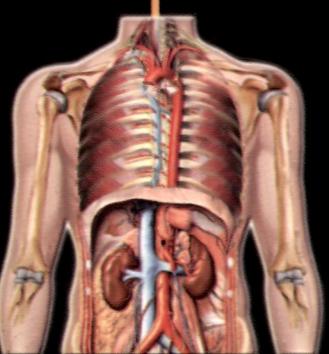


A Text Book of Anatomy *(Rachana Sharira)*



II

Dr. P. K. Moharana

A Text Book of Anatomy

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.



Dr. P. K. Moharana is presently working as Reader in Sri Jayendra Saraswathi Ayurveda College & Hospital, Chennai-602103. He did his B.A.M.S. from Govt. Ayurveda College, Bolangir, Orissa in 1997 and ranked first in the batch. Later he completed M.D. from I.P.G.A.E. & R. at S.V.S.P. Hospital, Kolkata in 2000 and again stood first in the batch.

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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A TEXT BOOK OF ANATOMY

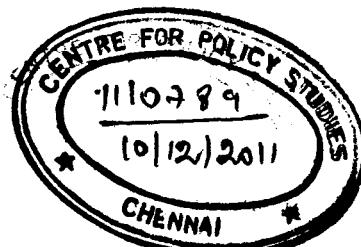
THE
CHAUKHAMBA AYURVIJNANA STUDIES
91

A TEXT BOOK OF ANATOMY

(According to the Syllabus of CCIM, New Delhi)

Volume Two

By
Dr. Pradeep Kumar Moharana
M.D. (Ay).



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**DEDICATED TO MY BELOVED PARENTS
AND STUDENTS**

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AASHAYA AND KOSHTHA

आशया: अवस्तान प्रदेशः ॥

(Su. Samhita 5 — Dalkhana Commentary)

Aashayas are receptacles.

आशया: यानि स्रोतासि ॥

(Ast. Sam. Indu. Commentary)

Aashayas are synonyms of *Srotasa*.

There is a controversial opinion about the *Aashayas*.

Charaka has described about the fifteen *Koshthanga* only but not about the *Aashayas*.

Sushruta has described about the seven *aashayas*, but not about the *Koshthangas*.

Aashaya

सप्ताशयाः क्रमात् असृक्फामपित्तपक्वायुमूत्राधाराः ।

द्विणां पित्तपक्वाशयोर्मध्ये गर्भाशयो अष्टमः ॥

वाताशयः, पित्ताशयः, श्लेष्माशयः, रक्ताशयः, आमाशयः,
पक्वाशयः, मूत्राशयः, द्विणां गर्भाशयो अष्टम् इति ।

(Ast. Sam. Sha. 5/45, 63)

The seven *Aashayas* in both the sexes are:

Vatashaya, pittashaya, shleshmasya, raktashaya, aamashaya, pakvashaya, mutrashaya in women there is one more *aashaya* namely *garbhashaya*.

पुरुषेभ्योधिकाशचान्यो नारीणाम् आशयाः त्रयः ।

धरा गर्भाशयः प्रोक्तः स्तनौ स्तन्याशयौ भूतौ ॥

(Sharngadhara samhita, Prathama Khanda 5/14)

According to Sharngadhara, there are seven *aashaya* namely *Vatashaya, pittashaya, shleshmashya, raktashaya, aamashaya, pakvashaya, mutrashaya* in case of male and ten *aashaya* in case of female *Vatashaya, pittashaya, shleshmashaya, raktashaya, amashaya, pakvashaya, mutrashaya*, two *stanyashaya* and one *garbhashaya*.

Koshtha

स्थानानि आमाग्निपक्वानां मूत्रस्य रुधिरस्य च ।

हृदुण्डुकः फुफ्कुसश्च कोष्ठ इति भिधियते ॥

(Su. Chi. 2/12)

The interior of the trunk or (the thoracic and abdominal cavities together) contains

1. The seats of *ama* and *agni*.
2. Parts up to the colon and rectum.
3. Urinary apparatus.
4. The seats of *rakta*, i.e *yakrit* and *pliha*
5. The heart
6. The caecum and
7. The lungs.

Charaka has described about the fifteen *Koshthanga*

पञ्चदश कोष्ठाङ्गानि; तदथा—नाभिश्च, हृदयं च, क्लोमं च, यकृत्, प्लीहा च, वृक्तौ च, बास्तिःच,
पुरीषाशारश्च, आपाशयश्च, पक्षाशयश्च, उत्तरगुदं च, अधरगुदं च, क्षुद्रान्त्रं च, स्थूलान्त्रं च, वपावहनं चेति ॥

(Ch. Sha. 7/10)

They are:

1. <i>Nabhi</i>	— Umbilical area of abdomen
2. <i>Hridayam</i>	— Heart
3. <i>Klomam</i>	— Trachea and bronchial tree
4. <i>Yakrit</i>	— Liver
5. <i>Pliha</i>	— Spleen
6. <i>Vrikkau</i>	— Both kidneys
7. <i>Basti</i>	— Urinary bladder
8. <i>Purishadvara</i>	— Caecum and sigmoid colon
9. <i>Aamashaya</i>	— Stomach
10. <i>Pakvashaya</i>	— Colon
11. <i>Uttaragudam</i>	— Rectum and anal canal
12. <i>Adharagudam</i>	— Anal Canal
13. <i>Kshudantram</i>	— Small intestine
14. <i>Sthulantram</i>	— Large intestine
15. <i>Vapavahanam</i>	— Omentum

Phupphusa, Pliha, Yakrit

तद्वामे फुफ्कसप्लीहो दक्षिणाङ्के यकृत् तिलम् ॥

उदानवायोराधारः फुफ्कुसः प्रोच्यते बुधैः ।

रक्तवाहिशिरामूलं प्लीहा ख्याता महर्षिभिः ।

यकृत्प्ररज्ञकपितस्य स्थानं रक्तस्य संश्रयः ।

जलवाहिसिरामूलंतुष्णाच्छादनकं तिलम् ।

(*Sharngadhara Samhita, Prathama Khanda 5/79-83*)

The *Phupphusa* and *pliha* are present to the left of the *hridayam* (*vamaparshva*), whereas the *yakrit* is seen in the *dakshina parshva*, i.e., to the right of the *hridayam*. The *Kloma* is also seen on the right side.

Aashaya of Phupphusa, Pliha, Yakrit and Kloma

Phupphusa is the base of *Udanvayu* (*kanthasthitavayu*) while *pliha* is the base and origin of the *raktavahasira*. *Yakrit* is the *sthana* for *ranjakapitam* and also for *rakta*. *Kloma*, otherwise known as *tilam* is the original for the *jalavahasira*.

Position of *Phupphusa*, *pliha*, *yakrit* and *kloma* according to Sushruta
तस्याधो वामतः हा फुफ्सस्च दक्षिणतो यकृत् क्लोमं च।

The *Pliha* and *Phupphusa* are present to the left side of the *hridayam* and the *yakrit* and *kloma* are present to the right of the *hridayam*. The *pliha* is present below the *hridayam*.

Formation of Yakrit Pliha and Phupphusa in the Garba

गर्भ-गर्भस्य यकृत्प्लीहानौ शोणितजौ ।
शोणित फेन प्रभवः फुफ्सः ॥

The *yakrit* and *pliha* are formed from *shonita* in the *garbha* while *phupphusa* is formed from *shonita phena* (froth from blood)



MAHASROTASA GASTRO-INTESTINAL TRACT

कोष्ठः पुनरुच्यते महास्रोत शरीरमध्यं महानिम्नं आमपक्वाशयश्चेति पर्याय शब्दस्तन्त्रे ॥
अन्तःकोष्ठो महास्रोत आमपक्वाशयश्रयाः ॥

(Ch. Su. 11/48)

Synonyms of koshtha

- 1. *Mahasrotas*
- 2. *Sharira madya*
- 3. *Mahanimna*
- 4. *Abhyantara rogamarga*
- 5. *Amapakwasaya*

The last synonym is a combination of *amasaya* and *pakwasaya*, the two organs related to the digestion of the food.

The alimentary canal or *mahasrotasa*, a portion of the digestive tract is called as *antahkoshtha*.

It is unfortunate that the study of anatomy is totally based on the dead, preserved body in which the body texture and appearance of the organs has been altered. This is happened due to the stoppage of the heart and brain. As the heart and brain controls the all systematic function of all organs present in the body. The student should remember that the purpose of such studies is to allow him to visualize the living body in action so that he can appreciate the effects by injury or disease and he will be able to identify, an abnormality from his knowledge of the normal.

Dissection is only a means to the end of a full understanding of function.

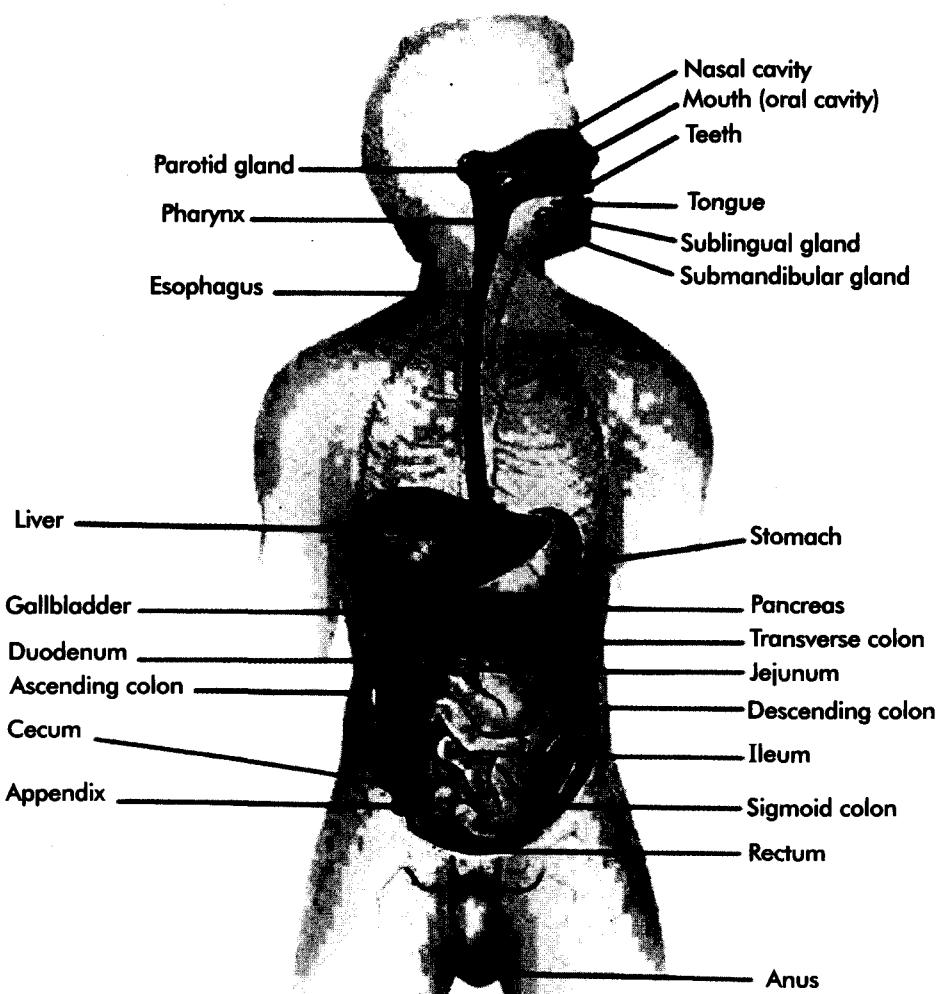
Without sufficient knowledge of anatomy the normal and abnormal could not be understand properly.

Food is vital for life because it is the source of energy which drives the chemical reactions occurring in every cell and provides matter that is used to form new tissues or to repair damaged tissue.

Energy is needed for each and every activity of the body e.g., muscle contraction, conduction of nerve impulses and secretory and absorptive activities of many cells.

In Ayurveda, we believe that each and every parts of the body are nourished by the *aahara pachana karma*. First it goes to the *koshtha*, by the action of *koshthaagni* or *jatharaagni* the food is digested and the essence part goes through the micro and macro channels of the body. The *dhatu's* are nourished by *rasa agni* influences the

Organs of Digestive System & Related Structures



nourishment of rasa *dhatu* by the help of *rasa vaha srotas*. Like this the *aahara* reaches to all the minute parts of the body.

Digestion

The breaking down of larger food molecules in to molecules, small enough for use by body cells is called as digestion. The organs collectively perform this function compose the digestive system.

The digestive system prepares food from consumption by the cells through five basic activities.

Ingestion :– Taking food in to the body.

Movement of food :– Passage of food along the G.I. tract.

Digestion :– The breakdown of food by both mechanical and chemical processes.

Absorption :– The passage of digested food from the gastrointestinal tract in to the cardiovascular and lymphatic systems for distribution to cells.

Defecation :– the elimination of indigestible substances from the G.I. tract.

For the sake of convenience the abdomen is divided in to regions by means of four imaginary lines, two horizontal and two vertical.

The vertical lines on either side is drawn vertically upwards form the mid-inguinal point. The upper horizontal line corresponds to the transpyloric plane and passes midway between the supra sternal notch and the symphysis pubis.

The lower horizontal line passes across the highest points of the iliac crest. The upper sections or regions extent up under the ribcage to the dome of the diaphragm and is subdivided into right and left hypochondriac and epigastric regions, middle section is subdivided into the umbilical and the right and left lumbar region. The lower section is subdivided in to hypogastrium (suprapubic) and right and left iliac regions.

Certain intra-abdominal structures and organs which lie in relation to these arbitrary subdivisions should be kept in mind:

1. *Right Hypochondrium* :– It is in relation to the right lobes of liver, gall bladder, hepatic flexure of colon, upper part of right kidney and right supra renal gland.
2. *Epigastrium* :– In this region there is pylorus of stomach, part of liver, pancreas, aorta and duodenum.
3. *Left Hypochondrium* :– The spleen, tail of the pancreas, splenic flexure of colon, upper part of left kidney, left supra renal gland and part of stomach are related to this region.

4. *Right Lumbar Region* :— Lower part of right kidney, ascending colon, part of duodenum and jejunum are in this region.
5. *Umbilical Region* :— Omentum, transverse colon, part of jejunum and ileum are in this region.
6. *Left Lumbar Region* :— This area bears relationship to the left kidney, descending colon, part of jejunum and ileum.
7. *Right Iliac Fossa* :— It contains the lower end of the ileum, caecum, appendix, right ureter and right ovary in female and right spermatic cord in male.
8. *Hypogastrium* :— It contains the urinary bladder, enlarged or gravid uterus and coils of ileum.
9. *Left Iliac Fossa* :— Sigmoid colon, left ureter and left ovary in female and left spermatic cord in male are situated in this region.

Umbilicus

It lies opposite to the upper part of the fourth lumbar vertebra and situated almost in the center of umbilical region.

Aorta

It bifurcates about three fourth of an inch below and slightly to the left of the umbilicus.

Transpyloric Plane

It lies about half way between the xiphisternal junction and the umbilicus and it corresponds posteriorly to the lower border of the first lumbar vertebra.

Aahara

Aahara is generally categorized in to four types

1. *Asitam or Asanam* :— Which does not require to be chewed.
Ex:— the soft articles like cooked rice.
2. *Peyam or Panam* :— Drinks, beverages.
3. *Lehya* :— Which is to be licked because it contains a minimum quantity of water, linctus.
4. *Khadya or Bhakshya* :— Which are hard and have to be chewed thoroughly, masticables.

Bhavamishra has divided the food in to six varieties.

आहारं षड्विधं चूर्यं पेयं लेहं तथैव च भोज्यं भक्ष्यं तथा चर्व्यम् ॥

1. *Chosyam* – Any article of food to be sucked like sugarcane, pomegranate etc. (juice to be sucked).
2. *Peyam* – Beverage
3. *Lehyam* – Linctus
4. *Bhojyam* – Wholesome eatables
5. *Bhakshyam* – Anything eatable, cooked rice, pulses etc.
6. *Charvyam* – Masticable articles.

समांश्चैव शरीरधातुन् प्रकृतो स्थापयति विषमांश्च समीकरोत्तित्येतद्वितं विद्धि, विपरीतं त्वहितमिति ।

(Ch. Su. 25/33)

1. The food articles which maintain the equilibrium of *shariradhatu* and help in eliminating the disturbance of their equilibrium are to be regarded as wholesome; otherwise they are unwholesome.
2. If consumed according to rules, the wholesome dietetic articles provide fuel to the *jatharagni*, promote mental as well as physical strength, strength of *dhatus* and complexion and they are pleasing to the senses.

आहारं शयनाब्रह्मचर्ये युक्त्याप्रयोजितैः ।

शरीरं धार्यते नित्यमागारमिव धारणैः ॥

(Ast. Hru. Su. 7/52)

Properly utilized diet (and beverages) nourishes and supports the body like the pillars support the house.

Wholesome diet promotes the following:

आहारः प्रीणनं सद्यो बलकृत् देहधारकः ।

आयुस्तेजः समुत्साह स्मृत्योजोऽग्रिविवर्धनः ॥

(Su. Chi. 24/67-68)

- | | |
|---|--------------------------------------|
| 1. Nourishment and strength to the tissues. | 2. Longevity |
| 3. Complexion | 4. Enthusiasm |
| 5. Memory | 6. <i>Ojas</i> – immunity to disease |
| 7. Stimulation of the power of digestion. | |

Annavaha Srotas

The *srotas* related to the digestion of food, i.e., *annavaha srotas* is one of the important srotas in the body. It is a part of *koshta*.

ORAL CAVITY PROPER

Anteriolaterally it is bounded by teeth, the gums and alveolar arches of the jaws.

It has

- Roof
- Floor

Roof is formed by soft and hard palate.

Floor is formed by the tongue posteriorly.

Posteriorly the oral cavity proper is communicated with the pharynx through the oropharyngeal isthmus (Isthmus of fauces).

In the median plane there is a fold of mucosal passing from the inferior aspect of the tongue to the floor of the mouth. This is the frenulum of the tongue.

Sublingual papillae are present on the both side of the frenulum.

Lymphatics from the anterior part of the floor of the mouth pass to the submental nodes. The gums and the rest of the floor drain in to the submandibular nodes.

There are two folds of mucous membrane extending down from the soft palate. The anterior fold is called the palatoglossal arch and this forms the posterior limit of the oral cavity.

The posterior fold is the palatopharyngeal arch and it lies in the oral part of pharynx.

The palatine tonsils lie between the two arches. The mouth cavity proper communicates posteriorly with the pharynx through the isthmus of the fauces which is the space bounded by the two palatoglossal arches. The soft palate and the dorsum of the tongue.

Oral Cavity

The oral or buccal cavity is also referred as mouth. It is the first subdivisions of the digestive system and divisible by the intervention of teeth in to two parts:

1. Vestibular of the mouth.
2. Mouth cavity proper.

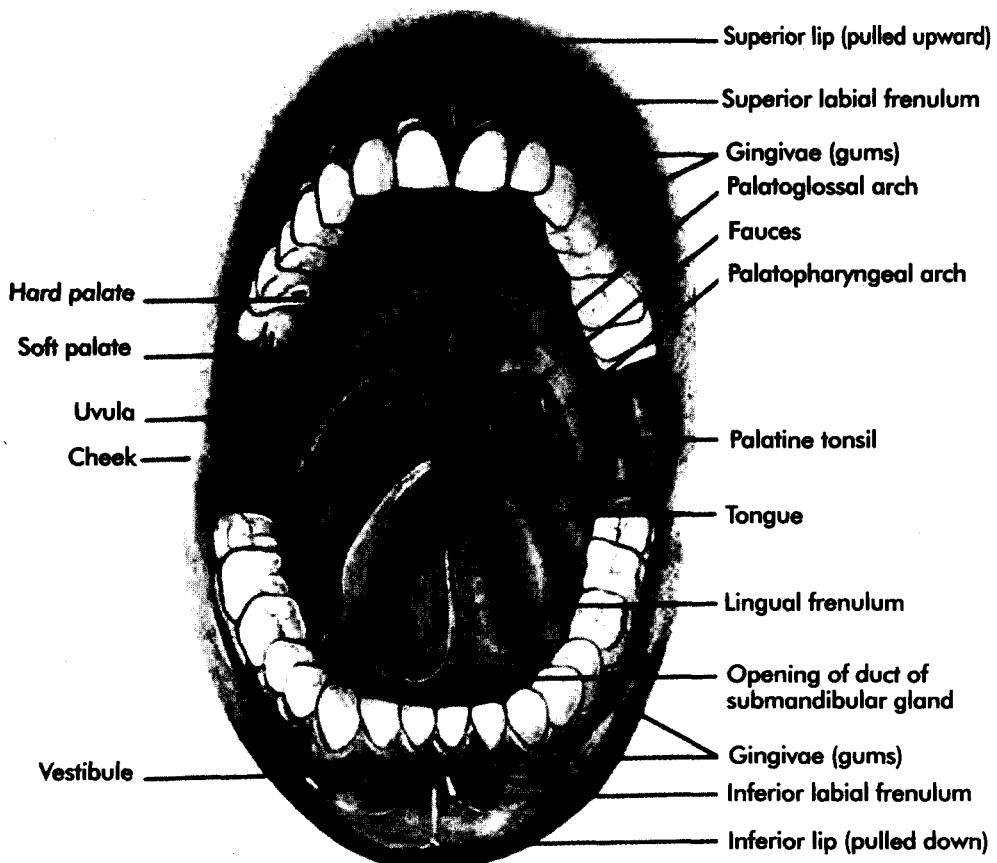
Vestibular of the Mouth

The vestibule (=entrance to a canal) of the oral cavity is a space bounded externally by the cheeks and lips and internally by the gums and teeth.

Cheeks

The cheeks are fleshy flaps continuous in front with the lips at the naso-labial groove

Structure of Oral cavity



which runs downwards and laterally from the ala of nose towards the angle of mouth ending at about 1 cm lateral to it.

The structure of the cheeks is similar to that of the lips except that muscular layer is formed by the buccinator muscle. External to the posterior part of the buccinator is an encapsulated pad of fat, the suctorial or buccal pad in the newborn. It helps to prevent in drawing of the cheeks during sucking and is responsible for the round face of a healthy baby. The parotid duct runs forwards in the cheek over the masseter and at the anterior border of the muscle it hooks medially and pierces the buccal pad of fat, the buccopharyngeal fascia and the buccinator muscle.

Blood Supply:– The arterial supply of the cheek comes from the facial artery, the infra-orbital branch of the maxillary artery.

The veins drain into the anterior facial vein.

Nerve Supply:– The sensory nerves are the branches from the maxillary and mandibular divisions of the trigeminal.

Lymphatic Drainage:– The lymphatics drain into the submandibular and pre-auricular nodes.

These are the muscular structures covered externally by skin and internally by non-keratinized stratified squamous epithelium. The anterior portions of the cheeks end at the lips.

OSHTHA - LIPS – (LABIA)

These are fleshy folds surrounding the opening of the mouth. They are covered externally by skin and internally by mucous membrane. The skin and mucous membrane joins in a transition zone called as muco-cutaneous junction at the edge or vermillion.

The inner surface of each lip is attached to its corresponding gum by a mid line fold of mucous membrane called the labial frenulum.

The lip is covered by skin, superficial fascia, orbicularis oris, submucosa containing mucous labial glands and blood vessels and mucous membrane.

During chewing, contraction of the buccinator muscles in the cheeks and orbicularis oris muscle in the lips help keep food between the upper and lower teeth. They also assist in speech.

Blood Supply: – The arterial supply is from facial artery. The venous drainage is into the facial vein.

Lymphatic Drainage:— The lymphatics drain in to submental and submandibular nodes.

Nerve Supply:— The musculature of lips is supplied by the facial nerve.

