) Amashaya (c) Pakwashaya
(b)Pupphusa (d) Vapabahana

379. Total number of urdvajatrugata marma
 (a)37 (c)44
 (b)26 (d)30
380. Dhanta (teeth) is an example of
 (a) Tarunaasthi (c) Kapalaasthi
 (b)Nalakaasthi (d) Ruchakaasthi
381. Pramana of para ojas
 (a) 1 anjali (c) ½ anjali
 (b)6 drops (d)8 drops
382. Length of human body acc to charaka
 (a)84 anguli (c) 120 anguli
 (b)116 anguli (d) 86 anguli
383. Length of human body acc to Susrutha
 (a)84 anguli (c) 120 anguli
 (b)116 anguli (d) 86 anguli
384. Number of garbha utpadaaka bhavas
 (a) 5 (c)7
 (b)6 (d) 8
385. Srigataka marma is situated at
 (a) Chest (c) Abdomen
 (b) Thigh (d) Nose
386. In which month of pregnancy oja is not stable
 (a) 2 (c)6
 (b)4 (d)8
387. How many layers are present in artery & vein
 (a) 3 (c) 4
 (b) 6 (d) 10
388. Mental foramen is present in
 (a) Ethmoid bone (c) Occipital
 (b) Axilla (d) Mandible
389. Total number of bones present in face
 (a) 8 (c) 26
 (b) 14 (d) 6
390. Which cranial nerve is supplied to heart
 (a) 10th (c) 7th
 (b) 6th (d) 8th
391. Bare area is present in
 (a) Stomach (c) Liver
 (b) Pancreas (d) Spleen
392. Number of muscles constitute to form
 Quadriceps femoris
 (a) 4 (c) 6
 (b) 3 (d) 5
393. Number of valves present in heart
 (a) 2 (c)6
 (b) 4 (d)8
394. Hilum is present in
 (a) Heart (c)Liver
 (b)Lungs (d)Deodenum
395. The example of sesamoid bone is
 (a) Clavicle (c) Sternum
 (b)Patella (d) Carpal bones
396. Acetabulum is an important structure in
 (a) Wrist joint (c) Hip joint
 (b)Ankle joint (d) Elbow joint
397. Tendo – Achilles is related to
 (a) Wrist joint (c) Hip joint
 (b)Ankle joint (d) Elbow joint
398. Presence of hCG hormone in urine
 signifies
 (a) Pragnancy (c) Menarche
 (b)Menopause (d) Delivery
399. 11th and 12th ribs are known as
 (a) True ribs (c) False ribs
 (b)Floating ribs (d) Deeping ribs
400. The length of foetus at the time of birth
 (a)40 cm (c)60 cm
 (b)50 cm (d)70 cm

ANSWERS FOR PART- C

No	Ans	No	Ans	No	Ans	No	Ans	No	Ans
251	d	281	b	311	a	341	b	371	a
252	c	282	b	312	d	342	a	372	c
253	d	283	a	313	a	343	b	373	d
254	c	284	c	314	c	344	d	374	c
255	b	285	d	315	a	345	d	375	b
256	c	286	a	316	b	346	c	376	d
257	d	287	c	317	a	347	c	377	d
258	d	288	b	318	c	348	b	378	b
259	b	289	c	319	d	349	b	379	a
260	d	290	c	320	b	350	d	380	d
261	d	291	c	321	b	351	b	381	d
262	c	292	c	322	c	352	c	382	a
263	d	293	c	323	b	353	d	383	c
264	d	294	c	324	d	354	b	384	b
265	d	295	a	325	b	355	d	385	d
266	b	296	b	326	a	356	a	386	d
267	a	297	b	327	b	357	d	387	a
268	c	298	b	328	c	358	b	388	d
269	d	299	b	329	b	359	c	389	b
270	d	300	d	330	c	360	b	390	a
271	d	301	a	331	d	361	b	391	c
272	b	302	c	332	b	362	a	392	a
273	a	303	b	333	a	363	a	393	b
274	b	304	b	334	a	364	d	394	b
275	c	305	a	335	c	365	a	395	b
276	d	306	d	336	a	366	a	396	c
277	c	307	b	337	a	367	a	397	b
278	d	308	d	338	c	368	c	398	a
279	c	309	b	339	b	369	d	399	b
280	c	310	a	340	c	370	d	400	b

Key words

A.H.-Astanga Hrudayam
A.S.-Astanga Samgraham
Su. – Susruta Samhitha
Ch. - Charaka Samhitha
Sha.-Shareera sthana
Su.-Sutra sthana
Vim.-Vimana sthana
Chi.-Chikitsa sthana

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