The sensory nerves of the upper lip come from the infraorbital branch of the maxillary division of trigeminal. The sensory innervation of the lower lip is by the mental branch of the inferior alveolar nerve, which comes from the mandibular division of the trigeminal.

GUMS OR GINGIVA

The dense fibrous tissue surrounding the neck of teeth and attached to the alveolar margins of the jaws is known as the gum.

It has two parts:

1. *A free part* – It surrounds the neck of the tooth like a collar.
2. *Attached part* – It is firmly fixed to the alveolar arch of the jaw.

Lymphatics of the upper gum pass to the submandibular nodes. The anterior part of the lower gum drains in to the submental nodes, whereas the posterior part drains in to the submandibular nodes.

DANTA - TEETH

The teeth (dentes) are the accessory structures of the digestive system located in sockets of the alveolar processes of the mandible and maxillae. The teeth are meant for mastication and fixed to the jaws.

There are two types of teeth:

- (1) Milk or deciduous teeth (primary teeth) and
- (2) Permanent teeth

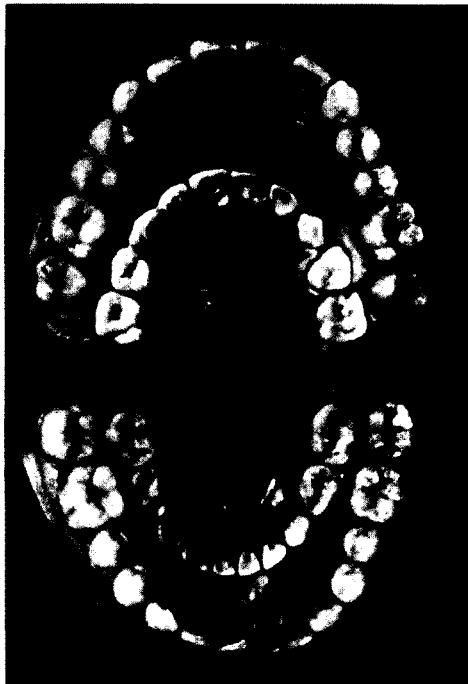
(I:C:M = 2:1:2)

2 1 2	2 1 2 (Maxilla)
2 1 2	2 1 2 (Mandible)

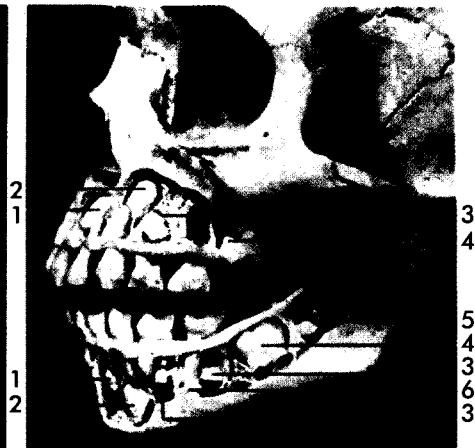
Primary Teeth

Deciduous teeth is comprised of twenty teeth, ten in each jaw that is five in each quadrant, two incisors, one canine and two molars.

Teeth (Comparison between Deciduous & Permanent Teeth)

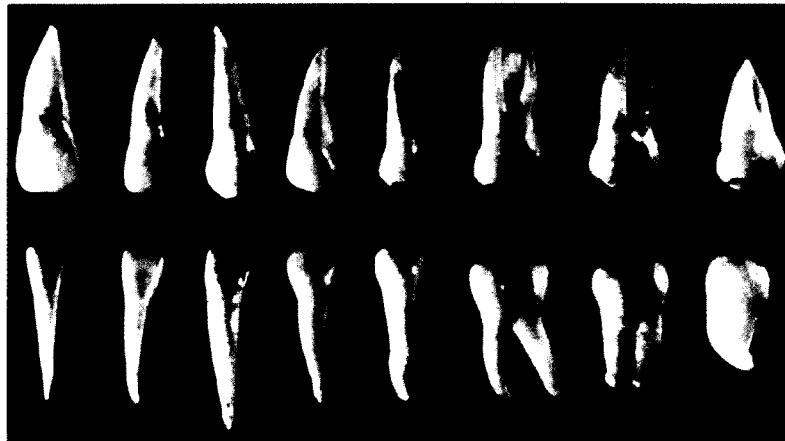


Comparison of the deciduous and permanent teeth



Deciduous teeth in child's skull. The developing crowns of the permanent teeth are displayed in their sockets in the maxilla and mandible.

- △
- 1 Permanent incisors
- 2 Permanent cupid (canine)
- 3 Premolars
- 4 First permanent molar
- 5 Second permanent molar
- 6 Mental foramen



Isolated teeth of the alveolar part of the maxilla (top row)

(I:C:P:M = 2:1:2:3)

3 2 1 2	2 1 2 3 (Maxilla)
3 2 1 2	2 1 2 3 (Mandible)

The dental formula for a child is:

The eruption of primary or deciduous teeth begins six months after birth and is completed by the end of the second year. The first teeth to appear are the lower central incisors at about six months.

The approximate number of teeth at a particular age is equal to the age of the child in months minus six. It is limit up to the age of two years. They start shedding round about 6-7 years.

Permanent Teeth

It is comprised of thirty two teeth that is eight in each quadrant, two incisors, one canine, two premolars and three molars.

The dental formula is as follows.

They begins to appear about the sixth or seventh year and replace the deciduous teeth by about the erupts on the lingual aspect of the primary dentition.

The first tooth to erupt is the first molar.

Approximately four teeth are replaced every year. Children between six and twelve years of age have a mixed dentition of primary and secondary teeth.

The teeth has three principal parts are:

- *Crown* – It is the visible portion above the level of gums.
- *Root* - It is embedded within the alveolar socket of the jaw.
- *Neck* – It is a constricted junction where the crown and the root join each other.

Types of tooth and their functions:

1. *Incisors* – It has chisel shaped crowns for biting upper and lower incisors normally over lap each other and do not meet each other in the resting position.
2. *Canines* – It has conical crowns for tearing and cutting.
3. *Premolars* – It has two cusps in their crown. It is also known as bicuspid tooth.

4. *Molars* – It has five cusps and helpful for crushing the food. Upper molars have four cusps, while the lower molars have five cusps.

Structural Composition

Structurally each tooth is composed of

1. *Dentin* – It is a calcified connective tissue layer that gives the tooth its basic shape and rigidity.
2. *Pulp and Pulp Cavity* – The dentin encloses a cavity. The enlarged part of the cavity, the pulp cavity lies in the crown and is filled with pulp, a connective tissue containing blood vessels, nerves and lymphatic vessels.
3. *Enamel* – The dentin of the crown is covered by a layer of enamel that consists of primarily of calcium phosphate and calcium carbonate. Enamel is the hardest substance of the body and it protects the tooth from the wear of chewing.
4. *Cementum* – It covers the root of the dentin. It is another bone like substance which attaches the root to the periodontal ligament.
5. *Periodontal Ligament* – The alveolar processes are covered by gingivae or gums, which extend slightly in to each socket forming the gingival sulcus. It holds the root its socket. The membrane acts as a periosteum to both the cementum as well as bony socket.

Eruption of Teeth

The deciduous teeth begin to erupt at about sixth month and all teeth eruption usually completed with in the end of the second year or soon after.

The teeth of the lower jaw erupt slightly earlier than those of the upper jaw.

The approximate ages of eruption are:

Lower central incisors about 6 months

Upper central incisors about 7 months

Lateral incisors about 8-9 months

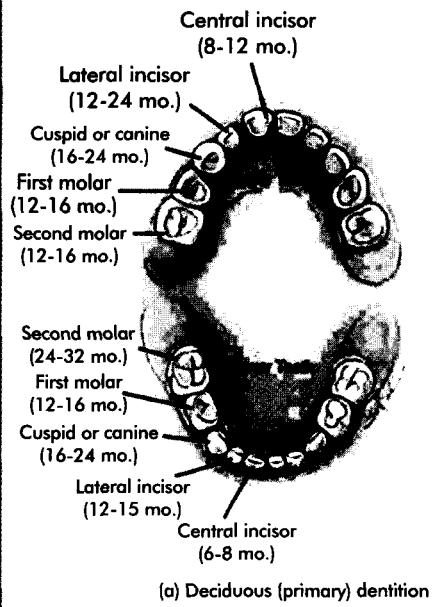
First molar – 1 year

Canines – 18 months

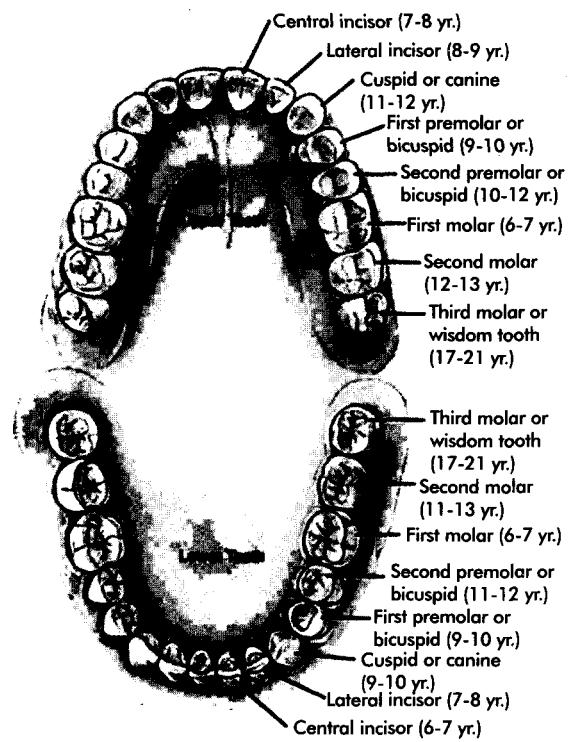
Second molars – 2 years.

Third molar (wisdom teeth) – in between 17- 25 years of even later.

Dentition and Times of Eruptions



(a) Deciduous (primary) dentition



(b) Permanent (secondary) dentition

Arterial Supply

The three superior alveolar arteries from the third part of the maxillary artery named after the nerves and accompanying them supplying the corresponding teeth in upper jaw.

The inferior alveolar artery from the first part of maxillary artery accompanies the inferior alveolar nerve to supply the teeth in lower jaw.

Nerve Supply

The upper teeth are supplied by the maxillary division of the trigeminal. The posterior superior alveolar nerve supply the molars, the middle superior alveolar nerves the premolars and the anterior superior alveolar nerves the incisors and canine.

The lower teeth are supplied by the inferior alveolar branch of the mandibular division of trigeminal.

Lymphatic Drainage

The lymphatic drains in to the cervical nodes around the internal jugular vein.

Applied Anatomy

1. *Dental caries* – It is the disintegration of one or more components (enamel and dentine) of the tooth.
2. *Pyorrhoea* – It is otherwise known as chronic periodontitis chronic inflammation of gums with pocket formation between the teeth and gums resulting in chronic pus discharge at the gum margin.
3. *Gingival Hyperplasia* – It is usually seen due to the deficiency of vitamin C, in this the gums are swollen and spongy, and bleed on touch.
4. Irregular dentition is common in rickets. Usually the upper permanent incisors may be noticed. If the notching corresponds to a large segment of a small circle then it is known as Hutchinson's teeth.

ROOF OF THE MOUTH

Palate is the roof of the mouth and has two parts:

1. The hard palate.
2. The soft palate

Talu – Hard Palate

It is a partition between the nasal and oral cavities. The hard palate is made up of the palatine processes of maxilla and the horizontal plate of the palatine bone.

It is covered by keratinised stratified squamous epithelium and is provided with numerous mucous secreting palatine glands in the posterior half.

It has two surfaces:

1. *Superior surface* – It contributes to form the floor of the nose.
2. *Inferior surface* – It forms the roof of the oral cavity.

Vessels and Nerves

1. *Arteries* – Greater palatine branch of maxillary artery.
2. *Veins* – Go to the pterygoid plexus of veins.
3. *Nerves* – Greater palatine and nasopalatine branches of the pterygopalatine ganglion.
4. *Lymphatics* – They drain mostly to the upper deep cervical nodes and partly to the retropharyngeal nodes.

Soft Palate

It hangs from the posterior margin of the hard palate and belongs both to the mouth and the pharynx. It is a muscular fold which separates the nasopharynx from the oropharynx, and is often looked upon as a traffic controller at the passage between food and air passages.

It has two surfaces:

1. *Anterior (oral) surface* – It is concave and is marked by a median raphe.
2. *Posterior surface* – It is convex and is marked by the floor of nasal cavity.

It has two borders:

1. Superior border
2. Inferior border

Superior Border

It is attached to the posterior border of hard palate, blending on each side with pharynx.

Inferior Border

It is free and bounds the pharyngeal isthmus.

From the inferior border there is the hanging conical projection called as uvula.

From the base of the uvula there are two curved folds of mucous membrane extend laterally and down wards.

The anterior fold is called as palatoglossal arch. It contains the palatoglossus muscle and reaches the side of the tongue at the junction of its oral and pharyngeal parts.

The posterior fold is called as palato pharangeal arch. It contains palatopharyngeus muscle. It forms the posterior boundry of the tonsillar fossa, and merges inferiorly with the lateral wall of the pharynx.

Muscles of the Soft Palate

- | | | |
|------------------|---------------------|--------------------|
| 1. Palatoglossus | 2. Palatopharyngeus | 3. Levator –Palati |
| 4. Tensor Palati | 5. Uvulae Musculus | |

Blood Supply

1. Greater palatine branch of maxillary artery.
2. Ascending palatine branch of facial artery.
3. Palatine branch of ascending pharyngeal artery.

Veins

They pass to the pterygoid and tonsillar plexuses of veins.

Lymphatic Drainage

It drains in to the upper deep cervical and retropharyngeal lymph nodes.

Nerve Supply

1. *Motor nerves* – All muscles of the soft palate except the tensor palati are supplied by the pharyngeal plexus.
2. Greater sensory nerves are derived from the middle and posterior palatine nerves, which are the branches of the maxillary nerve.

Applied Anatomy

1. *Paralysis of the soft palate causes* – Nasal regurgitation of liquids.
2. *Cleft palate* – It is a result of non fusion of the right and left palatine processes. In the most severe cases the cleft in the palate is continuous with harelip.

GRASANIKA – PHARYNX

It is a common passage to the upper end of the digestive and respiratory tracts. It is a wide muscular tube, situated behind the nose, the mouth and the larynx. It is divided into three parts.

- (a) Nasal
- (b) Oral
- (c) Laryngeal

Nasopharynx

It is present behind the nasal cavity (the nasopharynx) which is entirely respiratory oropharynx the part behind the mouth (the oropharynx) and it is helpful for the passage of air and food.

Laryngopharynx

It is behind the larynx which is both respiratory and alimentary. It is helpful for the passage of food.

The nasopharynx and oropharynx normally contain air, but the laryngopharynx is compressed antero-posteriorly except during the passage of food.

It is about 12-14 cm in length its upper part is widest (3.5 cm) and non collapsible. Middle part is narrow and lower end is the narrowest part of G.I. tract (except for the appendix).

It extends from the under surface of the basi-occiput the level of sixth cervical vertebra which corresponds to the lower border of the cricoid cartilage beyond which the pharynx continues as the oesophagus.

The naso-pharynx communicates with the oropharynx through the pharyngeal isthmus. The conchae (posterior nasal apertures) form the junction between the nasopharynx and the nasal cavity proper.

Sub Divisions

Nasopharynx – It extends from the choanae to the level of the soft palate and has the following boundaries:

Anteriorly – Posterior nasal apertures and the sloping upper or posterior surface of the soft palate.

Posteriorly – Atlas and axis vertebrae with prevertebral muscles fascia and retropharyngeal space.

Superiorly – The roof formed by the body of sphenoid and the basilar part of the occipital bone.

Inferiorly – The pharyngeal isthmus which communicates it with oropharynx. Pharyngeal isthmus is bounded anteriorly by soft palate, laterally by palato-pharyngeal arches, posteriorly by the posterior pharyngeal wall.

On the Posterior Wall

Pharyngeal tonsil is a mass of lymphoid tissue in the upper part of the posterior wall. It is commonly known as adenoids.

Pharyngeal bursa which is sometimes present as a median recess in the pharyngeal tonsil and from which many folds radiate forwards.

On The Lateral Wall

Pharyngeal ostium of the auditory tube which is a triangular opening with apex upwards.

Tubal tonsil, a collection of lymphoid tissues round the margins of the ostium of the auditory tube.

Pharyngeal recess is a depression behind the torus tubarius.

Salpingopalatine fold which passes from the anterior part of the tubal elevation of the soft palate.

Oropharynx

It is the middle part of the pharynx lies below the naso-pharynx separated from it incompletely by the soft palate. Between the soft palate and the posterior wall of the pharynx is the pharyngeal isthmus through which the nasopharynx and oropharynx communicate.

Boundaries

Anteriorly – Orophayngeal isthmus through which it communicates with the mouth cavity. The pharyngeal isthmus is bounded by the soft palate above, the palatoglossal arches on the sides and dorsum of the tongue below.

Posteriorly – Retropharyngeal space, C2 and C3 vertebra covered by pre-vertebral fascia and muscles.

Inferiorly – Upper border of the epiglottis, below which it is continuous with the laryngopharynx.

Superiorly – Pharyngeal isthmus communicates it with the nasopharynx.

Internal Structure of Oropharynx

Anterior wall

- It contains lingual tonsil which is made up of numerous nodules of lymphoid tissues.
- Upper free end of epiglottis.

Lateral wall

Tonsillar fossa, which is a triangular space between the palatoglossal (anterior) and palatopharyngeal (posterior) folds occupied by the palatine tonsil.

Palatine Tonsils

These are the largest collections of lymphoid tissue which form part of the waldeyer's ring which is formed dorsally by the pharyngeal tonsil, dorsolaterally by the tubal tonsils and laterally by the palatine tonsils and ventrally by the lingual tonsils at the entrance in to the alimentary tract.

The tonsils are the first line of defences of the body against bacterial invasion. They differ from a lymph node in having an incomplete capsule and no lymph sinus and so the tissue fluid is filtered directly in them.

Shape

The tonsil is oval in shape. It resembles like a large diamond. It is about 2 cm in its greatest dimension.

It has two poles – upper and lower pole

Two borders – anterior and posterior

Two surfaces – medial and lateral

Arterial Supply

It is primarily by the tonsillary branch of facial artery secondary supply are:

- (i) Ascending palatine branch of facial artery.
- (ii) Dorsal lingual branch of lingual artery.
- (iii) Descending palatine artery.

Venous Drainage

The principal drainage is by the tonsillar branch of the lingual vein.

Paratonsillary vein is a large vein which descends from the soft palate across the upper part of the tonsil.

Nerve Supply

It is supplied by

1. Tonsillar branches of glossopharyngeal nerve.
2. Lesser palatine nerves.

Lymphatic Drainage

1. Jugulodigastric node mainly.
2. Nodes of the deep cervical group.

Laryngopharynx

It extends from the upper border of the epiglottis to the lower border of cricoid cartilage where it becomes continuous with the oesophagus. It is the lower part of the pharynx situated behind the larynx.

Boundaries

Anteriorly – a) Laryngeal opening – it is oval in shape,

b) Soft tissues covering the back of arytenoids and cricoid cartilages.

Posteriorly – typical cervical vertebra, C3 through C6, covered by prevertebral muscles and fascia.

Superiorly – oropharynx

Inferiorly – oesophageal opening.

On the lateral wall – It presents a depression called the piriform fossa one on each side of the inlet of the larynx. It is just like a pear standing on its apex. It is bounded medially by aryepiglottic fold, and laterally by thyroid cartilage and the thyroid membrane, posteriorly by the pharyngeal wall.

Structure of Pharynx

The wall of the pharynx consists the following layers with in outwards:

1. Mucous coat
2. Fibrous coat
3. Muscular coat
4. Aerolar coat

Muscle of Pharynx

1. Outer Circular Layer

Muscles forming the outer circular layer are the three constrictions of the pharynx.

Each one of them is fan shaped. The narrow origin is anterior, and wide insertion, posterior and median. They are arranged like flower pots placed one inside the other, so that they overlap, but are open front at the entries of the nasal, buccal and laryngeal cavities.

- (i) Superior constrictor (ii) Middle constrictor (iii) Inferior constrictor

2. Inner Longitudinal Layer

Muscles forming inner longitudinal layer are also three in number. They pass in to the pharyngeal wall from above.

- (i) Palatopharyngeus (ii) Salpingopharyngeus (iii) Stylopharyngeus

Action of Muscles of Pharynx

1. The constrictors of pharynx by a descending wave of action propel the bolus of food downwards.
2. The stylopharyngeus and palatopharyngeus due to their attachment to the thyroid cartilage lift up the larynx during swallowing.
3. Salpingopharyngeus and palatopharyngeus open the auditory tube during swallowing to equalize the pressure on the two sides of the tympanic membrane.

Blood Supply of Pharynx

Arteries supplying the pharynx are:

- Ascending pharyngeal
- Lingual
- Facial
- Maxillary

Veins drains into

- Facial veins
- Internal jugular vein

Nerve Supply

All the muscles of pharynx are supplied by the pharyngeal plexus except stylopharyngeus which is supplied by the glossopharyngeal nerve.

LALAGRANTHI – SALIVARY GLANDS

Saliva is a fluid that is continuously secreted in to the mouth. It helps cleanse the mouth and teeth. Saliva is secreted to keep the mucous membrane of the mouth and pharynx moist.

Secretion of saliva increases when food enters the mouth saliva lubricates dissolves and begins the chemical breakdown of the food. The mucous membrane lining the mouth contains many small glands.

There are three pairs of large salivary glands (parotid, submandibular, sublingual). In addition to this there are numerous small glands present in the tongue, the palate, the cheeks and the lips they are called as buccal glands. It secretes small amount of saliva. However, most saliva is secreted by the major salivary glands.

Chemically saliva contains:

- 99.5% water
- 0.5% solutes (Na, K, Cl, PO₄, HCO₃)

Saliva contains one digestive enzyme – salivary amylase which begins the digestion of carbohydrates.

PH of saliva is about 6.35 – 6.85 which is slightly acidic. Saliva also contains lysozyme which helps to destroy bacteria. It contributes to protecting the mucous membrane from infection and teeth from decay. Totally 1000-1500 ml of saliva is secreted per day. Normally parasympathetic stimulation promotes continues secretion of a moderate amount of saliva. It keeps the mucous membrane moist and lubricates the movements of the tongue and lips during speech.

Parotid gland

It is the largest gland. It weighs about 15 gm. It is situated below the external acoustic meatus between the ramus of mandible and the sternomastoid. Anteriorly, the gland also overlaps the masseter muscle.

The parotid glands are located inferior and anterior to the ears between the skin and masseter muscle. Each secretes in to the oral cavity vestibule via a duct called the parotid (stensen's duct), that pierces the buccinator muscle to open in to the vestibule opposite the second maxillary (upper) molar tooth.

The investing layer of the deep cervical fascia forms a capsule for the gland. A portion of the deep lamina, extending between the styloid process and the mandible is thickened to form the stylomandibular ligament which separates the parotid gland from the submandibular salivary gland.

ANNANALIKIA – OESOPHAGUS

The oesophagus is a muscular food passage lying between the trachea and vertebral column. It is helpful for the transportation of food materials from oropharynx to

the stomach. It expands during the passage of food material by pressing in to the membranous part of the trachea. It is about 25 cm long it dilates only during the passage of food.

It has three parts are:

1. Cervical part,
2. Thoracic part,
3. Abdominal part.

The cervical part of the oesophagus extends from the lower end of the pharynx at the level of the sixth cervical vertebra or cricoid cartilage to the superior border of the manubrium sterni.

It passes downwards behind the trachea.

It begins in the mid line but inclines slightly to the left as it descends.

It has two sphincters:

1. Upper esophageal sphincter
2. Lower esophageal sphincter

Relations

Anteriorly

- Trachea
- Recurrent laryngeal nerve.

Posteriorly

- Vertebral column
- Longus colli muscle.
- Thoracic duct.

Laterally

- Lateral lobes of thyroid
- Carotid sheaths with its contents.

Arterial Supply

- Inferior thyroid artery.

Venous Drainage

- Veins drain in to inferior thyroid veins.

Lymphatic Drainage

- pretracheal glands.
- Deep cervical nodes.

Thoracic Part of Oesophagus

The oesophagus begins in the neck at the lower border of cricoid cartilage where it is continuous with the lower end of pharynx.

It descends gradually through the superior and posterior parts of the mediastinum and pierces the diaphragm at the level of T10 vertebra. It opens in to the cardiac end of the stomach at the level of T11 vertebra.

It has two side to side curvatures, one present at the root of the neck and the other near the lower end.

It has four constrictions at the level of

1. At the beginning (6 inches distal from incisor teeth)
2. At the level of aortic arch where it is crossed (9 inches distal from incisor teeth)
3. where it is crossed by the left bronchus (11 inches from the incisor teeth)
4. Where it pierces the diaphragm (15 inches from incisor teeth).

Relations

Anteriorly – Trachea, diaphragm, pericardium, left bronchus.

Posteriorly – Vertebral column, thoracic duct, thoracic aorta, right pleural recess, diaphragm.

Right side – Right lung and pleura, azygos vein, right vagus nerve.

Left side – Aortic arch, left sub clavian artery, left lung, left recurrent laryngeal nerve.

Blood Supply

Inferior thyroid arteries supply the cervical part.

Thoracic part is supplied by the oesophageal branches of aorta.

Left gastric artery supplies the abdominal part.

Venous Drainage

Blood from:

Cervical part drains in to brachiocephalic veins

Thoracic part drains in to azygos vein

Abdominal part drains in to left gastric vein.

Lymphatic Drainage

Cervical part drains in to deep cervical nodes.

Thoracic part drains in to posterior mediastinal nodes.

Abdominal part drains in to left gastric nodes.

Nerve Supply

1. *Parasympathetic Nerves* – Upper half of oesophagus is supplied by recurrent laryngeal nerves. Lower half by the vagus.
2. *Sympathetic nerves* – T1 – T4 thoracic ganglia.

Applied Anatomy

- During the endoscopy the surgeon has to be cautious about the constrictions of oesophagus.
- Oesophagitis* – Inflammation of oesophagus is known as oesophagitis.
- Oesophageal varices* – In portal hypertension the communications between the portal and systemic veins supplying the lower end of the oesophagus dilate. These dilations are called as oesophageal varices.
- Achalasia cardia* – When the lower oesophageal sphincter fails to open for the passage of food is called as achalasia cardia.

AAMASHAYA – STOMACH

आमाशयाश्रयां पितं रञ्जकं रसरञ्जनात् ।

(As. Hri. Su. 12/13)

It is the site for *ranjaka pitam*.

It is a J shaped enlargement of the G.I. tract directly under the diaphragm occupying the epigastric, umbilical and left hypochondriac regions.

It is also called as gaster.

The adjective form of gaster is gastric. It is a muscular organ forming the most dilated part of the alimentary canal.

It lies in upper left quadrant of the abdominal cavity.

Shape and Size of Stomach

Within each individual, the position and size of the stomach vary continually. For instance, the diaphragm pushes the stomach downward with each inspiration and pulls it upward with each expiration.

It is vertical – when the stomach is empty.

Piriform shaped – when it is partially distended.

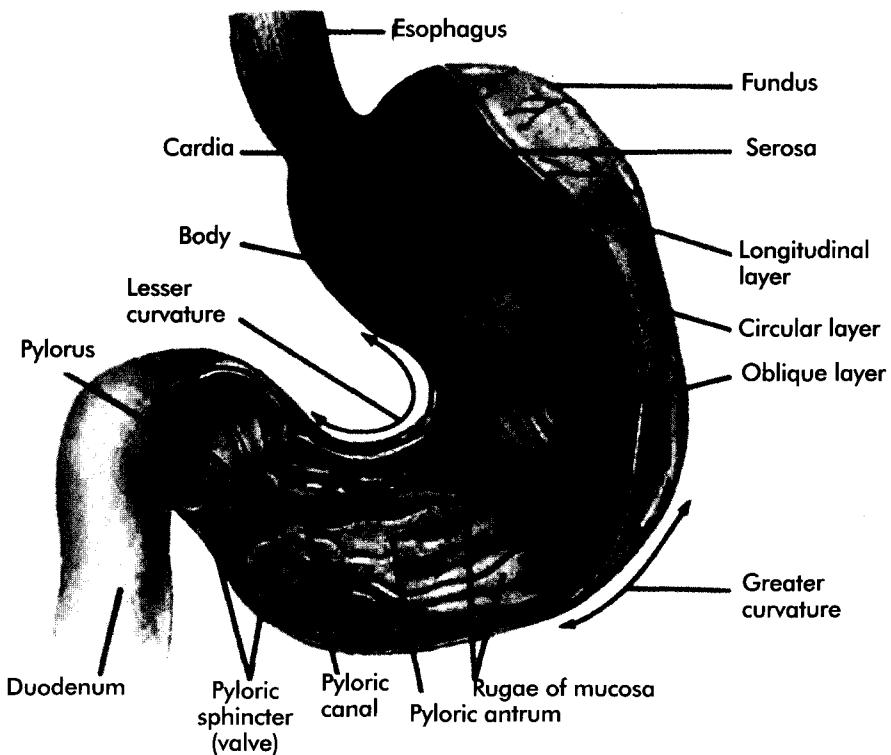
Horizontal – in obese persons.

It is about 10 inches (25 cm) long.

Capacity – 30 ml at birth.
 – 1000 ml at puberty.
 – 1.5 – 2 liters in adults.

The superior portion of the stomach is a continuation of the oesophagus. The infe-

Muscles and Parts of Stomach



rior portion empties in to the duodenum, the first part of the small intestine. Its upper part is broader than the lower part.

It has two surfaces:

1. Anterior (antero superior) which faces forwards and upwards.
2. Posterior (postero inferior) which faces backwards and downwards.

It has two curvatures:

1. *Greater curvature* – Which is concave and forms the left border of the stomach. It is attached with the greater omentum; gastrosplenic ligament and gastrophrenic ligament.
2. *Lesser curvature* – It is concave and forms the right border of stomach. It provides attachment to the lesser omentum. It is marked by angular notch or *incisura angularis*.

It has two orifices:

1. Pyloric orifice – It lies at the level of L1 vertebra in supine position. It opens in to the duodenum.
2. Cardiac orifice – It is joined by the lower end of the oesophagus. It lies behind the left seventh costal cartilage one inch from its junction with the sternum, at the level of vertebra T11.

Parts of Stomach

The stomach is divided in to four parts:

1. Cardia
2. Fundus
3. Body
4. Pylorus

Cardia surrounds the superior opening of the stomach.

The rounded portion superior to and to the left of the cardia is the fundus.

Inferior to the fundus is the large central portion of the stomach, called the body.

The region of the stomach that connects to the duodenum is the pylorus.

Pylorus is divided in to two parts:

Pyloric antrum – It is connected to body of stomach.

Pyloric canal – It is connected to the duodenum.

Relations

Anterior surface is related to

Inferior surfaces of the left lobe and quadrate lobe.

Left half of the diaphragm.

Anterior abdominal wall.

Posterior surface is related to structures which are referred to as stomach bed

- Diaphragm.
- Gastric surface of spleen
- Left suprarenal gland
- Left kidney
- Pancreas
- Transverse mesocolon
- Transverse colon

Histology

The stomach wall is composed of the same four basic layers

1. Mucosa - mucous surface cells secrete mucus.
 - i) Chief cells – secrete pepsinogen
secrete gastric lipase
 - ii) Parietal (oxyntic) cells – secretes HCl
IF
 - iii) Mucous surface cells – mucus
 - iv) Enteroendocrine cells – secretes gastrin.
2. Submucosa – It is composed of areolar connective tissue.
3. Muscularis – Three layers of smooth muscle.

Outer – longitudinal layer
Middle – circular layer
Inner – oblique layer
4. Serosa – It covers the stomach and part of the visceral peritoneum.

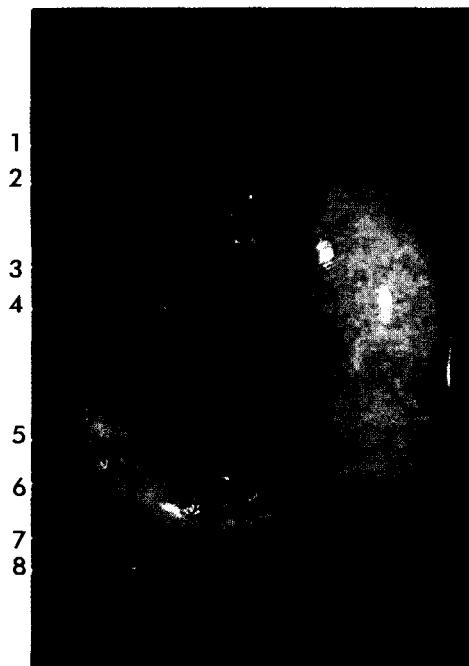
Blood Supply

It is supplied by celiac artery or its branches which run along its curvatures.

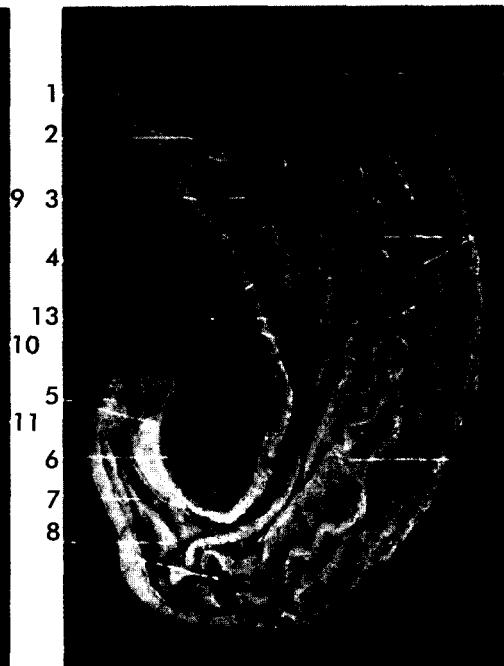
1. Left gastric artery
2. Right gastric artery
3. Right gastroepiploic artery
4. Short gastric artery which is a branch of splenic artery.

Veins supply – The veins of the stomach drain into the portal, superior mesenteric and splenic veins.

Stomach, Mucosa of Posterior Wall of Stomach



Stomach (ventral aspect)



Mucosa of posterior wall of stomach (ventral aspect).



Parasagittal section through upper part of left abdominal cavity

- 1 Esophagus
- 2 Cardiac notch
- 3 Cardiac part of stomach
- 4 Lesser curvature of stomach
- 5 Pyloric sphincter
- 6 Angular notch (incisura angularis)
- 7 Pyloric canal
- 8 Pyloric antrum
- 9 Fundus of stomach
- 10 Greater curvature of stomach
- 11 Body of stomach
- 12 Folds of mucous membrane (gastric rugae)
- 13 Gastric canal
- 14 Right ventricle of heart
- 15 Diaphragm (cut edge)
- 16 Abdominal portion of esophagus
- 17 Liver
- 18 Cardiac part of stomach (cut edge)
- 19 Position of pyloric canal
- 20 Body of stomach
- 21 Transverse colon
- 22 Small intestine
- 23 Lung (cut edge)
- 24 Fundus of stomach (section)
- 25 Lumbar portion of diaphragm (cut edge)
- 26 Suprarenal gland
- 27 Splenic vein
- 28 Pancreas
- 29 Superior mesenteric artery and vein
- 30 Intervertebral disc

Lymphatic Drainage

The lymphatic of the stomach drained in to

- Gastroepiploic nodes
- Inferior gastric nodes
- Pancreato – splenic group of lymph nodes.

Nerve Supply

Sympathetic – T6 to T10 spinal segments from the celiac and hepatic plexuses.

Parasympathetic – anterior gastric (mainly formed by left vagus).

Posterior gastric (mainly formed by right vagus).

Applied Anatomy

1. *Gastritis* – Inflammation of the stomach.
2. Gastric pain is felt in the epigastrium because the stomach is supplied by T6 to T10 spinal segments.
3. *Upper G.I endoscope* – The stomach can be visualized to diagnose perforation or gastric ulcer.

KSHUDRANTRA – SMALL INTESTINE

It starts from the pylorus and ends in the ileocaecal junction. The major events of digestion and absorption occur in a long tube called as small intestine. Since almost all the digestion and absorption of nutrients occur in the small intestine, its structure is specially adapted for this function. The small intestine begins at the pyloric sphincter of the stomach, coils through the central and inferior part of the abdominal cavity and eventually opens into the large intestine.

It averages 2.5cm (inch) in diameter. The length is about 3m (10ft) in a living person and about 6.5metre (21 ft) in a cadaver due to loss of smooth muscle tone after death.

The whole intestine is divided into three parts:

- (a) The upper which is fixed – Duodenum.
- (b) The lower part which is mobile and forming a very long convoluted tube consisting of jejunum and ileum.

GRAHANI – DUODENUM

तदधिष्ठानमप्रस्य ग्रहणाद् ग्रहणी मता ।

सैव धन्वन्तरिमते कला पित्तधराह्या ॥

(Ast. Hru. Sha. 3/50)

अग्नि अधिष्ठानम् अप्रस्य ग्रहणात् ग्रहणी मता ॥

(Ch. Chi. 15/56)

It is the seat for *Jatharagni, anna*, and it accepts food materials that's why it is named as *grahani*.

It is the first part of the small intestine. It is the shortest, widest, thickest and most fixed part of the small intestine.

The term duodenum is derived from the greek word duodekadaktul meaning twelve fingers.

The width of 12 fingers is about ten inches or 25 cm.

It is extended from the pylorus to the duodenojejunal flexure. It is situated on the posterior abdominal wall opposite to the bodies of L1 to L3 vertebra. It is mostly retroperitoneal.

It is curved like letter 'C' around the head of the pancreas.

Subdivisions

It is divided in to four parts which are:

1. First part or superior part – 2 inches long
2. Second part or descending part – 3 inches long.
3. Third part or horizontal part – 4 inches long.
4. Fourth part or ascending part – 1 inches long.

Superior (First) Part

It is about 2 inches (5cm) in length and starts at the pylorus of the stomach and therefore in the transpyloric plane, 2.5cm to the right of the mid line. Its runs upwards to the right side and also posteriorly to meet with the superior duodenal flexure.

Peritoneal Relations

The first 2.5 cm are completely covered by peritoneum so that its upper and lower borders give attachment to the right extension of the lesser and greater omentum respectively. Its posterior surface is related to lesser sac.

The second 2.5cm of the superior part is covered with peritoneum only on the anterior surface.

Relations of the Superior Part

Anteriorly

- Quadratus lobe of liver
- Gall bladder.

Posteriorly

- Lesser sac
- Common bile duct
- Portal vein
- Inferior vena cava
- Gastroduodenal branch of hepatic artery

Superiorly

- Foramen epiploicum

Inferiorly

- Head of pancreas.

This part of duodenum is visualized in radiographs as the duodenal cap.

Descending (Second) Part

It is 3 inches in length and begins at the superior duodenal flexure passes downwards to reach the bodies of L2 and L3 vertebra and curved towards the left.

Anteriorly

- Transverse colon crosses in the middle and this is the only part not covered by peritoneum.
- Right lobe of liver above the colon.
- Coils of small intestine below the transverse colon.

Posteriorly

- Hilum and anterior surface of right kidney.
- Right renal vessels and pelvis of right ureter.

Medially

- Head of pancreas.

Laterally

- Right kidney.
- Right colic flexure.

The second part of duodenum has two papilla where the common bile duct and pancreatic duct opens.

1. *Major duodenal papilla* – It is present 8 to 10 cm distal to the pylorus. It is present in an elevated manner.
2. *Minor duodenal papilla* – It is present 6 to 8 cm distal to the pylorus where the minor pancreatic duct opens.

Horizontal (Third) Part

It is more in length in comparison with the other part of the duodenum. It measures about 10 cm. it starts from the inferior duodenal flexure from the right side of third lumbar vertebra to the left side of join with the fourth part in front of the abdominal aorta.

Relations

Anteriorly – Root of the mesentry, coils of small intestine trunk of superior mesenteric artery, superior mesenteric vein.

Posteriorly from right to left

Right ureter,

Psoas major,

Inferior vena cava

Right testicular or ovarian vessels,

Aorta with the origin of inferior mesenteric artery.

Superiorly

Head and uncinate process of pancreas.

Inferiorly

Coils of jejunum.

Ascending (Fourth) Part

It is 2.5 cm long, passes upwards to the left of the L2 vertebra and bends forwards to become the jejunum at the duodeno –jejunal flexure.

Anteriorly – coils of jejunum

Posteriorly – left margin of abdominal aorta

- left psoas major
- left gonadal artery.

Laterally - left kidney

- left ureter
- inferior mesenteric vein.

The first and fourth parts of duodenum have peritoneum on their anterior and posterior surface where they are adjacent to the stomach and jejunum.

There is a suspensory ligament called as ligament of treitz. Which is a fibromuscular structure which arises from the right crus of diaphragm and descends deep to the pancreas to get inserted in to the muscular coat of the duodenojejunal flexure.

Artery Supply

Since the duodenum is derived from both the foregut and mid gut, which meet just distal to the common opening of the bile and pancreatic ducts, its blood supply comes from the artery of the foregut. The celiac and the artery of the midgut – superior mesenteric.

The duodenum is supplied by the superior pancreateo duodenal artery and inferior pancreateo-duodenal artery.

Venous Drainage – The veins of the duodenum drain into the pancreatoco-duodenal lymph nodes lying between the head of the pancreas and the duodenum.

Nerve Supply

Sympathetic – T9-T10

Para sympathetic – vagus.

Applied Anatomy

The first part of the duodenum is one of the commonest sites for peptic ulcer because of direct exposure to the acidic contents reaching from the stomach.

THE JEJUNUM AND ILEUM

The jejunum and ileum lie in coils in the middle of the abdominal cavity framed by the large intestine.

The coils lie more or less in the middle of the abdominal cavity and also hang down in to the pelvis.

The jejunum and ileum both represent the mobile part of the small intestine.

The upper two-fifths of the mobile intestine are known as the jejunum and the lower three fifths are known as the ileum.

The jejunum starts at the duodenojejunal flexure on the left side of the second lumbar vertebra.

The upper two fifths are designated as jejunum and lower three-fifths as ileum.

This is arbitrary as there is no clear cut demarcation between the two. The ileum ends at the ileocaecal junction in the right iliac fossa.

Relations

Anteriorly

Anterior abdominal wall.

Greater omentum.

Posteriorly

Retro-peritoneal structures of posterior abdominal wall.

Superiorly

Transverse meso colon.

Transverse colon.

Blood Supply

The jejunum and ileum are supplied by branches from the superior mesenteric artery and are drained by corresponding veins.

Nerve Supply

Sympathetic – T9-T11

Parasympathetic – vagus

Jejunum

1. Mucous surface presents with numerous transverse folds.
2. It has a thick wall.
3. It has fewer arterial arcades.
4. It has longer vasa recta.
5. It has less fat on its mesentry.
6. Solitary and aggregated lymphatic follicles are small and less in number.

Ileum

1. Mucous surface presents with fewer transverse folds.
2. It has a thin wall.
3. It has more arterial arcades.
4. It has shorter vasa recta.
5. It has more fat on its mesentry.
6. Solitary and aggregated lymphatic follicles (Peyer's patches) are and more in number.

YAKRIT – THE LIVER

Formation of Yakrit, Pliha

गर्भ-गर्भस्य यकृतस्त्रीहानौ शोणितजौ ।

(Su. Sha. 4/25)

The *Yakrit* and *pliha* are formed from *shonita* in the *garbha*.

It is a largest, solid gland situated in the right upper quadrant of the abdominal cavity. It is reddish brown in living organisms, soft and very flexible. In males it weighs about 1600 gms and females about 1300gms.

Location

It occupies whole of right hypochondrium, the greater part of epigastrium, extends to left hypochondrium reach to left lateral line.

It is covered by ribs and costal cartilage with in infrasternal angle, except in upper part of epigastrium which is in contact with anterior abdominal wall.

It is surrounded by thin fibrous (glissons) capsule lies beneath the visceral peritoneum.

It secretes bile to perform metabolic functions, which is yellow, brownish or olive green liquid whose PH is 7.6 to 8.6. it contains bile salts, bile acids, water and some bile salts like bilurubin and biluviridin and some ions.

Surface Marking

In surface projection, liver is triangular when seen from front.

(a) Upper border

- First point in the left fifth intercostal space 9 cm from medial plane.
- Second point at the xiphisternal joint
- Third point at upper; border of right fifth costal cartilage in the right lateral vertical plane.
- Fourth point at sixth rib is mid axillary line.
- Fifth point at inferior angle of right scapula.
- Sixth point at eighth thoracic spine.

(b) Lower border

- First point at left fifth intercostal space 9 cm from medial plane.
- Second point at the tip of eighth costal cartilage on left costal margin.
- Third point at transpyloric plane in the midline.
- Fourth point at tip of the ninth costal cartilage on right costal margin.
- Fifth point at 1 cm below the right costal margin at the tip of tenth costal cartilage.
- Sixth point at eleventh thoracic spine.

Right Border

It is marked on the front by a curved line convex laterally, drawn from a point a little below the right nipple to a point of 1 cm below the costal margin at the tip of tenth costal cartilage.

External Features

It is wedge shaped and resembles a four sided pyramid laid on one side.

Five surfaces:

- | | | |
|-------------|--------------|-------------|
| 1. Anterior | 2. Posterior | 3. Superior |
| 4. Inferior | 5. Right | |

Inferior surface is well defined because it is demarcated anteriorly by a sharp inferior border. The other surfaces are more or less continuous with each other and are imperfectly separated in ill defined manner with rounded borders.

One prominent Border

Inferior border is anteriorly sharp and it separates anterior surface from it surface and it is again laterally rounded separates right surface from left surface.

Sharp anterior part is marked by

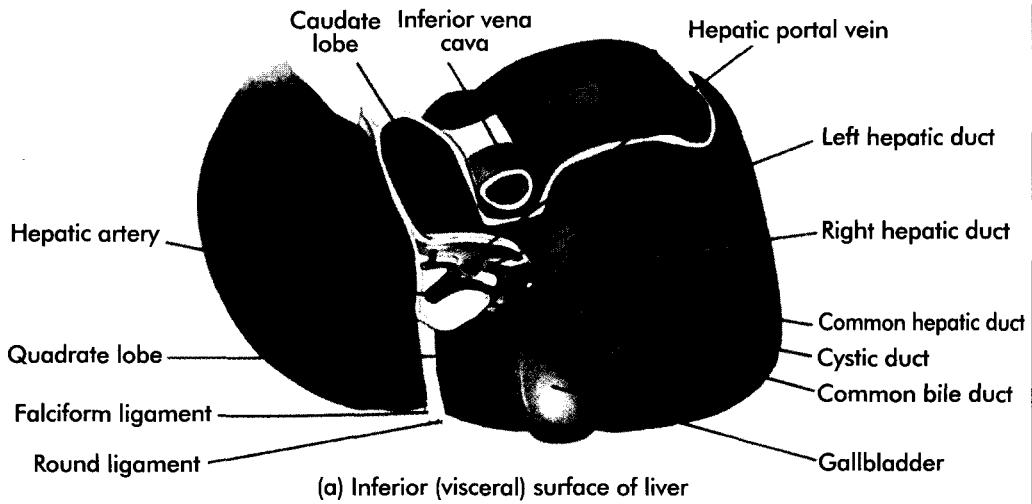
- Inter lobular notch or notch for ligamentum teres.
- Cystic notch for the fundus of gall bladder.

In epigastrium the inferior border extends from left eighth costal cartilage to right ninth costal cartilage.

Lobes

Liver is divided right and left lobes by attachment of falciform ligament, anteriorly

Inferior Surface of Liver



and superiorly by fissure for ligamentum teres inferiorly and by fissure for ligamentum venosum, posteriorly.

Right lobe is large than left lobe form five/sixth of liver which contribute all five surfaces and presents the caudate and quadrate lobes.

Caudate

On the posterior surface it is bounded by groove for inferior vena cava on the left by fissure for ligamentum venosum, and inferiorly by the porta hepatis. Below and to right just behind the porta hepatis it connected to right lobe of liver by caudate process. Below to left is a small rounded elevations called papillary process.

Quadrata

It is situated on the inferior surface it is rectangular in shaped and bounded anteriorly by inferior border, posteriorly by porta hepatis on the right by fossa for gall bladder and on the left by fissure for the ligamentum teres.

Porta hepatis

It is deep transverse on inferior surface of right lobe separating caudate and quadrate. It lips attached to lesser omentum. The portal vein, hepatic artery and hepatic plexus of nerves enter the liver through porta hepatis, while the right and left hepatic duct and few lymphatic leave it.

Left lobe forms one-sixth of right lobe of liver and it is flattened from above downwards.

In the left lobe near the fissure of ligamentum venosum, its inferior surface is round elevated and comes in contact with lesser omentum called as omental tuberosity or tuber ometale.

LIGAMENTS

Falciform Ligament

Which attaches the anterior and superior surface of liver to the diaphragm and the anterior abdominal wall.

Below the two layers of this continuous and its free margin encloses the ligamentum teres.

Ligamentum Teres

From the liver it run down to reach the umbilicus. It is a solid, fibrous cord formed by oliberation of left umbilical vein, soon after the birth, runs downwards across the inferior surface and border of liver, in a fissure to the left end of porta hepatis which is depressed oval area on inferior surface of liver.

Ligamentum Venosum

It is a second fibrous cord formed by liberation of ductus venosus. It diverges from left end of porta hepatis.

Surgical sub-divisions of right and left lobes.

Fossa for Gall Bladder

Lying on inferior surface of liver. The narrow neck of gall bladder passes in to right end of porta hepatis.

Groove for Inferior Vena Cava

It is a deep, vertical groove on the posterior surface of liver, containing the upper part of inferior vena cava.

The fissure of ligamentum venosum, ligamentum teres and fossa for gall bladder, groove for inferior vena cava along with porta hepatis form an H shaped pattern on the postero-inferior aspect of liver.

The rectangular portion of liver between the fossa for gall bladder and the fissure for ligamentum venosum is quadrate lobe.

The caudate and quadrate lobes belong to the left lobe.

RELATIONS

Peritoneal Relations

- (a) Most of the liver is covered by peritoneum and an area which is triangular it is not covered called bare area. It is on posterior surface of right lobe limited by a upper and lower layers of coronary ligament and by right triangular ligament.
- (b) *Groove for inferior vena cava*:- On posterior surface of right lobe of liver and it is on between caudate and bare area.
- (c) The fossa for gall bladder which lies on inferior surface of right lobe to the right of quadrate lobe.

- (d) The coronary ligamentum having superior and inferior layers which enclose bare area.
- (e) Lesser omentum.

Falciform Ligament

It is sickle shaped double folded of peritoneum which stretch from liver to diaphragm and anterior abdominal wall has a convex an concave margin and a right and left layer.

The convex is attached to inferior surface to diaphragm and anterior abdominal wall up to umbilicus.

The right layer is continuous with upper layer of coronary ligament.

Left Triangular Ligament

On posterior surface of right lobe of liver has a superior and inferior layer.

Superior layer stretches between postero-superior aspect of right lobe of liver and diaphragm along upper part of bare area.

Inferior layer stretches between postero-inferior aspect of right lobe of liver.

Diaphragm along lower part of bare area.

Right Triangular Ligament

Two layers of coronary ligament fuse on right to form the right triangular ligament between them is the bare area of liver.

Lesser Omentum

Derived from ventral mesogastrium and two layered folds of peritoneum.

Attachment

Superiorly to the fissure for ligamentum venosum and lips of porta hepatis along an L shaped line.

Inferiorly to the lesser curvature of stomach and first inch of superior part of duodenum.

Relation

Its margin forms anterior boundary of foramen epiploicum posterior to it is lesser sac, anteriorly to it is left intraperitoneal subdiaphragmatic space.

Content

The free margin contain portal vein, hepatic artery and common bile duct, others are left, right gastric vessels, lymphatic from stomach, lymph nodes and nerve plexus.

Visceral Relations

Anterior Surface

It is triangular, slightly convex, related to xiphoid process and to anterior abdominal wall in medial plan and diaphragm on each side.

The diaphragm separates these surfaces from pleura groove the level of a line drawn from the xiphisternal joint and tenth rib.

Mid axillary line and from the lung above the level of a line from the same joint to eighth rib. The falciform ligament is attached to the surface a little to the right of medial plane.

Posterior Surfaces

It is triangular and its middle part is concave for vertebral column.

Bare area is related to diaphragm and to right supra renal gland near the lower end of the groove for inferior vena cava.

The groove for inferior vena cava lodges the upper part of vessel and its floor is pierced by hepatic veins.

Caudate lobe is in superior recess of lesser sac. It is related to curve of diaphragm above the aortic open to right inferior phrenics artery and to celiac trunk.

The fissure for ligamentum venosum is very deep and extends inform of caudate lobe, it has two layers of lesser omentum. The ligamentum venosum on its floor it is remnant of ductus venosus of foetal life it is connected vein near its entry to inferior vena cava.

The posterior surface of left lobe is marked by oesophageal impression.

Superior Surfaces

It is quadrangular and concavity, in middle it shows cardiac impression on its each side surface is convex to fit the dome of diaphragm, which separates this surface to pericardium and the heart in middle and from pleura and lung on either side.

Inferior Surface or Visceral Surface

It is not related to diaphragm. It sits up on the upper abdominal viscera which form liver bed the left to right side.

It is quadrangular and directed downwards, backwards to left and marked by impression for neighbouring visceral as follows.

Left lobe on its inferior surface there is a large concave gastric impression.

The fissure for ligamentum teres passes from inferior border to left end of porta hepatis.

The quadrant lobe is related to lesser omentum of stomach pylorus, first part of duodenum. If stomach is empty the quadrate is related to first part of duodenum and to part of transverse colon.

Lesser omentum relates to a prominence of left lobe called tubermentale.

Fossa for gall bladder lies to right or quadrate which is non-peritoneal.

To the right of this fossa the inferior surface of right lobe bear the colic impression for hepatic flexure of colon, the renal impression for upper part of right kidney and the duodenal impression due to superior-descending part of duodenum at neck of gall bladder for Second part of duodenum.

Right Surface

It is wedge or quadrangle shape and convex, related to diaphragm opposite to seventh to eleventh ribs in mid axillary line. It is separated by diaphragm from pleura up to tenth rib and from the lung up to eighth rib. Thus, the upper one third of superior surface is related to diaphragm then right pleura and lung. The middle one third from right pleura to diaphragm and costodiaphragmatic recess of pleura and lower $1/3^{\text{rd}}$ of diaphragm alone.

Hepatic Segments

On the basis of intra hepatic distribution of hepatic artery, the portal vein and bile artery ducts the liver can be divided in to right and left functional lobes.

Right lobe subdivided –(i) Anterior segment. (ii) Posterior segment.

Left Lobe – (i) Medial segment. (ii) Lateral segment.

The left lobe again divided in to left lateral and left medial.

The right lobe again divided in to right anterior and right posterior.

Blood Supply

Eighty percent of blood supplied by portal vein.

Twenty percent of blood supplied by hepatic artery (branch of celiac).

The de-oxygenated blood drains into central vein and eventually passes into hepatic vein which drain directly to inferior vena cava.

Each branch is an end artery as there are no anastomosis between adjoining hepatic arterial territories.

End artery means the artery does not divide in segmentation.

Branch of hepatic portal vein, hepatic artery and hepatic duct are called portal triad.

Lymphatic System

May be superficial or deep

Superficial

They run on surface of organ beneath the peritoneum.

Deep

They end partly in the nodes around inferior vena cava and partly in the hepatic nodes.

Nerve Supply

Sympathetic – nerves from hepatic plexus.

Parasympathetic – vagus.

Histology

- The lobules are functioning unit of liver which are hexagonal in shape.
- The lobules contain specialized hepatic cells or hepatocytes. It is an epithelial cell.
- Liver has large spaces lined by endothelium.
- The sinusoids are lined by Kupffer cells or stellate reticuloendothelial cells.
- Bile enters bile capillaries or canaliculi, which enter into corresponding hepatic duct which unite to form common hepatic duct.

Hepatic Ducts

From porta hepatis right and left hepatic ducts emerge and unite to form common hepatic duct which is formed at right edge of porta hepatis.

Cystic duct forms gall bladder and the common hepatic duct forms the common bile

Inferior Aspect of Liver with Porta Hepatis



Liver (inferior aspect). Dissection of porta hepatis, Gallbladder partly collapsed. Ventral margin of liver above.

- | | |
|----|---|
| 1 | Fundus of gallbladder |
| 2 | Peritoneum (cut edges) |
| 3 | Cystic artery |
| 4 | Cystic duct |
| 5 | Right lobe of liver |
| 6 | Inferior vena cava |
| 7 | Bare area of liver |
| 8 | Notch for ligamentum teres and falciform ligament |
| 9 | Ligamentum teres |
| 10 | Falciform ligament of liver |
| 11 | Quadrata lobe of liver |
| 12 | Common hepatic duct |
| 13 | Left lobe of liver |
| 14 | Hepatic artery proper |
| 15 | Common bile duct |
| 16 | Portal vein |
| 17 | Caudate lobe of liver |
| 18 | Ligamentum venosum |
| 19 | Ligament of inferior vena cava |
| 20 | Appendix fibrosa (left triangular ligament) |
| 21 | Coronary ligament of liver |
| 22 | Hepatic veins |
| 23 | Porta hepatis |

} Portal triad

duct, pancreatic duct and common bile duct enter in to second part of duodenum by hepatic pancreatic ampulla or ampulla of vater or sphincter of oddi.

The liver acini is defined as the liver around a preterminal branch of hepatic arteriole between two adjacent central veins.

Cystic duct join to hepatic duct and form bile duct. It is a spiral fold known as valve of heister maintain potency.

Functions

- Metabolism of carbohydrates fats, proteins.
- Synthesis of bile and prothrombin.
- Excretion of drugs, toxins, poisons, cholesterol, bile pigment and heavy metals.
- Protection by conjugation, destruction, phagocytosis, antibody formation and excretion.
- Storage of glucogen, iron, fat vitamin A & D.

Bile duct

It is formed by the union of the cystic duct and common hepatic ducts near the porta hepatis. It is about 8 cm long and has a diameter of about 6 mm.

Course— The bile duct runs downwards and backwards, first in the free margin of the lesser omentum, supra duodenal part then behind the first part of the duodenum in the retro-duodenal part; and lastly behind, or embedded in the head of the pancreas infraduodenal part. Near the middle of the left side of the second part of the duodenum it comes in contact with the pancreatic duct and accompanies it through the wall of the duodenum, the intraduodenal part. Within the wall of the duodenum the two ducts usually unite to form the hepatopancreatic ampulla or ampulla of Vater. The distal constricted end of the ampulla opens at the summit of the major duodenal papillae 8 to 10 cm distal to the pylorus.

Relations-

A. Supraduodenal part in the free margin of lesser omentum.

Anteriorly – Liver

Posteriorly – portal vein and epiploic foramen.

To the left- Hepatic artery

B. Retro-duodenal part-

Anteriorly – First part of duodenum

Posteriorly – Inferior vena cava

To the left – Gastro duodenal artery

C. Infraduodenal part

Antriorly – A groove in the upper and lateral parts of the posterior surface of the head of the pancreas.

Posteriorly – Inferior vena cava

AGNASHAYA – PANCREAS

The pancreas is a combined of exocrine and endocrine gland.

The exocrine gland secretes the digestive pancreatic juice into the second part of duodenum.

The endocrine part secretes some hormones which controls the blood sugar.

Shape and Situation

It lies almost horizontally over the posterior abdominal wall in the epigastric and left hypochondrium at the level of L1 and L2 vertebrae. As it is situated in deep position cannot be palpated.

It is a tubulacinar gland about 12-15 cm long 3 cm broad and 2.5 cm thick. Average weight is 90 gms.

It is present just posterior to the greater curvature of the stomach and connected by two ducts into the duodenum.

Subdivisions

It is divided into four parts from right to left side:

1. Head 2. Neck 3. Body 4. Tail

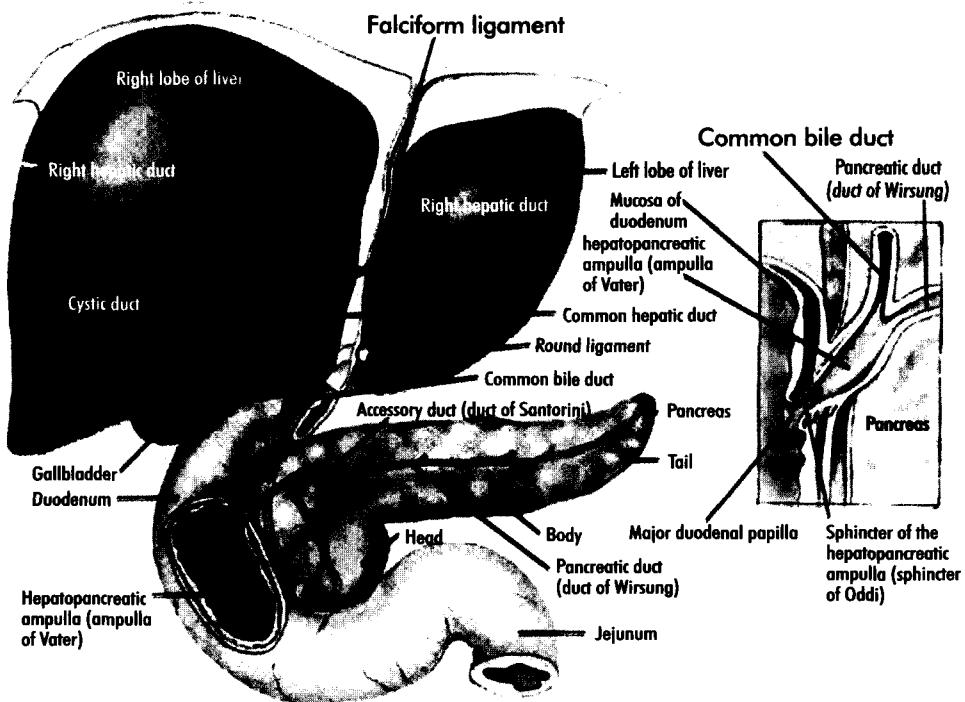
Head

It is the expanded portion near the concavity C shaped duodenal loop at the level of L2 vertebra.

It has Two surfaces – anterior and posterior

Three borders – superior, inferior and right lateral

Relation of Pancreas to Liver Gall Bladder & Duodenum



One process – uncinate process, which is projected from the lower and left part of the head towards the left side.

Relations

Superiorly – First part of duodenum, superior pancreatoduodenal artery.

Inferiorly – Third part of duodenum, inferior pancreatoduodenal artery.

Right laterally – Second part of duodenum, terminal part of bile duct.

Anteriorly – Transverse colon, gastroduodenal artery and jejunum.

Posteriorly – Inferior vena cava, right side of diaphragm, bile duct.

Uncinate process – It appears like hook and extended upto the left forming the pancreatic notch.

Neck

It is the constricted portion present in between the head and body of pancreas.

It is directed forwards, upwards and to the left side.

It has two surfaces : (i) Anterior (ii) Posterior

Anteriorly – It is related with the pylorus and peritoneum.

Posteriorly – It is related to the termination of the superior mesenteric and portal vein.

Body

It lies at the level of First lumbar vertebra. It is elongated passes towards the left.

It has Three borders – anterior, superior and inferior.

Three surfaces – anterior, posterior and inferior.

Relations

Anteriorly – It is attached with transverse mesocolon.

Posteriorly – Aorta, left side of diaphragm, left supra renal gland, renal artery.

Superiorly – Celiac artery and splenic artery.

Inferiorly – Duodenojejunal flexure and left colic flexure.

Tail

It is the continuation of the body and the narrow left end of the pancreas. It lies at the level of twelfth thoracic vertebra. It lies on the gastric surface of the spleen between the hilus and left colic flexure. The tip part of the pancreas completely surrounded by peritoneum.

Ducts of the Pancreas

It has two ducts which communicate with each other

1. Main pancreatic duct (duct of wirsung).
2. Accessory pancreatic duct (duct of santorini).

Duct of Wirsung

It begins in the tail and runs through the body to the neck, receiving the secretions from above and below. It bends down into the head and joins the end of a bile duct to form the hepato-pancreatic ampulla.

Its lumen is about 3 mm in diameter. The ampulla opens on an elevation of the duodenal mucosal known as the duodenal papilla, about 10 cm below the pylorus.

Duct of Santorini

It starts at the lower part of the head crosses in front to the main duct which communicates with the duodenum at the minor duodenal papilla which is present 2 cm above the main duct or 7-8 cm distal to the pylorus.

Artery Supply

Both the head and neck are supplied by

Superior pancreateo duodenal artery – branch of gastroduodenal artery.

Inferior pancreateo duodenal artery – branch of superior mesenteric artery.

Both the body and tail are supplied by *Splenic artery*.

Venous Drainage

Portal vein through the tributaries of the splenic and superior mesenteric veins.

Lymphatic Drainage

- (a) Pancreato-splenic nodes
- (b) Celiac and superior mesenteric nodes.

Nerve Supply

Sympathetic – splanchnic.

Para-sympathetic – vagus.

Applied Anatomy

Diabetes mellitus – due to the deficiency of insulin.

Acute pancreatitis – serum amylase is increased.

Deficiency of pancreatic enzymes causes digestive disturbances.

PITTASHAYA – GALL BLADDER

The gall bladder is a pear shaped organ present at the fossa of visceral surface of liver between the right lobe and quadrate lobe. It is a fibromuscular sac of 7 to 10 cm long and 3 cm wide. This fossa extends from the right end of porta hepatis to inferior border of liver. The correct position is it is present between twelfth rib and L1 lumbar vertebra. Gall bladder mainly store bile.

Surface of Gall Bladder

The outer coat is visceral peritoneum.

The middle part is a muscular coat which is made of smooth muscle fibres.

Gall bladder lacks submucosa.

The mucosal is made of simple columnar epithelium, which just resembles those of the stomach.

Parts of Gall Bladder

Gall bladder can be divided into three parts.

They are:

1. fundus
2. Body
3. Neck

1. Fundus

Fundus is a bulbous end which is entirely surrounded by peritoneum. This is present between ninth costal cartilage and lateral border of right rectus abdominus.

It projects beyond the inferior border of the liver.

It relates anteriorly to anterior abdominal wall.

Posteriorly to beginning of transverse colon just to left of hepatic flexure.

2. Body

The body of the gall bladder is following the fundus which is a dilated part present in

the fossa of liver. The upper narrow end is then continue as a neck near the right end of porta hepatis.

The body has two surface:

- (a) Superior surface. (b) Inferior surface.

The superior surface is directly contact with the fossa and devoid of peritoneum, so they are adherent to the liver.

The inferior surface relates with first and second part of duodenum and right transverse colon. This surface is covered by peritoneum.

3. Neck

Neck is the narrow upper end of gall bladder. It curves medially and continuous as a cystic duct. A constriction is found at junctions of cystic duct.

Superiorly – neck attached to liver by areolar tissue in which cystic vessels embedded.

Inferiorly – relates to first part of duodenum.

The obstruction to the in or out flow of bile is prevented by spirally folded mucus membrane in the neck.

A dilated outwards pendulous pouch at the posteromedial wall called the Hartmann's. This part is between the body and neck.

Some say this is the normal features but it may be pathological also.

Gall stone is found in this pouch.

Artery Supply

Cystic artery – A branch of right hepatic artery passes behind the cystic duct to the neck of the gall bladder where it divides.

Cystic artery crosses calot's or cysto hepatic triangle.

They has flowing boundaries:

1. Hilum of the liver above
2. Left side of common hepatic duct
3. Right side of cystic duct.

Venous Supply

Cystic vein which drains in to portal vein.

Lymphatic Drainage

1. Portal hepatic nodes
2. Cystic node in calot's triangle
3. Anterior border of epiploic foramen node.

Applied Anatomy

1. Inflammation of gall bladder is known as cholecystitis.
2. Stones present in the gall bladder is referred as cholelithiasis.
3. ERCP– Endoscopic Retrograde Cholangio Pancreatography is a technique helpful to visualize the internal structures of duct of gall bladder and pancreatic duct.

PLIHA - SPLEEN

Formation of Yakrit, Pliha

गर्भ-गर्भस्य यकृप्लीहानौ शोणितजौ ।

(Su. Sha. 4/25)

The *Yakrit* and *pliha* are formed from *shonita* in the *garbha*.

It is a lymphatic organ coming under reticulo endothelial system. It act as a filter for blood and plays an important role in the immune responses of the body.

Location

It is a wedge shaped organ lying mainly in the left hypochondrium partly in the epigastrium. It is present in between the fundus of the stomach and diaphragm. It is soft, highly vascular, dark purple in colour.

Length and Size

It is 7 ounces in weight. 12.5 cm long, 7.5 cm broad, 2.5 cm thick. It is obliquely present along the long axis of the tenth rib.

External Features

It has two ends:

Anterior end – It is directed downwards and forwards and reaches the mid axillary line.

Posterior end – It is rounded directed upwards, backwards and medially towards the upper pole of the left kidney.

Three Borders

Superior border – It has a notch near the anterior end.

Inferior – It is rounded.

Intermediate – It is directed towards the right side and rounded.

Two Surfaces

Diaphragmatic surface – It is convex and smooth related with diaphragm.

Visceral surface – It is concave and irregular in shape.

It has following impressions

1. Gastric impression – For the fundus of the stomach and it is the larger one.
2. Renal impression – For the left kidney.
3. Colic impression – For the left colic flexure of the large intestine.
4. Pancreatic impression – For the tail of the pancreas.

Relations

It is surrounded by peritoneum by the help of the following ligaments:

1. *Gastro Splenic Ligament* – It extends from the hilum of the spleen to the greater curvature of stomach.
2. *Lienorenal Ligament* – It extends from the hilum of the spleen to the anterior surface of the left kidney.
3. *Phrenico Colic Ligament* – It is not attached to spleen but it supports the anterior end, it is made up of horizontal fold of peritoneum extending from the splenic flexure of the colon to the diaphragm opposite of the eleventh rib in the mid axillary line.

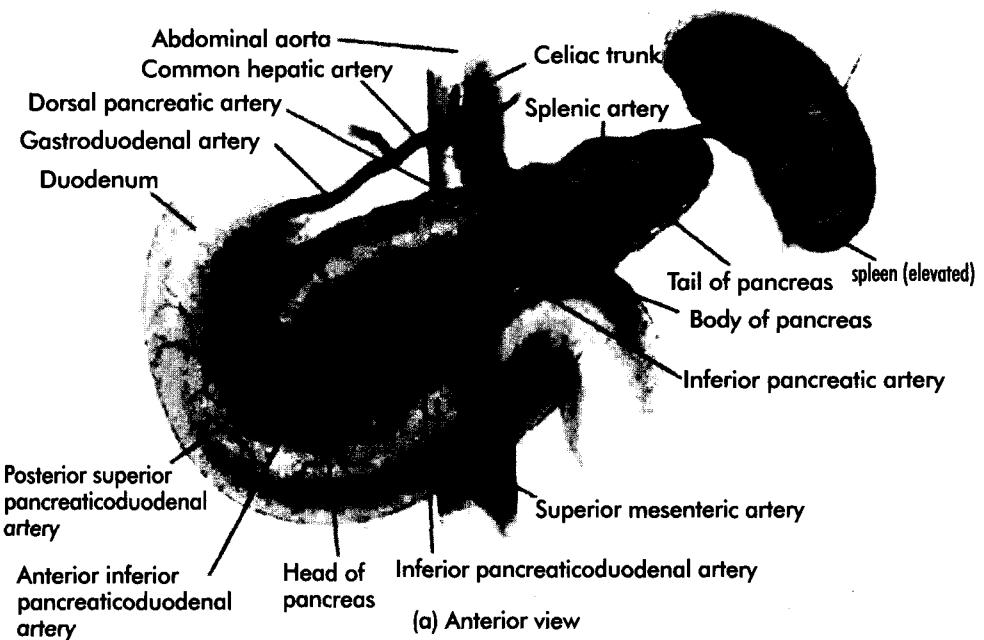
Visceral Relations

The visceral surface is related to the fundus of the stomach, the anterior surface of the left kidney, the splenic flexure of the colon and tail of the pancreas.

Diaphragmatic Surface

It is related to diaphragm which separates the spleen from the costodiaphragmatic recess of pleura.

Pancreas with Duodenum and Spleen



Artery Supply

It is supplied by splenic artery which is the largest branch of the celiac trunk within the spleen it divides repeatedly to minute branches.

Venous Drainage

It is drained by the help of the splenic vein which again drains into the superior mesenteric vein and lastly to the portal vein.

Lymphatics

It contains pancreateo splenic lymph nodes.

Nerve Supply

Sympathetic fibres are derived from the coeliac plexus.

Applied Anatomy

Splenomegaly – enlargement of spleen.

Splenectomy – surgical removal of the spleen.

Palpation of the spleen – normally the spleen is not palpable unless it attends its double size.

Normal Function of the Spleen

1. *Storage of RBC* – Red blood cells can be stored in the spleen and released into the circulation whenever it is needed.
2. *Haemopoiesis* – Spleen is an important haemopoietic organ during foetal life but lymphopoiesis continues throughout life. Lymphocytes take part in immune system of the body in the adult spleen, haemopoiesis can be restarted in certain diseases like chronic myeloid leukaemia and myelosclerosis.
3. *Phagocytosis* – Spleen is an important organ in the reticuloendothelial system. The splenic phagocytes include: (a) Reticular cells and free macrophages of the red pulp. (b) modified reticular cells of the ellipsoids. (c) free macrophages and endothelial cells of the venous sinusoids. (d) the surface reticular cells of the lymphatic follicles. The phagocytes present in the organ remove cell debris and old and affected RBC's other blood cells and microorganisms, and thus filter the blood.

Phagocytosis of the circulating antigens initiates humoral and cellular immune responses.

BRIHADANTRA - LARGE INTESTINE

सार्थ त्रिव्यामान्यन्त्राणि पुंसा त्रिणामर्धव्यामहीनानि ॥

(Su. Sha. 5/9)

Intestine are $3\frac{1}{2}$ Vyama in males, while in females they are less by $\frac{1}{2}$ Vyama.

The large intestine consists of caecum, vermiform appendix, ascending colon, transverse colon, descending colon, sigmoid colon, rectum and anal canal.

It is extended from the ileocaecal junctions to the anus. The length is about 150 cm (1.5 mts).

Vermiform appendix is arised from the angle present between the terminal part of ileum and caecum.

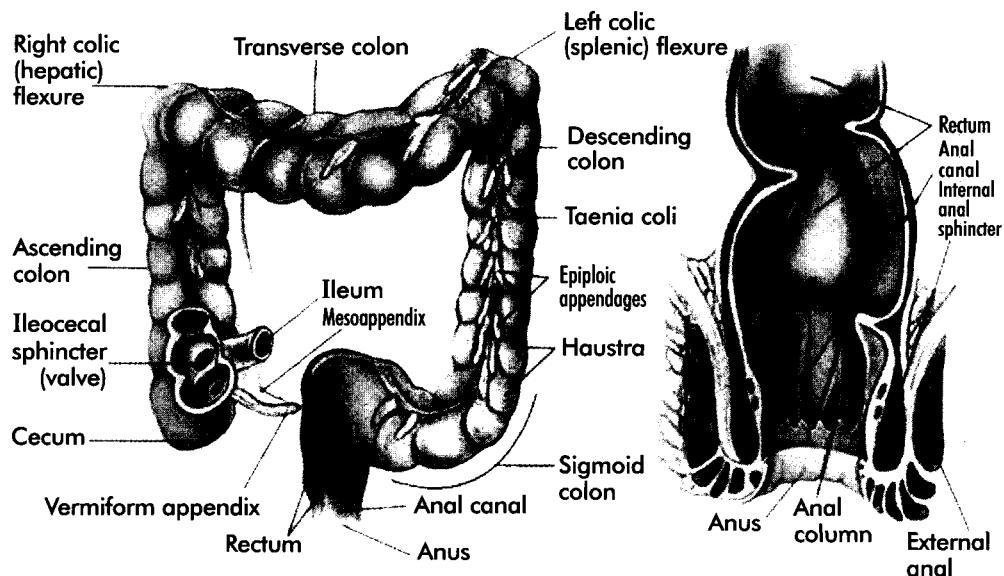
It is helpful for storage of food materials which is reaching it from the small intestines and for absorption of fluid and solutes. It contains the columnar epithelium which is helpful for absorption. It does not contain any villi. It provides numerous mucous secreting cells which provides adequate lubrication.

Due to the presence of numerous solitary lymphatic follicles it provides protection against bacteria present in the lumen of the intestine.

Special Features of Large Intestine

1. *Taenia coli* – These are three thickened bands formed by the aggregation of the longitudinal muscle coat.
Proximally the taenia converge at the base of appendix, and distally they spread out on the terminal part of the sigmoid colon to become continuous with the longitudinal muscle coat of the rectum.
2. *Appendices epiploicae* – These are fatty projection of the serous coat on the antimesentric border of the different parts of the colon. These are scattered over the surface of the large intestine, except for the appendix, the caecum and the rectum.
3. It is wider in caliber than the small intestine, it is greatest at its commencement and gradually diminishes towards the rectum where it is dilated to form the rectal ampulla just above the anal canal.
4. The greater part of the large intestine is fixed, except for the appendix, the transverse colon and the sigmoid colon.

Large Intestine with Anal Canal



UNDUKA – CAECUM

शोणित किण्ठ प्रभव उण्डुकः ॥

(Su. Sha. 4/25)

It is formed from the waste of *Shonita*.

It is the large blind commencement of the large intestine inferior to the entry of the ileum.

Posteromedially the caecum communicates with the appendix, medially with the caecocolic junction and superiorly with the ascending colon. It is present in the right iliac fossa just above to the inguinal ligament lateral to the right lateral plane. It is fully covered with the peritoneum.

The length and breadth of the caecum is about 6cm and 7.5cm respectively.

The caecum and prostate are the organs of the body that have greater width than the length.

Relations

Anteriorly

Coils of small intestine and anterior abdominal wall.

Posteriorly

- | | |
|--------------------------------|---------------------------|
| (a) Iliacus and psoas muscles. | (b) Femoral nerve |
| (c) Genitofemoral nerve | (d) External iliac artery |
| (e) Posterior caecal artery. | |

Different Types of Caecum

Initially the appendix arises from the apex of the caecum. However, due to rapid growth of the lateral wall of the caecum, the attachment of the appendix shifts medially.

There are three types of caecum:

1. *Conical type* (13%) – where the appendix arises from the apex of the caecum.
2. *Intermediate type* (9%) – where the right and left caecal pouches are equal in size, and the appendix arises from a depression between them.
3. *Ampullary type* (78%) – it is normally seen in the young individuals. The right caecal pouch is much larger than the left, and the appendix arises from the medial side.

Blood Supply

It is supplied by the caecal branch of ileocolic artery.

The veins drained in to the superior mesenteric vein.

Nerve Supply

Sympathetic – T11 – L1

Para sympathetic – vagus.

Vermiform Appendix

It is one of the vestigial organ arised posteromedially to the caecum, it is a worm like tubular structure present 2.5 cm below the ileocaecal junction.

The length varies from 2 to 20 cm averagely 9 cm. it is longer in children because in the early childhood it is responsible to stabilize the immunity level.

Diameter is about 5 mm.

The base of the appendix is situated in the Mcburney's point where maximum tenderness is found on acute appendicitis.

One imaginary straight line can be drawn from the tip of anterior superior iliac spine (right side) to the umbilicus. The point where the lateral one third and posterior two third joins together, that is referred as mcburney's point.

Positions of Appendix

The appendix lies in the right iliac fossa. The base of the appendix is fixed but the tip can point in any direction.

Depending on the basis of the direction of tip following positions are mentioned.

Retrocaecal or retrocolic position (12' o clock)

It is seen in 65% of the cases where the appendix lies behind the caecum or colon. It is most common position.

Pelvic (4'o clock) position.

It is seen in 20-30% of the cases. It is second most common position. It crosses the pelvic brim or descended into the pelvis.

Subcaecal or midinguinal (6' o clock) position.

Appendix is present just below the caecum and may point towards the inguinal ligament.

Pre ileal and post ileal (2'o clock) position.

The appendix may present in front of the ileum or behind the ileum. It pass upwards and to the left towards the spleen. It is seen in 2% of the cases.

Paracolic (10'o clock) position.

The appendix may pass upwards and to the right side.

Relations with Peritoneum

It is connected to the ileum by a triangular extension of the posterior fold of mesentery forming the meso appendix.

Blood Supply

Artery Supply – the appendicular artery is a branch of the lower division of the ileo colic artery it anastomoses with the branch of posterior caecal artery which runs towards the tip of the appendix.

Veins Supply – blood from the appendix is drained by the appendicular, ileocolic and superior mesenteric veins to the portal vein.

Lymphatic Drainage

The lymphatic vessel terminate in the ileocaecal and appendicular nodes.

Nerve Supply

Sympathetic – T9-T10 spiral segments.

Parasympathetic – vagus.

Applied Anatomy

1. *Appendicitis* – inflammation of appendix is known as appendicitis.
2. *Appendectomy* – surgical removal of appendix is called as appendectomy.
3. *Mc Burney's point* – maximum tenderness found in appendicitis.
4. When the appendix is situated in retrocaecal position, it causes pain in extension of hip joint due to stretch of psoas major muscle.

COLON

The colon extends from the caecum in the right iliac fossa to its junction with the rectum which in from of the middle piece of sacrum.

It is divided into

1. Ascending colon
2. Transverse colon
3. Descending colon
4. Sigmoid or pelvic colon.

Ascending Colon

It is 20 cm long. It ascends up from the caecum to the inferior surface of the right lobe of liver and turns abruptly to the left at the level of second lumbar vertebra called as right colic or hepatic flexure. The colon continues across the abdomen to the left side as the transverse colon.

Relations

Anteriorly

- Anterior abdominal wall
- Coils of small intestine
- Right edge of greater omentum.

Posteriorly

- Right kidney
- Subcostal nerve and vessels
- Iliacus, quadratus lumborum and transverses abdominis
- Ilioinguinal and iliohypogastric nerves.
- Twelfth rib.

Right Colic or Hepatic Flexure

It is formed by the terminal part of the ascending colon which turns downward, forward and to the left to become continuous with the transverse colon. It lies below the transpyloric line.

Relations

Anteriorly

- Inferior surface of right lobe of liver.

Posteriorly

- Anterior surface of the lower pole of right kidney.
- Transverses abdominis muscle.

Transverse Colon

It is about 20 inches long and extended in upper abdomen from the hepatic flexure to the splenic flexure. It is a hanging structure suspended by the help of transverse meso colon.

Greater part of transverse colon hangs down to a variable extent, sometimes in to the pelvis.

Relations

Anteriorly

- Greater omentum

Posteriorly

- Right kidney
- Descending part of duodenum
- Head of pancreas
- Duodenojejunal flexure
- Left kidney.

Left Colic or Splenic Flexure

It is present at the junction of the transverse colon and descending colon. Here the splenic flexure bends downwards and backwards. By the help of phrenicocolic ligament it is attached with the eleventh rib in the mid axillary line.

Anteriorly

- Head of pancreas
- Left costal margin
- Stomach

Posteriorly

- Left kidney
- Colic surface of the spleen.

Descending Colon

It is about 20-25 cm in length and extends the splenic flexure to the beginning of the sigmoid colon. It is narrower than the ascending colon.

First it passes down along the lateral margin of left kidney to its lower, then it runs vertically to the iliac crest and to the medial side of the left anterior superior iliac spine. Then it turns medially to the pelvic brim where it becomes the sigmoid colon.

Relations

Anteriorly

- Coils of small intestine

Posteriorly

- Transverses abdominis
- Quadratus lumborum
- Iliacus and psoas major
- Femoral
- Genitofemoral nerves
- Iliac branch of iliolumbar vessels.
- Testicular artery
- External iliac artery.

Sigmoid or Pelvic Colon

It is about 40 cm long. It is called sigmoid since it describes an 'S' shaped curve. It begins near the left iliac crest, projects inward to the mid line and terminates as the rectum at about the level of the third sacral vertebra. It hangs downwards in to the pelvis in front of the rectum and behind the bladder or uterus. It is suspended by the help of sigmoid mesocolon.

GUDA – RECTUM

It is present in between the sigmoid colon above and anal canal below. It is 13cm long and 4cm diameter. It is a retroperitoneal structure. It is situated in the posterior part of the lesser pelvis in front of the lower three pieces of the sacrum and coccyx.

It is a continuation of the sigmoid colon at the level of S3 vertebra.

The terminal 2.3cm of the rectum is called as anal canal.

The rectum is curved in an anteroposterior direction and also from side to side.

Taenia coli, appendices epiploicae and sacculations are absent in the rectum, which are the cardinal features of large intestine.

Shape

It is tubular organ not of uniform caliber. The rectum is capable of considerable distension and is usually empty since the faeces are stored in the sigmoid colon. It presents curvature in both anteroposterior and lateral directions.

There are two anteroposterior curvatures:

1. *An upper sacral curvature*

the sacral flexure of the rectum follows the concavity of sacrum and coccyx.

2. *A lower perineal curvature*

the perineal flexure of the rectum is the backward and continuous with the anal canal.

There are three lateral curvatures:

1. *Upper lateral curvature* – It is convex to the right side.

2. *Middle lateral curvature* – It is the most prominent one and convex to the left side.

3. *Lower lateral curvature* – It is convex to the right side.

Peritoneal Reflection

- Anterior surface and sides of upper one-third is covered by peritoneum.
- Anterior surface of middle one-third is covered by peritoneum.
- Lower one third is devoid of peritoneum.

It lies below the rectovesical pouch in males and rectouterine pouch in case of females.

Relations

Anteriorly

In males –

Peritoneum, sigmoid colon and rectovesical pouch upper two third.

Urinary bladder, vas deferens, seminal vesicles and prostate to the lower third.

In females –

Pelvic colon and recto-uterine pouch to the two thirds. The pouch separates the uterus and vagina.

Posterior fornix and middle part of the posterior wall of vagina are related to the lower third.

Posteriorly –

1. Sacrum, coccyx and ano-coccygeal ligament.
2. Coccygeus, pyriformis and levator ani.
3. Median sacral and lateral sacral vessels.

4. S3, S4 and S5 nerves and coccygeal nerves. (S3, S4, S5, Co1 and pelvic splanchnic nerve)

Lateral –

1. Lateral ligaments of rectum in both sexes.
2. Uterosacral folds and ligaments in the female.

Arterial Supply

The rectum is supplied by the following arteries:

1. *Superior rectal* – It is the continuation of inferior mesenteric artery and divides into a right and a left branch which descend on the sides of the rectum.
2. *Middle rectal* – It is a branch of the anterior division of internal iliac.
3. *Inferior rectal* – It is a branch from the internal pudendal.

Vein Supply

The rectum is drained by the following veins:

1. Superior rectal which continues up as inferior mesenteric vein which ends in the splenic vein. This drains into the portal system.
2. Middle rectal and
3. Inferior rectal end in the internal iliac vein.

Lymphatic Drainage

The rectum is divided into upper half and lower half. For study of its lymphatic drainage lymphatics from

Upper half drains into – inferior mesenteric nodes.

Lower half drains – internal iliac nodes.

Nerve Supply

Sympathetic – L1, L2

Para sympathetic – S2, S3, S4

Applied Anatomy

1. Piles, fistula, fissures are the commonest ano-rectal disorders.

2. Digital examination per rectum (P/R). In a normal person, the following structures can be palpated by a finger passed per rectum:
 - In males – posterior surface of prostate, seminal vesicles and vasa deferentia.
 - In females – perineal body, cervix.
 - In both sexes – anorectal ring, coccyx and sacrum.
3. Bowel control – due to weak musculature of the rectum and loss of tone of external sphincter leads to rectal disturbance tend to cause constipation, although complete lesions may cause reflex defecation.
4. Prolapse of rectum – two types of prolapse usually occurs:
 - *Incomplete prolapse* – It occurs due to violent straining and imperfect support of rectal mucosal.
 - *Complete prolapse* – In this condition the whole thickness of the rectal wall protudes through the anus and it is caused due to laxity of the pelvic floor, excessive deep rectovesical or rectouterine pouch.

ADHARAGUDA - ANAL CANAL

असूजः श्लेष्मणिषापि: यः प्रसादः परो मतः ।

तं पच्यमानं पित्तेन वायुश्चाप्यनुधावति ॥

ततोऽस्यान्त्राणि जायन्ते गुदं बस्तिश्च देहिनः ।

(Su. Sha. 4/26-27)

When the *sara* (*prasadah*) of *asrija* and *sleshma* undergo digestion by *pitta* and get acted by the *vata*, *antrani*, *gudam* and *basti* are formed.

It is the terminal part of gastro-intestinal tract. It is about 3.6–4cm long. It starts from the anorectal junction and ends in the anus. It is directed downwards and backwards.

The mucous membrane of the anal canal is arranged in longitudinal folds called anal columns that contain a network of arteries and veins. The opening of the anal canal to the exterior is called anus. It is guarded by an internal sphincter of smooth muscle (involuntary) and an external sphincter of skeletal muscle (voluntary). Normally, the anus is closed except during elimination of faeces.

The ano-rectal junction lies slightly below the tip of coccyx.

The anus is the surface opening of the anal canal, situated about 4cm below and in front of the tip of the coccyx in the cleft between the two buttocks.

The skin which surrounds the anus is pigmented and made in to radiating folds and contains a ring of apocrine glands.

RESPIRATORY SYSTEM – TRACHEA

Trachea starts from larynx and divides at the level of fourth thoracic vertebra in to two primary bronchi seen as carina during bronchoscopy. It is a non collapsible, wide tube, helpful for air passage and the beginning of the lower respiratory passages. It is a mid-line structure, which is slightly to the right side after entering the thorax, having cartilaginous rings which are incomplete posteriorly joined by flexible membranes.

It is about 10-12 cm long with 2.5 cm diameter in adult but can be flexed and elongated and the luminal size may be markedly reduced by circular muscle contractions and invagination of the posterior wall.

The marked luminal narrowing is seen during the forced expiration or cough aimed at clearing the foreign particles and secretions from the lumen of the lungs.

Trachea is a mobile structure and can be pulled up to 3 cm from the top and 1 cm at the bifurcation on swallowing. During inspiration there is caudal stretching and the trachea moves anteriorly away from the vertebral column.

It has two parts:

1. Cervical part of trachea.
2. Thoracic part of trachea.

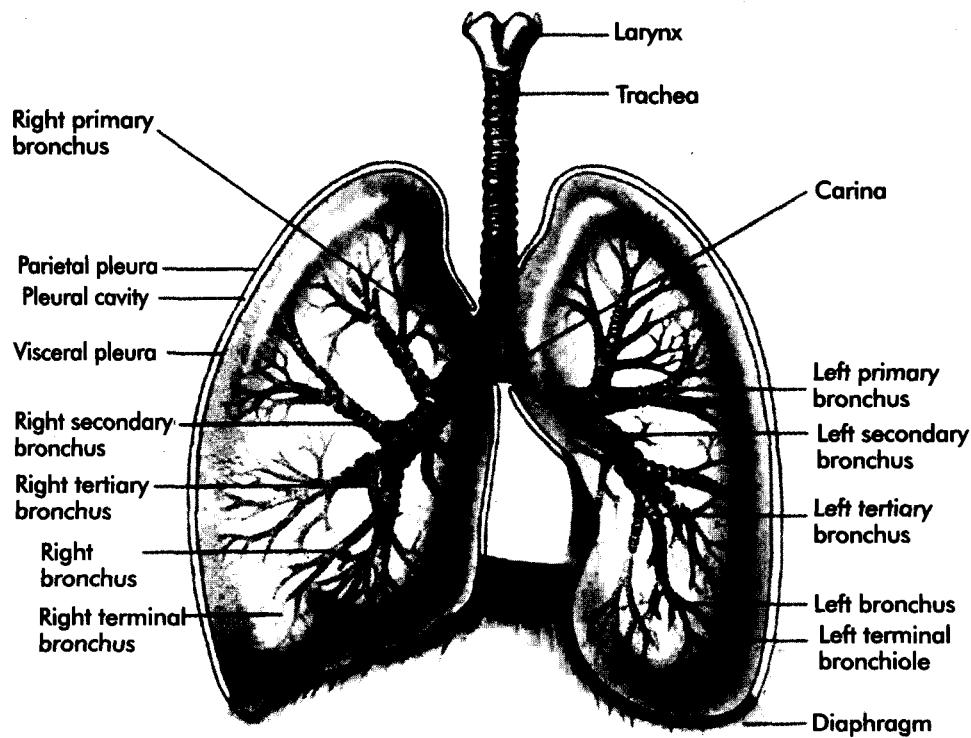
1. Cervical Part

It is extended from the cricoid cartilage at the level of sixth cervical vertebra to the level of supra-sternal notch. It is about 7 cm in length. It is tubular with a flattened posterior wall due to a deficiency in the cartilaginous rings. This gives it a horse-shoe shape in cross section.

Anteriorly

Isthmus of thyroid gland lying on the second, third and fourth rings of trachea. Anastomosis of the two superior thyroid arteries along the upper border of isthmus. Inferior thyroid veins and the thyroideaima artery below the isthmus. Anterior jugular veins and the jugular arch in the suprasternal space of burns. The skin and superficial fascia.

Bronchial Tree in Association with Larynx Trachea & Lungs



In children the left brachiocephalic vein extends in to the neck and then lies in front of the trachea.

Laterally

Medial surface of the lateral lobes of thyroid.

Inferior thyroid arteries.

Common carotid arteries within the carotid sheath.

Posteriorly

Oesophagus

Recurrent laryngeal nerves.

Blood Supply

Inferior thyroid arteries mainly.

Veins drain in to the brachio-cephalic veins via the inferior thyroid veins.

Lymphatic Drainage

Inferior group of deep cervical nodes.

Nerve Supply

Vagus gives parasympathetic supply.

Middle cervical ganglion is the source of sympathetic fibres.

2. Thoracic Part

In the thorax it is median above but inclines very slightly to the right as it descends to its bifurcation opposite the sternal angle at T4. In deep inspiration the bifurcation may descend to the level of T6. It divides in to right and left principal bronchi.

Relations of Trachea

- Posteriorly*
- Oesophagus
 - Recurrent laryngeal nerve and vertebral column.

- Anteriorly*
- Manubrium sterni.
 - Anterior part of arch of aorta.
 - Brachio-cephalic and left common carotid arteries.
 - Left branchio-cephalic vein.
 - Remains of the thymus.

On the right – right lung and pleura

- Right vagus
- Azygos vein.

On the left – Arch.of aorta, left common carotid and left sub-clavian arteries, left phrenic nerve.

Blood Supply

The trachea is supplied by branches from the inferior thyroid arteries. Its veins drain in to the left brachiocephalic vein.

Lymphatic Drainage

It drains in to the pretracheal and para tracheal nodes.

Nerve Supply

Parasympathetic nerves (from the vagus through the recurrent laryngeal nerve) are sensory and secretomotor to the mucous membrane, and motor to the trachealis muscle.

Sympathetic nerves (from the cervical ganglion) are vasomotor.

Applied Anatomy

Palpation of trachea gives clear information regarding the position of primary bronchus and corresponding lung. It is usually palpated by the tip of the middle finger parallel with the suprasternal notch.

1. The trachea may get compressed by pathological enlargements of the thyroid, the thymus, lymph nodes and the aortic arch. It causes Dyspnoea, irritative cough and often a husky voice.
2. Tracheostomy is a operation done in case of laryngeal obstruction (foreign body, diphtheria, carcinoma).

Procedure

A skin incision is made, followed by a short longitudinal incision in to the trachea inferior to the cricoid cartilage. The patient breathes through a metal or plastic tracheal tube inserted through the incision. Another method is intubation.

LARYNX

The larynx is an organ for respiration and phonation. It is also an air passage and acts as a sphincter at the inlet which connects the laryngopharynx with the trachea.

Situation

It lies in the middle of the anterior part of neck opposite the fourth, fifth and sixth cervical vertebra. It becomes continuous with the trachea at the level of sixth cervical vertebra (C4-C6).

It is extended from the root of the tongue to the trachea.

Size

Larynx is 5 cm in length, 4 cm in width and 3.5 cm in its antero-posterior diameter. At the time of puberty, male larynx grows rapidly and becomes larger than the female larynx. Due to the larger growth there is high pitched tone of the voice in case of male.

Skeleton of Larynx

The larynx is formed by a rigid framework of cartilages, ligaments and by a number of muscles. There are three single and three set of paired cartilages.

The three unpaired are larger and are comprised of

1. Thyroid
2. Cricoid
3. Epiglottic

Paired

1. Arytenoid
2. Corniculate
3. Cunciform

The cavity of larynx is lined by mucous membrane.

Thyroid Cartilage

It is the largest cartilage of the larynx. It lies 1.25 cm below the body of the hyoid bone and has the quadrilateral laminae which are joined anteriorly.

Each lamina has

Two surfaces – Lateral and medial.

Four borders – Superior, inferior, anterior and posterior.

Two horns or cornea – Superior and inferior.

The thyroid cartilage (Adam's apple) consists of two fused plates of hyaline cartilage that form the anterior wall of the larynx and give it its triangular shape. It is usually larger in males than in females due to the influence of male sex hormones during puberty. The ligament which connects the thyroid cartilage to the thyroid bone is called as thyrohyoid membrane.

Cricoid Cartilage

This cartilage is shaped like a ring. It is present below the thyroid cartilage at the level of sixth cervical vertebra. It is likened to a signet ring with a broad laminal posteriorly and a narrow arch posteriorly. The arch is about 6 mm high and the lamina about 25 mm high. The lamina articulates superiorly with the arytenoids cartilage. The surfaces of the cartilage are anterolateral, medial and posterior.

Epiglottic Cartilage

It is the third of the large, unpaired cartilages. It is leaf like, broad above and narrow below, guarding the inlet of the larynx. It has upper and lower ends, anterior and posterior surfaces and two lateral borders. Its anterior surfaces is connected to the tongue by a median glossoepiglottic fold and to the hyoid bone by the hyoepiglottic ligament. The posterior surfaces is covered with mucous membrane, and presents a tubercle in the lower part.

Arytenoid Cartilages

They are the largest of the smaller paired cartilages and pyramid in shape. It is present on the upper border of the lamina of the cricoid cartilage. Each has an apex, a base, two processes (vocal and muscular) and three surfaces (antero-lateral, medial and lateral).

Corniculate Cartilages

This is a small nodule above the apex of the arytenoids, in the lower end of the free edges of the aryepiglottic fold, above the quadrangular membrane. It produces a bulge called the corniculate tubercle.

Cunciform Cartilage

These are two rod like cartilages in the lower part of the aryepiglottic fold producing fold producing a perpendicular bulge known as cuneiform tubercle.

Histology of Laryngeal Cartilages

The thyroid and cricoid cartilages, and the basal parts of the arytenoids cartilages are made up of hyaline cartilage. They may ossify after the age of 25 years. The other cartilages of the larynx are made of elastic cartilage and do not ossify.

Ligaments and Membranes of Larynx

1. *Extrinsic* – the thyrohyoid membrane connects the thyroid cartilage to the hyoid bone.
 - *crico-tracheal membrane* – It extends between the lower border of cricoid cartilage and the first tracheal ring.
 - *Hyo-epiglottic ligament* – It connects the lower end of epiglottis to the hyoid bone.
2. *Intrinsic* – fibro-elastic membrane of the larynx lies external to the laryngeal mucosal. It has on both sides a thin upper part which is quadrangular and a thick lower part which is triangular.
 - *Quadrangular membrane* – It is attached anteriorly to the lateral edge of the epiglottic cartilage below the upper free end, and to the thyro-epiglottic ligament.
 - *Aryepiglottic ligament* – The free lower border is markedly thickened to form the vestibular ligament which is the basis of the vestibular fold or the false vocal cord.

BRONCHUS

At the superior border of the fifth thoracic vertebra, the trachea divides into two major bronchi,

- The right principal bronchus
- The left principal bronchus.

The respective bronchus is supplied to the respective lungs.

Right principal bronchus – It is shorter (2.5 cm), wider and more horizontal than the left bronchus.

Left principal bronchus – It is longer (5 cm), narrower and more oblique.

Each main bronchus divides into lobar bronchi (secondary bronchi), one for each lobe of the lung (3 on right upper, middle, lower and 2 on left-upper, lower).

Again the lobar or secondary bronchi continue to branch, forming still smaller bronchi called tertiary (segmental) bronchi that divides into bronchioles. Bronchioles, in turn, branch repeatedly and the smallest bronchioles branch into even smaller tubes called as terminal bronchioles.

This extensive branching from the trachea resembles a tree trunk with its branches and is commonly referred to as bronchial tree.

Lobar (secondary bronchus) divides in to segmental bronchus, one for each bronchopulmonary segment (10 on right and 8 on left side some authors consider 9 on left side considering left apicoposterior as two segments).

They are –

Right side – Upper lobe (apicoposterior, anterior, superior lingular, inferior lingular).

Lower lobe – (apical, anterior basal, lateral basal, posterior basal).

Each respiratory bronchiole ends in alveolar duct, atrium, air saccule and pulmonary alveolus.

This is called Acinus or Terminal respiratory unit and it takes part in gaseous exchange through the alveoli which are present on the wall of respiratory bronchioles and onward.

From the tracheal bifurcation the smallest bronchi are reached after 8-13 divisions; and terminal bronchioles from the segmental bronchus after 15-25 divisions.

There are about 25,000 terminal bronchi and total number of alveoli has been estimated between $2-6 \times 10^8$.

Airways upto 2 mm in diameter contains cartilage in their wall and those less than 2 mm in diameter lacks cartilaginous support and are, therefore, more readily compressed by dynamic airway changes. Flow in small airways less than 2 mm) is laminar. They contain surfactant in their mucosal which is secreted mainly from type II pneumocytes, although recently another source of surfactant is a surface active material and is responsible for alveolar stability by preventing the peripheral airway collapse.

The elastic property of the lung would ordinarily cause the lung in to collapse, but is prevented by normal negative intra-pleural pressure. The lung elastic recoil brings the lung to end-tidal volume after inspiration.

Relations of Bronchus

Right bronchus

- Anterior* – Right pulmonary artery.
 – Pericardium
 – Lower part of superior vena cava
 – Ascending aorta.
- Superior* – Arch of vena azygos
- Posterior* – Bronchial vessels
 - Posterior pulmonary plexus.

Left bronchus

- Anterior* – Left pulmonary artery
 – Pericardium
- Superior* – Arch of aorta
- Posterior* – Bronchial vessels
 – Posterior pulmonary plexus
 – Oesophagus
 – Descending aorta.

Bronchus is supplied by right and left vagus nerve.

It is supplied by bronchial artery and descending thoracic aorta.

Azygous vein and hemiazygous vein drains the blood.

Applied Anatomy

Due to the greater width and more vertical course of the right bronchus accounts for the greater tendency of the foreign bodies to passes in to right bronchus rather than in to the left.

PHUPPHUSA - LUNGS

तद्वामे फुफ्फुसप्लीहौ दक्षिणाङ्गे यकृत् तिलम् ॥
 उदानवायोराधारः फुफ्फुसः प्रोच्यते बुधेः ।
 रक्तवाहिसिरामूलं प्लीहा ख्याता मर्हषिभिः ।
 यकृदरञ्जकपित्तस्य स्थानं रक्तस्य संश्रयः ।
 जलवाहिसिरामूलं तृष्णाच्छादनकं तिलम् ।

(Sarngadhara Sam. Prathama Khanda, 5/ 79-83)

The *Phupphusa* and *pliha* are present to the left of the *hridayam* (*vamaparshva*), whereas the *yakrita* is seen in the *dakshina parshva*, i.e. to the right of the *hridayam*. The *Kloma* is also seen on the right side.

Aashaya of Phupphusa, Pliha Yakrit and Kloma

Phupphusa is the base of *Udanavayu* (*Kanthasthitavayu*) while *pliha* is the base and origin of the *raktavahsina*. *Yakrit* is the *sthana* for *ramjakapitam* and also for *rakta*, *kloma*, otherwise known as *tilam* is the origin for the *jalavahasira*.

Position of *phupphusa*, *pliha*, *yakrit* and *kloma* according to Shushruta.

तस्याधो वामतः प्लीहा फुफ्फुसश्च, दक्षिणतो यकृत् क्लोम च । (Su. Sha. 4/31)

The *pliha* and *phupphusa* are present to the left side of the *hridayam* and the *yakrit* and *kloma* are present to the right of the *hridayam*. The *pliha* is present below the *hridayam*.

Formation of Phupphusa in the Garba

शोणित फेन प्रभवः फुफ्फुसः ॥

(Su. Sha. 4/25)

The Phupphusa is formed by *shonita phena* (froth of the blood).

The both lungs are the main organs of respiration.

Introduction

Lungs are soft, spongy, elastic respiratory organ situated in the thoracic cavity. The lungs are covered by serous membrane called pleural membrane. The pleural membrane consist of parietal pleura attached to wall of thoracic cavity and visceral pleura covering the lungs. Between them pleural cavity is present which contain pleural fluid. They helps in lubrication and protection of lungs.

In child the lungs are pink, at young age it is brown or grey in colour. Then aged people it will become mottled black due to the deposition of inhaled carbon particles. The left lung weighs about 575 gm and right lung is 50 gm more than left lung e.g., 625 gm. The lung is conical in shape.

Lungs consist of:

1. *Apex* – It is blunt present at superior position.
2. *Base* – It is placed inferiorly diaphragm.

3. Two surfaces:

- (1) Coastal surface
- (2) Medial surface –
 - (i) Vertebral or posterior part.
 - (ii) Mediastinal or anterior part.

4. 3 borders

- a) Anterior.
- b) Posterior.
- c) Inferior.

1. Apex

It is blunt at upper end lies above the first rib. It projects upward in the neck an inch above the medial one-third of clavicle. It is covered by cervical pleura which lies the supra pleural membrane.

It is *Anteriorly* – grooved by subclavian artery.

Posteriorly – structures related from of first ribs.

Laterally – scalenus medius.

Medially – right lung has relation with oesophagus, trachea, bronchiocephalic artery, right brachiocephalic vein.

Left lung has relation with left subclavian artery.

2. Base

It is concave and semilunar in shape. It is intact with the upper cupola surface of diaphragm. The diaphragm separate the left lung from left lobe of liver, fundus of stomach and spleen.

The diaphragm separate the right lung from right lobe of liver.

3. Surfaces**1. Coastal surfaces or lateral surface:**

The lungs are convex and large. It is related to ribs and inter coastal spaces. It contacts with costal pleura and overlying thoracic wall.

2. Medial surface:

It is divided into two parts and has hilus through which nerves and blood vessels enter and exit.

(i) Posterior or vertebral part

It relates with vertebral bodies and inter vertebral discs. It also relates with intercoastal vessel and splanchnic nerves.

(ii) Anterior or mediastinal part

It relates with mediastinal septum, has cardiac impression and hilum. There are many relation between the mediastinal surface ant he two lungs.

4. Borders

(i) *Anterior border*

It is very thin, sharp and also shorter than the posterior border. The antereior border of left lung between fourth and sixth costal cartilage has a wide cardiac notch. Cardiac notch is a place where heart and pericardium is uncovered by lungs. Below the notch, a tongue shaped process called as lingual.

(ii) *Posterior border*

This is thick, present besides the vertebral column. It extends from seventh cervical spine to 10th thoracic spine.

(iii) *Inferior border*

It separates the base from medial and costal surface and it is sharp.

LOBES OF LUNGS

Right Lung

The right lung is broader and thicker shorter then left lung. The right lung is divided in to *three lobes by two fissures*. It is shorter because of liver, but wider due to heart on the left. The capacity is more than left lung.

The three lobes are superior, middle and inferior separated by oblique and horizontal fissure.

The oblique fissure runs at inferior border 2 inches upward and backward, across medial and costal surface. They cut posterior border 2.5 inch below apex and also cuts in to whole thickness of lungs except at hilum.

The horizontal fissure moves horizontally from anterior border in costal surface at fourth costal cartilage. They meet the oblique fissure at mid axillary line.

The middle lobe is bounded by horizontal and oblique lobe and formed a triangular lobe.

Lingula – A tongue shaped projection at left lung below the cardiac notch. It mainly corresponds to the middle lobe of the right lung.

Left Lung

The left lung is divided into upper and lower lobe by oblique fissure. The presence of oblique fissure give uniform expansion to whole lung. This fissure act as a cleavage during inspiration, extends the lungs forwards and laterally by elevation of ribs. They also moves lower part of lungs downward and backward by piston movement of diaphragm.

LOBE OF AZYGOS VEIN

It is accessory lobe. A part of upper, inner surface of right lung is cut off from the rest by double pleural septum, contains its apex the upper azygous vein. This is important as it may causes unusual appearance on chest X-ray.

Structure Related to

Right Lung

1. A hollow out, in front of hilum, mainly relates to atrium, auricle and part of right ventricle called cardiac impression.
2. A ventrical groove is produced by upper part of superior vena cavae and lower part of brachiocephalin vein above cardiac area and infront of hilum.
3. Ascending aorta, inferior vena cava, azygos vein, right phrenic nerve and right vagus are also associated with right lung.
4. right side of trachea, right edge of oesophagus, thoracic vertebrae are some structure relates with right lung.

Left Lung

Cardiac impression is produced by anterior surface by hilum and infundibulum of right ventricle.

Thoracic duct, phrenic nerve, pericardio phrenic vessels, arch of aorta, descending thoracic aorta, left common carotid are some of them related to the left lung.

Root of Lung

This is formed by the structures entering and leaving the lung. It is short, broad pedicle connect mediastinum and medial surface of lung.

The roots are made up of the following structure and these are arranged near the root of the lungs.

The structures are principal bronchus on left side, superior and inferior pulmonary veins, pulmonary artery, bronchial artery, bronchial vein etc.

Left	Right
1. This is longer and narrower.	This is shorter and broader
2. This has one fissure. i.e., oblique fissure.	This has tow fissure. i.e., oblique and horizontal.
3. Left lung has two lobes upper and lower lobe.	Right lung has three lobes superior, middle, inferior.
4. It is smaller and lighter weighs about 550-575 gms.	It is larger and heavier weighs About 600-625 gms.
5. Anterior border is interrupted by cardiac notch.	Anterior border is Straight.
6 . This has four openings (i) Pulmonary artery (ii) Left principle bronchus (iii) Superior pulmonary vein. (iv) Inferior pulmonary vein Hyparterial bronchus.	This has five openings Eparterial bronchus Pulmonary artery Superior pulmonary vein Inferior pulmonary vein
7. Lingula is present.	Lingula is absent.

Difference Between Left and Right Lung

Blood Supply

1. **Bronchial artery** – This is a branch of descending aorta which supplies to bronchial tree and pulmonary tissue.
2. **Bronchial veins** – It drains in to azygos vein on right and hemiazygos on left side.

The alveoli receives deoxygenated blood from terminal branch of pulmonary arteries and drains purified blood in to pulmonary veins which carries them in to the left atrium of heart.

Lymphatic Drainage

The lymphatic of lungs has mainly two plexuses. These are not related to alveoli wall.

1. *Superficial plexuses* – Beneath visceral pleura.
2. *Deep plexuses* – ramification of bronchi.

Nerve Supply

The branch of sympathetic trunk (T2-T5) and parasympathetic trunk which is vagus nerve.

These are afferent and efferent autonomic nerve fibres.

Efferent Nerve Fibres

Sympathetic – bronchodilation and vasoconstriction.

Para sympathetic – broncho constriction, vaso dilation, increased glandular secretion.

Afferent Nerve Fibres

These are bronchial mucous membranes acts as stretch receptor an alveolar wall to CNS and also in case of cough reflex, Dyspnoea in the type of nerve fibres.

Applied Anatomy

1. *Pneumonia* – Inflammation of lung parenchyma is called as Pneumonia.
2. Right lung is more prone to suffer from any type of infection particularly due to mycobacteria tubercle because it is vertical shorter and wider bronchus.
3. Excessive stimulation of parasympathetic neurons of the vagus produces asthmatic syndrome. *E.g.*, breathlessness, wheezing, tightness of chest pain, unproductive cough.

chest X-ray Posteroanterior view shows clear picture regarding the position, size and abnormality of the lung and heart.



VRIKKA - KIDNEYS

रक्तमेदः प्रसादाद् वृक्कौ।

(Su. Sha. 4/31)

It is made from the essence part of shonita and meda.

Kidney is a chief excretory organ of the body. There are a pair of kidney which is retro-peritoneal. The kidney is bean shaped and reddish brown in colour. They lies either of vertebral column, situated opposite to twelfth thoracic and L3 upper lumbar vertebrae. This is located above the waist between the peritoneal and posterior abdominal wall. The kidney is 11 cm in length, 5 cm breadth and 3 cm in thickness.

The kidney has

Two poles – upper and lower poles.

Two borders – medial concave and lateral convex.

Two surfaces – anterior and posterior.

The kidney occupies hypochondrium, epigastric, lumbar and umbilical regions. The upper pole is broad and contact with suprarenal gland and lower pole is pointed. The anterior surface is irregular and posterior surface is flat.

The right kidney lies little lower than the left as it is occupied by right lobe of the liver.

The average weight of kidney for males is 150 gms and female is 135 gms.

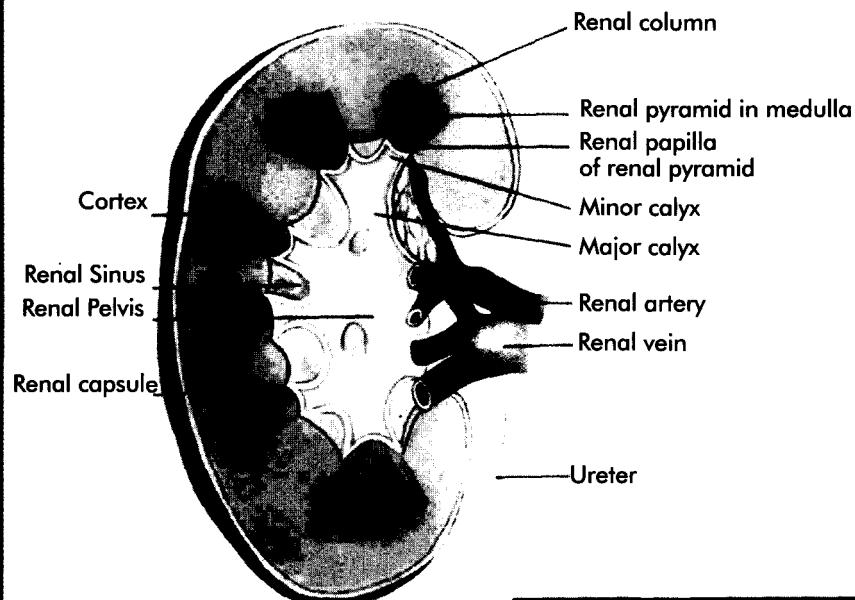
In foetus, the kidney has twelve lobules which gradually fuse and become smooth uniformly in adult. This evident of foetal lobes can persist.

The right kidney lies on eleventh upper border of rib and left kidney on 11th lower border of rib.

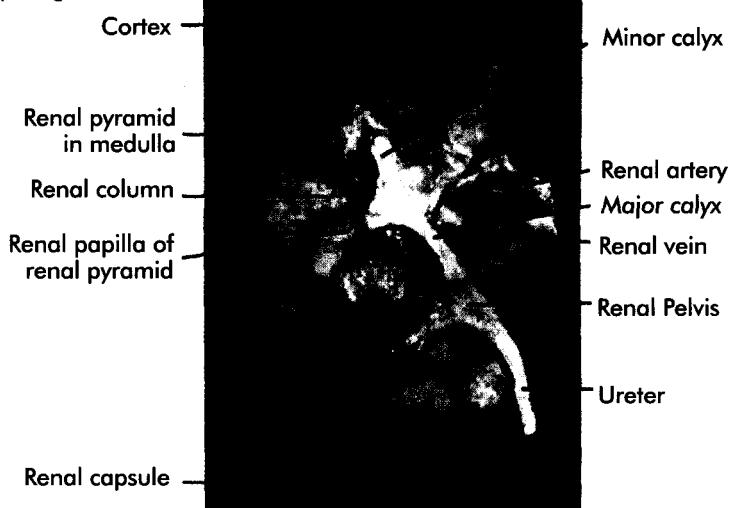
At the center, there is a helius in vertical cleft on concave medial border facing vertebral column.

The transpyloric plane lies on the upper part of right kidney and lower part of left kidney.

Coronal Section of Right Kidney



(a) Diagram



Transverse axis is directed laterally and backward.

The pelvis of kidney lies opposite to the first and second lumbar transverse process.

The structure seen in the hilum are:

1. Renal artery
2. Renal vein
3. Renal pelvis.

The hilus leads to a cavity in kidney known as renal sinus.

Surface of Kidney

The various tissues that covers the kidney are:

(i) Fibrous or Renal capsule

The thin inner most layer which is smooth, transparent and fibrous. It is easily stripped from the kidney but it will not be stripped in diseased stage. This mainly acts as a barrier and spread of infection to the kidney.

(ii) Perirenal or Perinephric or Adipose Capsule

This is the middle layer which contains adipose tissue lies outside the renal capsule. It is thickest. They also protect and hold firmly in abdominal cavity as it is solid at body temperature. It mainly fills extra space in renal sinus.

(iii) Renal Fascia

It is a dense irregular, thin outer most layer of kidney. This is a fibro aerolar sheath that surrounds the kidney and perirenal fat. This is mainly formed by condensation of perinephric fat. This is mainly formed by condensation of perinephric fat at periphery. Numerous trabeculae connect renal fascia to fibrous capsule across perirenal fat.

It consists of *two layers*.

They are:

Anterior layer (fascia of Toldt)

Posterior layer (fascia of Zuckerkandl)

The arrangement of the layer are:

- (i) *Superiorly* – There are two layers, first cover suprarenal gland in separate and fuse with other layer, then continuous as fascia, under aspect of diaphragm.
- (ii) *Inferiorly* – Anterior and posterior layers which open into the ureter where anterior layer merges with extraperitoneal connective tissue of iliac fossa, and posterior layer binds with fascia iliac.

(iii) *Medially* – The anterior layer is thin and ill developed. The posterior layer is thicker and well developed, they fused with fascia covering the quadratus lumborum and psoas major and vertebrae also invertebrae disc.

Medially both merge with tunica adventitia of renal vessels and inferior vena cave and connective tissue round aorta.

(iv) Pararenal or Paranephric Body

This consist of variable amount of fat lying outside the renal fascia. It mainly lies posteriorly and towards lower pole of kidney. This form cushion of the kidney.

Structure

There are three prominent layers:

- (i) Outer, reddish brown cortex.
- (ii) Inner, pale medulla.
- (iii) Space, the renal sinus.

(i) Cortex

The renal cortex is divided in to two parts:

1. *Cortical arches or cortical tubules* – they forms caps over the renal pyramids.
2. *Renal columns* – They dip in between the pyramids. It is streaked, granular and paler in appearance.

(ii) Renal Medulla

They are made up of conical masses called the renal pyramids and are separated each other by renal columns. The apices form the renal papillae.

(iii) Renal Sinus

The space in to which hilum lead and contains renal artery, renal vein and renal pelvis.

(iv) Renal Pelvis

It is formed by union of two or four major calices. Minor calyx is indented in to three renal papillae.

The kidney is composed of one to three million uriniferous tubules. It mainly consist of two parts which are embryologically distinct.

- (a) The secretory part – It contains mainly nephrons which is the functional unit of kidney, which forms the urine.

- (b) They in turn opens in to collecting tubules. The tubules unite to form ducts of Bellini which opens in to minor calices through renal papillae.

Relations of the Kidney

Both the kidney is related to corresponding supra renal gland. The lower pole lie one inch above iliac crests.

They have

Four Muscle

Diaphragm, Psoas major, Quadratus lumborum and Transverse abdominis.

Three nerves

Subcostal, Ilio inguinal, Ilio hypogastric.

Two ribs

- (i) Eleventh and twelfth on left side (ii) Twelfth on right side.

Two ligaments

Medial and lateral arcuate ligament subcostal artery and vein.

The anterior relation will be differ on two side

Anterior relation of right kidney

1. *Upper pole* – Supra renal gland and inferior surface of right lobe of liver.
2. *medial border* – Descending or second part of duodenum
3. *Inferior border* – Hepatic flexure of colon, coils of jejunum.

The area of liver and small intestine are covered by peritoneum.

4. Lateral border – Right lobe of liver, hepatic flexure of colon.

Relation of The Left Kidney Anterior

1. Upper medial border – Suprarenal gland.
2. Upper later half – Spleen.
3. Upper – Stomach of triangular area.
4. Pancreas.
5. Lower part – Upper jejunum.
6. Left colic flexure and descending colon.

Hilum of Kidney

Renal vein, anterior renal artery, pelvis of ureter and posterior renal artery enter in the hilum.

Blood Supply

- (i) *Renal arteries* – They are branch of abdominal aorta, inferior supra renal artery to supra renal gland.
- (ii) *Renal veins* – Right renal vein drain in to inferior vena cava.
Left renal vein

Lymphatic Drainage

The lymphatic of kidney drain in to the lateral aortic nodes.

Nerve Supply

Sympathetic – T10- L1 chiefly vasomotor.

Afferent nerve belong to T10 – T12.

Parasympathetic – Vagus fibres.

Applied Anatomy

1. *Congenital polycystic kidney* –
Non union of secretory and collecting part of kidney.
2. *Horse shoe kidney* –
Fusion of lower poles of kidney in which ureters pass anterior to isthmus of kidney.
3. Early pelvic portion may persist in which renal artery then arises from common iliac artery.
4. Aplasia or hypoplasia may also occur.

NEPHRON

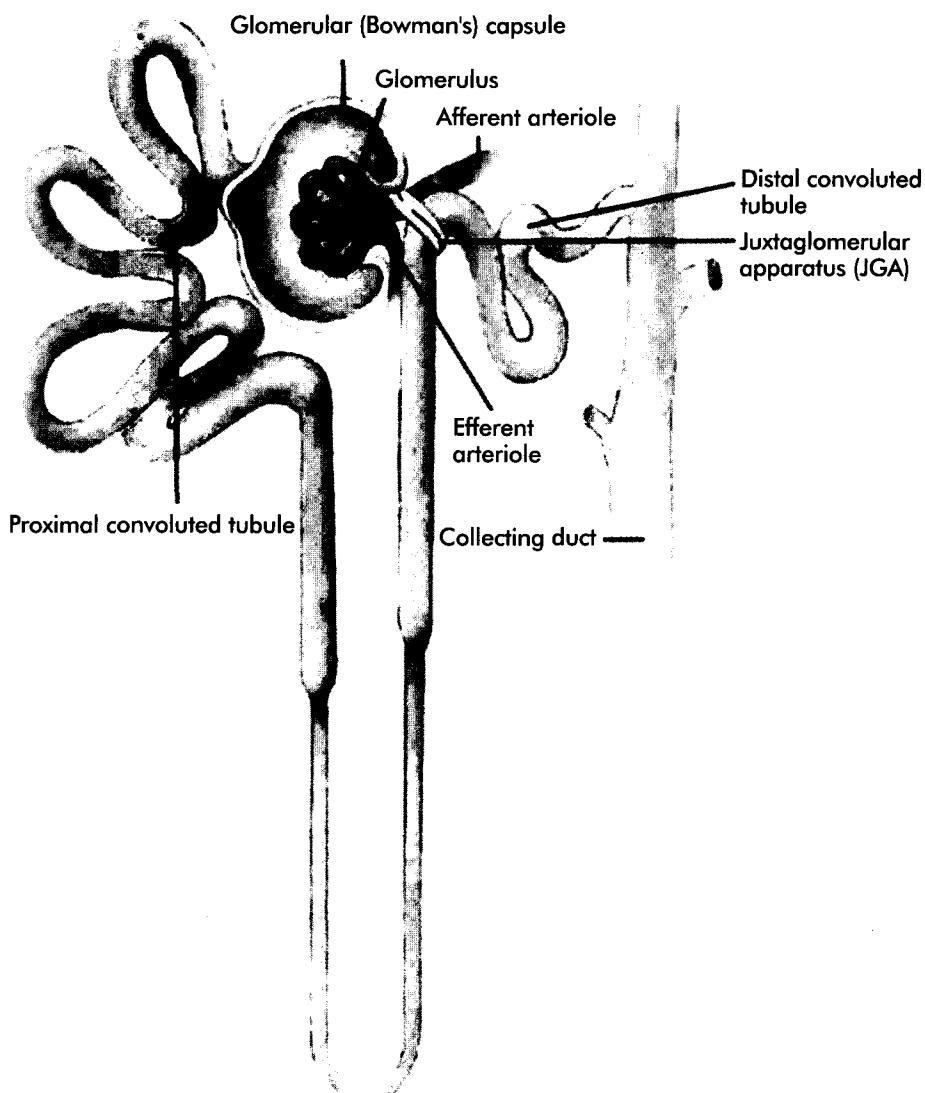
This is the structural and kidney in to a half by sagittal section. On the inner part of the kidney tissue there is a pyramid like isolateral masses of present and their bases directed towards the cortex. These masses of pyramids are called as medulla, but the colour is the medullar paller in relations to the cortex.

Some medullary substances extend in to the cortical masses from the bases of the pyramids in the form of rays known as medullar rays.

Apices of pyramids are fitted in to the concavity (hilum) of the kidney.

By a small mass of cortical tissue, the pyramids of kidney are separated known as Column of Bertin.

Nephron



Normally the apices of pyramids unit to form papillae which are many.

By the fusion of many papillae minor calyces are formed.

By the fusion of minor calyces major calyces are formed.

By the union of all major calyces, pelvis of ureter is formed.

The whole spectrum of description of the cut surface of the kidney has been follows.

Structural and functional units of kidney are nephron.

Again, each nephron consist of four typical parts and they are as follows:

1. The glomerulus and Bowman's Capsule (Present in the renal or Malpighian Corpuscle).
2. Proximal Tubule
3. Loop of Henle.
4. Distal Tubule

Nephron does not include collecting tubule, so this collecting tubule are discussed in separate heading.

Collecting Tubules

- They are not a part of nephron. But they described as a system of drainage ducts in to which urine is delivered from distal tubules.
- The length of collecting tubule in nephron is about 20 mm.
- The total length of nephron including collecting tubule 45-65 mm.
- Again, the distal tubules unit to form collecting ducts.
- Large ducts are known as Ducts of Bellini, are formed by coalesces of smaller collecting tubules.
- These ducts of Bellini is drained in to apex of a pyramid.
- Each nephron is provided with a collecting to pass urine in to a renal papillae.

Vascular system of the kidney have some peculiarities.

- At the hilum of the kidney, renal artery is divided in to anterior and posterior divisions.
- Usually, the anterior division gives three branches and posterior divisions gives two branches.
- Each posterior branch is divided into inter lobular arteries.
- Inbetween the spaces of two pyramids, each inter lobular arteries passes to form an arch (arcuate line).
- These inter lobular arteries are formed after being divided in to branches on the convex surface of the pyramid and form the convex side of the arcuate artery.

- At right angles, afferent arterioles are takes origin form each inter lobular artery.
- Afferent arterioles are divided in to multiple capillary plexus.
- Each capillary plexus is known as Glomerulus, which remains contat with blind proximal end of the tubule.
- Bowman, the renowned physiologist, shown the relationship between the renal tubule and the glomerulus.

According to him, only water is filtered through glomerulus in to the tubule.

But, according to Ludwig, water with electrolyte are filtered through the glomerulus from the plasma in to the tubule.

- There is a cup shaped depression present at the expanded blind end of the proximal tubule is called bowman's Capsule, where the glomerulus is lodged.
- The blind end of the tubules has two layers i.e, Parietal and Visceral layer.
- But the glomerulus with Bowman's Capsule is described as Malpighian Corpuscle.
- Near the capsule of the kidney, there is 85% of real corpuscles are present with in the cortex.
- But at the junction of the cortex and the medulla 15% of the renal corpuscles are present which is known as Juxta-medullary renal corpuscles.

Nephron is classified into two groups

1. Superficial Cortical Nephron.
 2. Juxtra-Medullary Nephron.
- The lining layer of glomerulus is made by endothelial cells which rest on basement membrane and a gap is present between two end of endothelial cells.
 - Visceral layer of Bowman's Capsule is lined with endothelial cells which are described as Podocytes, which rest on basement membrane of endothelial cells of tuft of capillaries.

Renal Tubule

It is 3 cm in length and is continued directly from the lumen of the bowman's capsule. It consist of three segments are:

1. Proximal Convulated tubule.
2. Loop of Henle.
3. Distal Convulated tubule.

Proximal Convulated Tubule

Its initial part is present within the cortex and it is 14 mm in length.

- Here, the inner lining cells are low columnar and brush borders which are present on the laminal surface of the said cells.
- The surface area of the said tubular cells is increased due to presence of brush borders, for the purpose of reabsorption.
- The proximal convoluted tubule has an extensive role for the function of reabsorption.
- The variable arrangement of the said tubule makes a key role for the reabsorption of water and other small molecular solutes.
- Due to the fact, the cell cytoplasm of the proximal tubular cells has large number of mytochondria, it is seen on its terminal portion of this tubule, it is straight and it descends downwards from the cortex to the medulla to become Loop of Henle.

Loop of Henle

- It penetrates in to the medulla, which is arising from juxta medullary glomerulus which extends up to the apex of the medulla.
- From the superficial cell cortical glomerulus, again loop of henle arises and extends upto superficial part of medulla.
- The first part of the descending limb of the loop of henle is a continuation of proximal convoluted tubule.
- The cells lining the thin segment of descending limb of loop of henle is squamous.
- The first portion of ascending limb, the cell lining of the said segment is similar to this segment of descending limb.
- By the lining of low columnar cell, the ascending limb shows thicker walls and this portion of loop of henle has some peculiarity *i.e.*, it is impermeable to water, but permeable to Na + ion.
- Its length is about 12 mm.
- Due to the presence of mitochondria the loop of henle plays a minimum role in reabsorption.
- The lining cells of the segments have no brush borders.

Distal Convoluting Tubule

- It is about 5 mm in length.
- It begins from the macula densa and ends to a collecting tubule.
- The lining cells of distal convoluted tubule is low columnar.
- The distal convoluted shows minimum reabsorption function because the number of brush borders on the luminal surface of these lining cells are negligible.

Collecting Tubule

The distal convoluted tubule ultimately end in collecting ducts, which drains in to the apices of the pyramids which form the renal pelvis.

The lining cells of collecting ducts are tall – columnar and there are no brush borders on the luminal surface of the lining cells.

GAVINI – URETERS

The ureter is a pair of narrow thin walled muscular tube extends between kidney and urinary bladder.

The ureter is 25 cm long in which upper held lies in the abdomen, and lower held in the pelvis. It is about 3 mm in diameter.

The ureter begin in the renal sinus as renal pelvis which is funnel shaped dilation. From pelvis tissue the hilus of kidney, it runs downward and medially then enter in to pelvic cavity.

Normal Constriction

The ureter has a slight constriction at three places:

- (a) Pelvic ureter junction,
- (b) Brim of lesser pelvis,
- (c) Its passage through urinary bladder wall.

Relation

i) Renal Pelvis

- (1) Renal sinus, Branch of renal vessels
- (2) *Posteriorly* : Psoas major muscle
- (3) *Anteriorly*

On right side – Renal vessels and second part of duodenum.

On left side – Renal vessels, pancreas, peritoneum and jejunum.

ii) Abdominal Part of Ureter

Right side Anteriorly – Third part of duodenum and peritoneum root of mesentery.

Right colic, ileocolic and gonadal vessels.

Terminal ileum.

Left side anteriorly – Peritoneum
Left colic vessels
Testicular artery
Sigmoid colon and sigmoid mesocolon.

Medially Right side – Inferior vena cava.

Left side – Left gonadal vein.
Inferior mesenteric vein.

Posterior: Psoas major,

Tips of transverse processes.

Genitofemoral nerve.

Pelvic Region

In forward course

In males (i) Ductus deferens. (ii) Seminal vesicle.
(iii) Vesical vein.

In female (i) Uterine artery.
(ii) Utrine lies about 2 cm lateral to supra vaginal portion of cervix.
(iii) Terminal portion of ureter lie anterior of vagina.

Intra Vesical Part

The ureter has valvular action, prevents regurgitation of urine from bladder to ureter.

Blood Supply

Renal artery, common iliac artery, gonadal artery, abdominal aorta.

Nerve Supply

Sympathetic T10-L1

Para sympathetic S2-4 nerves.

They reach the ureter through the renal, aortic and hypogastric plexuses. The nerves are sensory in function.

Lymphatic Drainage

Para-aortic and common iliac nodes.

Applied Anatomy

Renal colic

This term is used for severe pain due to ureteric stone which causes spasm of ureter.

BASTI (MUTRASHAYA) - URINARY BLADDER

मूत्राशयो धनुर्वक्रो बस्तिरल्पाखमांसगः ॥

एकाधेवदनो मध्ये कट्याः सद्यो निहन्त्यसून् । (As. Hr. Sh. 4/10-11)

अल्पमांसशोणितो आध्यन्तरतः कट्यां मूत्राशयो बस्तिः (Su. Sh. 6/25)

The *mutrashaya* otherwise known as the *basti* it is one of the *marma (trimarma)* and it is also a *pranayatana*. Hence, any injury to the *basti* leads to immediate death *saddomarana*.

मूत्राशयो मलाधारः प्राणायतनमुत्तमम् ।

(Su. Ni. 3/20)

नाभिपृष्ठकटीमुष्कगुदवङ्क्षणशोफसाम् ।

एकद्वारस्तनुत्वक्रो मध्ये बस्तिरथोमुखः ॥

(Su. Ni. 3/18)

The *basti* is present in the middle of the *kati*, surrounded by *mushka*, *guda*, *vankshana*, *shepha* etc., it has only opening (*dvara*) in its lower portion. It is covered by a very thin layer of skin. The *basti* does not contain much of *mansa shonita*.

Related structures:

बस्तिर्बस्तिशिरश्चैव पौरुषं वृषणो गुदः ।

एकसम्बन्धिनो ह्यते गुदास्थिविवराश्रिताः ॥

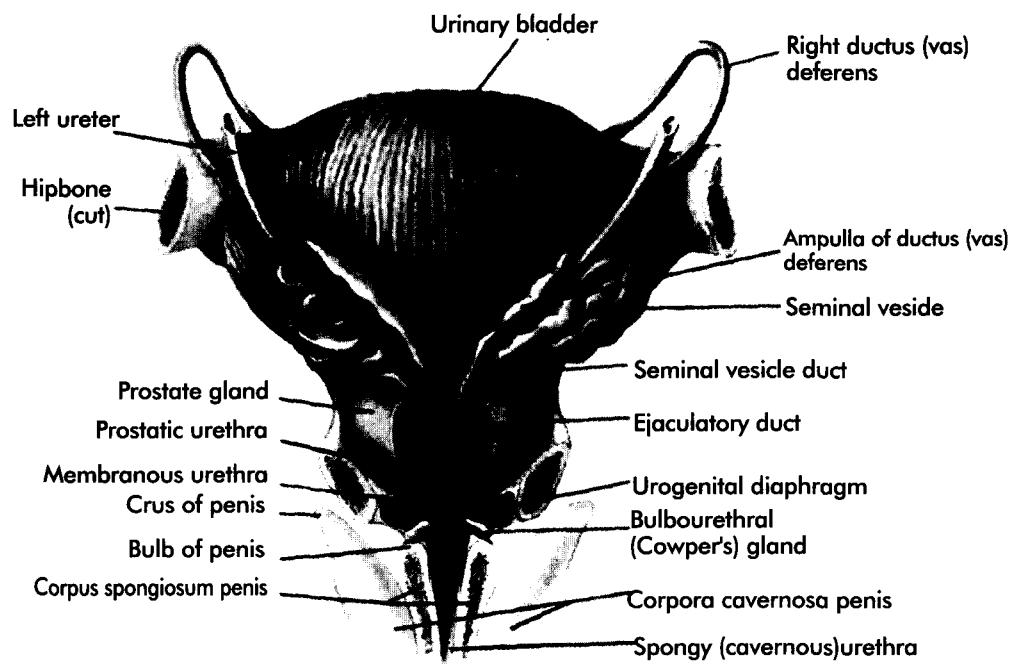
(Su. Ni. 3/19)

These are the following related structures of *Basti-mushka*, *guda*, *vankshana*, *shepha*.

Location

The urinary bladder is a hollow muscular organ situated retroperitoneally in the pelvic cavity, posterior to pubic symphysis.

Urinary Bladder with Reproductive Organs—Male



In males, it is directly anterior to rectum. In females, it is anterior to the vagina and inferior to uterus. It is a freely movable organ held in position by folds of peritoneum.

Size and Shape

The shape of urinary bladder depends on how much urine it contains. In empty, it is collapsed and lies within pelvis. It becomes spherical when slightly distended. As urine volume increases, it becomes pear shaped and rises into abdominal cavity. In general, bladder capacity is smaller in females because the uterus occupies space just below bladder.

External Features

Empty bladder is trihedral and has

(a) Apex

Which directed forwards and situated where superior and infero lateral surface meet, and is connected to umbilicus by median umbilical ligament.

(b) Base or Posterior Surface

Female – It related to uterine cervix and vagina.

Male – The upper part is separated from rectum by retrovertical pouch and contained coils of intestine.

The base is directed backwards and slightly downwards it is a triangular shape which opens in to supero-lateral angles.

(c) Neck

It lies below the lowest part of bladder, when it distends and fixed at neck because of ligamentum attachment.

Female – Neck and Urethra are connected by pubovesical ligaments.

Male – Neck related to prostate and puboprostatic ligament.

(d) Bladder has three surfaces

- (i) Superior
- (ii) Right
- (iii) Left infero lateral.

Superior Surface

It is a triangular in shape and bounded on each side by the lateral borders which extends postero-laterally from ureteric orifices.

Infero-Lateral Surface

These are devoid of peritoneum and separated anteriorly by anterior border and superior surface by lateral border.

Relations

Posterior Surface or Base

Male – peritoneum covering a small triangular area in the upper most part by ductus deferens and seminal vesicles thy diverge to leave a triangular area in direct relation to rectum.

The rectovesical fascia, it innervates between the ductus deference and seminal vesiclea and the rectum.

Female – Related to anterior wall of vagina and its anterior fornix.

Superior Surfaces

Males – Completely covered by peritoneum and related to pelvic colon and coils of ileum.

Females – Peritoneum is reflected to isthmus of uterus to form uterovesico pouch. It is related to supravaginal cervix, body of uterus.

Infero-Lateral Surface

Males – Retropubic space (or retzuis) containing loose fatty tissue and perito vesical and puboprostatic ligament.

Females – Contains pubovesicral ligaments and except puboprostate ligaments are replace by pubovesical ligament.

The boundaries of the cave of retzuis, which is a prevesical space are:

Anteriorly – They from posterior surface of pubis and posterior sheath of rectus abdominis.

Posteriorly – Infero lateral surfaces of urinary bladder.

Superiorly – Reflection of peritoneum from superior surface.

Inferiorly – Puboprostatic or pubovesical ligaments.

Ligaments of Bladder

These are divided in to true and false ligaments which supports the bladder.

True Ligament

They form by condensation of pelvic fascia.

The lateral true ligament extends from side of the bladder to the tendinous arch of

the pelvic fascia.

Males – Puboprostatic ligaments –

Lateral puboprostatic ligament – directed medially and laterally.

Medial puboprostatic ligament – directed downward and backwards.

Lateral Puboprostatic Ligament

It extends from anterior part of tendinous arch to pelvic fascia to where it meet the upper part of prostatic sheath.

Medial Puboprostatic Ligament

It extends from back of pubic bone to prostatic sheath. These ligaments forms floor of retropubic space.

In females, bonds similar to puboprostatic ligament are known as pubovesical ligament which are situated between pubis and bladder.

The posterior ligaments of bladder is directed backwards, upwards along the visceral plexus of veins and they form neurovascular pedicle which contains nerve plexus, ureter.

In males they include vas deferens.

False Ligament

These are peritoneal folds, which do not form any support.

Median Umbilical Ligament

These are peritoneal fold, which is remnant of urachus, if stretches from apex of bladder to umbilicus.

Lateral Umbilical Ligament

It formed by peritoneum of paravesical fossa. It does not support but it maintain the bladder against the anterior abdominal wall when bladder fills it rises out of pelvis.

Posterior False Ligament

Formed by peritoneum of sacrogenital folds (passing backwards to sacrum).

Interior of Bladder

In the floor of urinary bladder is a small triangular area the trigone, which as apex of triangle is the internal urethral orifice and base which lines the urethral orifice between the orifices the ureter there is a ridge called inter uretic ridge or bar of mercier due to presence of transverse bands, the ureteric ridge (its function is not clear, may be to urethral orifice) produced by terminal intravesical parts of ureter.

Males - Above and behind the internal urethral orifice shows a bulge known as uvula vesicae produced by media lobe of prostate.

Structure

Three coats make up the wall of urinary bladder.

Mucosal

The inner most coat is a mucous membrane composed of transitional epithelium and an underlying lamina propria.

Surrounding the mucosal is a muscular layer called detrusor muscle.

It contains three layers of smooth muscle fibres are:

1. Inner longitudinal layer.
2. Middle circular.
3. Outer longitudinal.

Around the opening to the urethra, the circular fibres form an internal urethral orifice, in males to provide an internal urethral sphincter muscle (it prevents seminal regurgitation in to bladder).

In both sexes, levator- ani passes close to urethra, it exerts a pincer action, which can be used to inter up urinary stream.

Inner layer consists of separate long or oblique stands. The outermost coat is formed by peritoneum on the superior surface of bladder.

Serous layer is thick connective tissue layer, with the same coat of the ureters.

Micturition

Urine is expelled from the urinary bladder by an act called micturition. Commonly known as urination or voiding. This response is brought by involuntary and voluntary nerve impulse these nerve impulse, by way of sensory tracts to cortex, initiate a conscious desire to expel urine and by way of a center in the sacral spinal cord, a reflex and micturition reflex.

Parasympathetic impulse from the micturition reflex center of the spinal cord conduct to the urinary bladder wall and internal urethral sphincter.

They cause contraction of the detrusor muscle and relaxation of the internal urethral sphincter.

Then the cerebral cortex of the brain permits voluntary relaxation of the internal urethral sphincter.

Bladder emptying may be assisted by contraction of abdominal wall, and the urethral is cleared by the bulbospongiosus muscle.

Blood Supply

Artery

Superior vesical artery supplies the upper part of bladder.

Inferior vesical artery supplies to the base of bladder.

Obturator, inferior gluteal, uterine and vaginal arteries gives small continuation to lower part of bladder.

Veins

Vesical venal plexus which supplies veins to urinary bladder and drain in to internal iliac veins.

Lymphatic Drainage

Lymphatic vessels drain in to

Internal iliac nodes

External iliac nodes

Nerve Supply

Sympathetic – pedendal nerve S2, S3, S4 supply nerves to para urethral striated muscle and striated external sphincter urethra.

(i) Sympathetic having supply to both efferent and afferent fibres.

Efferent –

The efferent fibres from T11 - L2 segments pass by way of hypogastric plexus.

Afferent –

Carrying pain and perception to bladder fullness reaches, T12-L2 conducted by sympathetic fibres in hypogastric nerves.

ii) Parasympathetic –

Efferent - the efferent fibres from S2,S3 and S4 (pelvic splanchnic or nervierigenetes)
Afferent - convey sensation of pain and bladder sensation.

MUTRAPRASEKA – URETHRA

It is a small tube leading from the floor of the urinary bladder to the exterior of the body.

Male Urethra

Size – 20 cm long *i.e.*, 8 inches.

Location – It is present immediately below the urinary bladder it passes vertically through the prostate gland (prostate urethra), then pierces the urinogenital diaphragm (membranous urethra) and finally pierces the penis (spongy urethra) where it has J-shaped 2 curvatures and takes a curve through its body and becomes J-shaped.

Prostatic Urethrae

Being at internal urethral orifice and runs vertically downwards through an anterior part of prostate.

Size and Length

It is widest and most dilated past, where it's part is wider in middle and narrow part which joins the membranous urethra. It is 3 cm long.

Features

On transverse section it is star shaped. Its posterior (part) wall shows for features.

Urethral crest (or) verumontanum

It is a medial longitudinal ridge of mucous mentrium.

Colliculus seminalis is an elevation on middle of urethral crest.

Opening of prostatic utricle, it is a blind sac. On above, elevation, it shows a slit like orifice through which the prostatic utricle opens in to urethra. The utricle is an embryological remnant resulting from union of caudal ends of paramesonephric (mullerian) ducts. It is homologue of female uterus.

Opening of two ejaculatory ducts one on each side of opening of prostatic utricle.

Prostatic sinus, a depression on each side of urethral crest which opens in to ducts of prostatic gland.

Blood Supply

Arteries – supplying the prostate are:

Mainly – Inferior vesical

– Medial rectal – Internal pudendal

Veins

Vesico-prostatic plexus (a groove between prostate and urinary bladder).

Nerve Supply

Sympathetic – Supply from inferior hypogastric plexus.

Para sympathetic – Supply from pelvic splanchnic nerves.

Lymphatic Drainage

Into internal iliac nodes and sacral nodes.

Structure of Prostate

It consists of

1. Fibrous tissue stroma
2. Smooth muscle
3. *Glandular tissue* – These are tubulo alveolar type and are two zones.

Outer zone

It consists of main glands which form bulk of prostate and their curving ducts open in to prostatic sinus.

Inner zone

It is periurethral. These are su-mucosal or mucosal. These glands of outer zone open in to prostatic sinus.

Mucous glands, separate and distinct from the prostate, subtrigonal and sub cervical in position lie in middle lobe. These are known as Glands of Albaran.

Membranous Urethra

Length and Course

It is 1.5 - 2 cm long and runs downward and obliquely forward through deep perineal space and pierces the perineal membrane and below the pubic symphysis.

Size

This is narrowest and least dilated part of male urethra.

Features

It is surrounded by sphincter urethra or external urethral sphincter.

The bulbourethral glands of cowper are placed one on each side of the urethra, although their ducts open in to spongy part after pierces the perineal membrane numerous urethral glands opens in to this urethrae.

Nerve Supply

Sympathetic – external urethric sphincter or sphincter urethrae.

Para sympathetic – supplied by perineal branch of the pudendal nerve (S2-S4) it controls the voluntary holding of urine.

Lymphatic Drainage

Internal iliac nodes

External iliac nodes – pathway.

Spongy/Penile Urethra

Length and Course

It is 15 cm long and has a fixed part which runs forwards and upwards in the bulb of penis. It bends downwards in front of lower part of pubic symphysis to continue as a free part and lies in corpus spongiosum and it terminates at external urethral orifice which located at tip of glans penis.

Size

It is narrow and 6mm in the body of penis.

It is dilated at,

- The commencement, to form the intrabulbar fossa, which bulges in to floor.
- Within glans penis to form the navicular or terminal fossa which bulges in to roof.
- The external urethral orifice is narrowest part.

Features

The ducts of bulbourethral glands opens in to fixed part of penile urethral about 2.5 cm below perineal membrane.

It has glands called urethral glands or litter glands.

Along these glands, several pits like recess or lacunae of Morgani, which is obliquely opened forward.

One lacunae is roof of navicular fossa is the largest and known as lacunae magna or sinus of guerin.

Nerve Supply

Sympathetic – Supplied from lower thoracic and upper lumbar segments of spinal cord.

Parasympathetic – Perineal branch of Pudendal nerve (S2 to S4)

The internal urethral sphincter or sphincter vesicae are involuntary in nature.

Lymphatics

Mostly – Inguinal nodes

Superficial inguinal and external iliac nodes partly.

Female Urethra

The urethra lies directly posterior to pubic symphysis. Its length is approximately 4 cm (1.5 in).

It is directed obliquely inferiorly and anteriorly and the exterior opening is the external urethral orifice (epithelium is non keratinised stratified squamous) and is located between the clitoris and vaginal opening.

The female urethra consists of

Mucosal layer.

Superficial muscularis.

Mucosa is mucous membrane, composed of epithelium and lamina propria.

The muscularis consists of circularly arranged smooth muscle.

YONI – THE VAGINA

Terms

Colposcopy, colpotomy and colporrhaphy

Kolpos- vagina (sheath).

The vagina is lower part of female genital tract, which is fibromuscular canal.

Location

Extends from the vulva to uterus marking angle of 90° and is situated behind the bladder and urethra because of slight forward concavity and in front of rectum and anal canal.

Size and shape –

Anterior wall – 8 cm long.

Posterior wall – 10 cm long.

Diameter gradually increases from below upwards. (The upper is 5 cm twice to lower i.e., 2.5).

The upper vagina surrounds the lower cervix above external os. The four recess around the cervix are known as anterior, posterior and lateral fornices related to anterior, posterior, lateral part of vagina.

The lumen is circular at the upper end because of protrusion of cervix in to it, below to it posterior and anterior wall are attached with each other, so that lumen is transverse slit in middle part, H shape in lower part.

In virgin

Lower end is particularly closed by a thin anular fold of mucous membrane called hymen.

Married Women

The hymen is represented by rounded elevations around the vaginal orifice, the caruncle hymenale.

Fornices of Vagina

The interior of the upper end of vaginal vault form of a circular groove, the groove becomes deeper from by backwards and divided in to four parts called vaginal fornices.

Anterior fornices – Infront of cervix and is shallowest.

Posterior fornices – Behind the cervix and is deepest.

Lateral fornices – Lie one on each side of cervix.

Relations

Anterior wall –

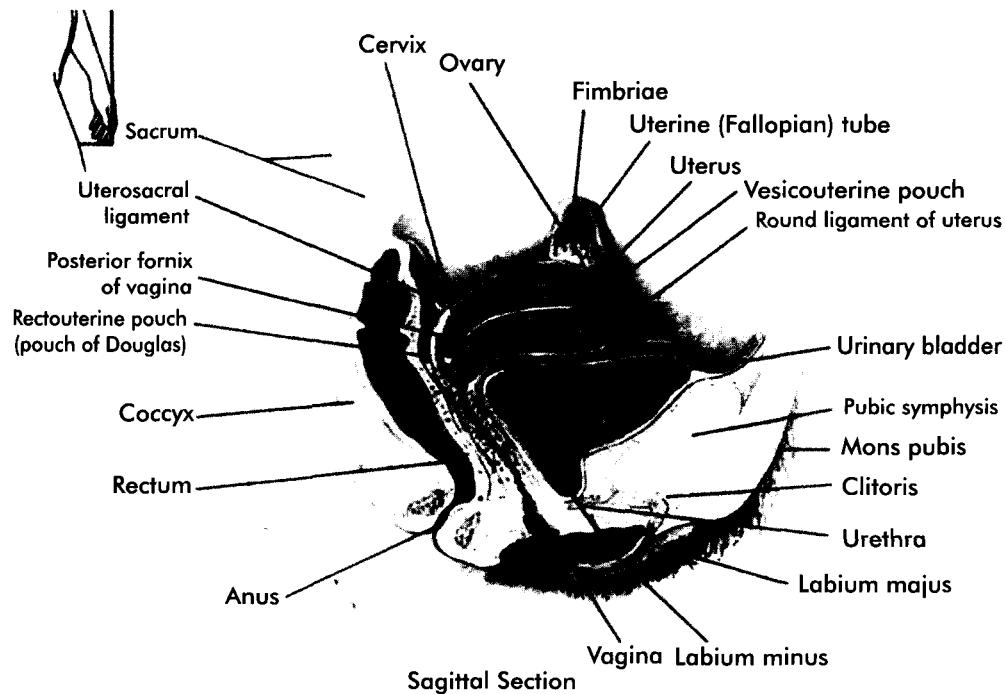
Upper half – related to base of bladder

Lower half – related to urethra.

Posterior wall –

One-fourth is separated from rectum by rectouterine pouch.

Sagittal Section of Female Reproductive System



Middle two-fourth separated from rectum by loose connective tissue. This rectum is separated by uterorectal septum.

Perineal body separates lower vagina from anal canal.

Lateral wall –

Upper One-third related to transverse cervical ligament of pelvic fascia.

Middle One-third related to pubococcygeous part of levator ani or pubo vaginalis part of levator ani.

Lower One-third pierces the urogenital diaphragm, below the levator ani or bulb of vestibule, the bulbospongiosus and the greater vestibular gland of Bartholin.

Histology

Mucous membrane is lined by non keratinized stratified squamous epithelium.

Lamina propria is made up of loose connective tissue.

Muscular coat consists of an outer longitudinal and inner circular layer.

Outer fibrous coat is the usual connective tissue.

There are no glands in vaginal mucosal. It is kept moist by cervical glands.

The vaginal fluid is acidic in nature, because the fermentation of glycogen (in vaginal cells) by Döderlein's bacilli.

Blood Supply

Arteries

Vaginal artery

Vaginal branch of uterine artery.

Vaginal branches from internal pudendal.

Veins

Internal iliac veins.

Lymph supply

One-third into external (and internal iliac nodes) iliac nodes.

Middle One-third into internal iliac nodes.

Lower One-third into superficial inguinal nodes.

Nerve Supply

Sympathetic – Upper two-third is supplied from fibres from the uterovaginal plexus.

Parasympathetic – S2-S4 nerves.
 (afferent travel along nervi evigints)
 lower One-third supplied by pudendal nerve.

OVARIES

The ovaries are female gonads, a pair of organs producing the oocytes and important hormones which act on uterus.

Position

Each ovary lies in ovarian fossa on lateral pelvic wall between the uterus behind and broad ligament in front. The ovarian fossa is bounded,

Anterior – Obliterated umbilical artery.

Posterior – Ureter and internal iliac artery.

Shape and Size

It is 3 cm long, 2 cm wide, 1 cm thick.

Nulliparous women

Its long axis is nearly vertical, so that the ovary is usually having upper and lower pole.

Multiparous Women

Its long axis becomes horizontal, so that upper pole points laterally and lower pole medially.

Young Girls

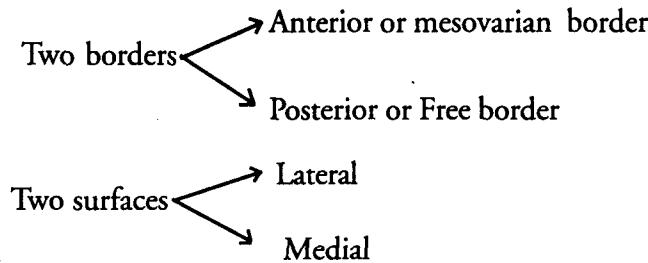
By the onset of puberty, the ovaries have smooth surface, which are greyish pink in colour.

After Puberty

The surface became uneven and colour changes from pink to grey.

Each ovary has two poles.

Upper or tubal pole and lower or uterine pole



Peritoneal Relations

The ovary is almost covered by peritoneum except mesovarian or anterior border where the two layers of the covering peritoneum are reflected on to posterior layer of uterus.

But ovary is connected to posterior layer by a short fold of peritoneum called mesovarium, it transmits the vessels and nerves to and from the ovary.

The lateral part of broad ligament of uterus extending from infundibulum of uterine tube and the upper pole of ovary to external iliac vessels, forms a distinct fold known as suspensory ligament of the ovary or infundibulam pelvic ligament, which contains ovarian vessels and nerves.

Visceral Relations

Upper or tubal pole

Conducts ovarian vessels and lymphatics.

Closely related to lateral end of uterine tube and external iliac vein, one of whose fimbriae is attached to ovary.

Lower or uterine pole

Connected to lateral margin of uterus near by the fundus by ligament of ovary.

Anterior or mesovarian

It is attached to posterior layer of broad ligament by a fold of that layer, mesovarium, containing the blood vessels and nerves of ovary.

Posterior or free border

It is free and related to uterine tube.

Lateral surface

It is related to ovarian fossa lined by parietal peritoneum. The peritoneum separates the ovary from obturator vessels and nerves.

Median surface

It is largely covered by uterine tube. The peritoneal recess between the mesosalpinx and this surface is known as ovarian bursa.

Histology

Germinal epithelium of cubical cells derived from peritoneum.

Tunica albuginea is a thin layer of connective tissue.

The cortex contains ovarian follicles at various stages of development. Each follicle contains one oocytes.

Liberation of an oocytes from ovary is ovulation. It occurs on or above fourteenth day of twenty-eighth day menstrual cycle. After the oocytes is liberated the graphian follicle converted in to corpus luteum.

The hormones – oestrogen is secreted by cells in the walls of ovarian follicles.
– Progesterone by corpus luteum.

Functions

Production of Oocytes

During reproductive life of about 30 yrs, i.e., (from puberty to menopause) the ovaries produce alternately one oocytes/month.

Liberation of ovum from ovary is ovulation. It occurs about fourteenth day of twenty eighth menstrual cycle. An oocytes is viable for 12-14 hours.

Production of Hormones

Oestrogen – Follicles and paraluteal cells.

Progesterone – luteal cells.

Blood Supply

Artery

Ovarian artery (direct branch of aorta).

(it anastomosis with branch of uterine artery).

Vein

Right ovarian vein.

Nerve Supply

Posterior gangloinic sympathetic – T10-T11 spinal segments.

Para sympathetic – S2, S3, S4 are vasodilator.

Lymph supply

It drains into the lumbar node along with the ovarian artery.

GARBHASHAYA - UTERUS

यथा रोहित मत्स्यस्य मुखं भवति रूपतः ।
तत्संस्थानां तथारूपां गर्भशश्यां विदुर्बुधाः ॥

(Su. Sha. 5/44)

It looks like face of a fish.

पित्त पक्षाशयोर्मध्ये गर्भशश्या, यत्र गर्भस्तिष्ठति ॥

It is situated in between pittashaya and *pakvashaya*.

गर्भशयोऽष्टमः स्त्रीणां पित्तपक्षाशयान्तरे ॥

(As. Hr. Sha. 3/11)

Garbhashaya is the eighth *ashaya*.

शंखनाभ्याकृतिर्योनिः श्यावतां सा प्रकीर्तिता ।
तस्यास्तृतीये त्वावते गर्भशश्या प्रतिष्ठिता ॥

(Su. Sha. 5/43)

It is present in the third circular ring of the vaginal canal.

Uterus (womb) serves as part of path way for sperm to reach the uterine tube.
It is the site for menstruation, implantation of the fertilized ovum and development of foetus during pregnancy.

Position

As it is a hollow muscular organ. It is situated between rectum and behind the urinary bladder in front.

Shape and Size

It is inverted pear shaped and flattened anterior posteriorly.

Nullipara

7.5 cm length (3'), 5 cm breadth (2') 2.5 cm width (1')

Its average weight is 40 gms during pregnancy it enlarges nearly 10 times.

Anatomical Subdivision

The dome shaped portion superior to uterine tube is called as fundus.

The Major tapering central portion called body.

The inferior narrow portion opening in to vagina called cervix.

In between body and cervix there is a junction, marked by circular constriction body forms upper two-third of organ, cervix forms lower one-third.

The secretory cells of mucosal of cervix produce a secretion called cervical mucus, which contains enzyme, water and other inorganic salts.

Axis and Angulations

The long axis of uterus forms 90 angle with the long axis of vagina which opens forward. The forward bending of uterus relative to vagina is called Angle of Ante version.

The uterus is slightly bend and forward itself on cervix is called Angle of Ante flexion.

Body

It has fundus.

Two surfaces

Antero-inferior surface or vesical

Postero-superior surface or intestinal

Two lateral borders

Right

Left

Fundus is convex like a dome, covered by peritoneum, it forms the upper end of uterus. The fertilized ovum is usually implanted in posterior wall of fundus.

Surfaces

Antero-inferior surfaces of vesical

It is covered by peritoneum and forms posterior wall of vesico uterine pouch. It is a flat structure related to urinary bladder.

Postero-superior surface or intestinal

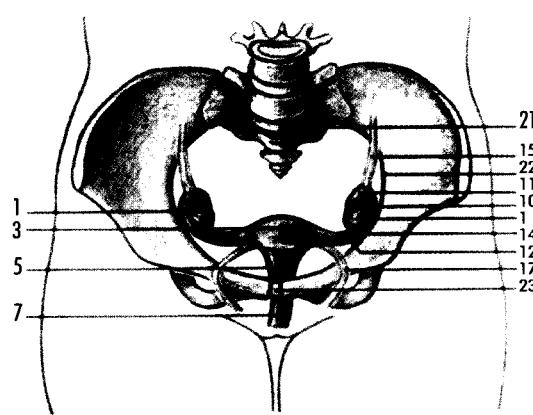
It is covered by peritoneum and forms posterior wall of recto uterine pouch which is convex and containing of small intestine and sigmoid colon.

Lateral border

It is round and convex provides attachment to broad ligament of uterus which connects it to the lateral pelvic wall.

The uterine tube opens into uterus at upper end of this border.

Uterus and Associated Structures



- 1 Ovary
- 2 Mesovarium
- 3 Fundus of uterus
- 4 Vesico-uterine pouch
- 5 Cervix of uterus
- 6 Vaginal portion of cervix
- 7 Vagina
- 8 Crus of clitoris
- 9 Labium minus
- 10 Fimbriae of uterine tube
- 11 Infundibulum of uterine tube
- 12 Ligament of the ovary
- 13 Mesosalpinx
- 14 Uterine tube
- 15 Suspensory ligament of ovary
(caudally displaced)
- 16 Broad ligament of uterus
- 17 Round ligament of uterus
- 18 Corpus cavernosum of clitoris
- 19 Glans of clitoris
- 20 Hymen, vaginal orifice
- 21 Promontory
- 22 Linea terminalis of pelvis
- 23 Public symphysis

Cervix

It is the lower one-third part below body separated from it by a broad groove known isthmus.

It has two halves

1. Supra vaginal cervix is upper half.
2. Vaginal cervix is lower half.

Supra-Vaginal Part

- (a) Anterior surface is related to posterior one-third of superior surface of bladder and not covered by peritoneum but posterior surface is fully covered by peritoneum.
Ureter passes forward in parametrium to the bladder about 1.5 cm lateral to supravaginal part of cervix.
- (b) Posterior to rectouterine tube.
- (c) On each side to ureter and to uterine artery. The fibro fatty tissue between two layer of broad filament is called parametrium. It is abundant near the cervix and vagina.

Vaginal Part

It projects anterior wall of vagina. The space between it and vaginal all are called vaginal fornices. The lower cervical canal open in to vagina by a opening called external os. The upper end is narrow and open in to cavity of body of uterus called internal os.

The cervical canal has oblique ridges radiating from the midline on its anterior and posterior wall often referred as arborvitae uteri.

Uterine Ligaments

Broad Ligaments

It is the double fold of peritoneum attaching the uterus to either side of pelvic cavity.

- Medially the two layers are attached to lateral border of uterus and then separate to enclose it.
- Laterally it is attached to side wall of pelvis.
- Inferior it is attached to floor by a broad base.
- Superiorly two layers are continuous around the uterine tube.
- The ovary is suspended from lateral part of postero-superior surface by mesovarium.

- The part of broad ligament between uterine tube and mesovarium is mesosalpinx.

The rest of broad ligament is mesometrium.

The part of mesometrium between lateral end of uterine tube and pelvic wall is suspensor ligament of the ovary.

Contents of Broad Ligament

Round Ligament

It is a fibromuscular band between the layers of broad ligaments.

Ligaments of Ovary

It is attached below and behind the uterine tube. It is visible as a ridge on superior surface of broad ligament.

- cardinal (lateral cervical) ligaments – extend inferior to bases of broad ligament between the pelvic wall and cervix and vagina.
- Uterosacral ligament also peritoneal extensions, lie on either side of rectum and connect the uterus to sacrum.
- Pubocervical ligament, extending from side of lower part of cervix towards the posterior surfaces of body of pubis.

The posterior tilting of uterus is retroflexion (Retro – backward).

Support of Uterus

The support and attachment of uterus are functionally significant in maintaining the normal position of uterus in living person.

Since cervix and vagina connected so support of both uterus and vagina are considered together. (The support of uterus is two groups).

Upper Groups

a) Ligments

- Cardinal or transverse cervical ligaments (or Mackerodt).
- Uterosacral
- Pubocervical
- Pubo vaginalis part of levator ani (it holds cervix up).
- Broad ligament (it gives little strength to uterus).

- Round ligament (hold uterus forward).
- Fascial sheaths of uterine and vaginal arteries. (indirectly support to uterus).

Lower Group

- Urogenital diaphragm with superior and inferior fascia.
- Perineal body
- Intra-abdominal pressure.
- Weight of uterus and its direct attachment to vagina keep it in ante version and ante flexion.

Age and Reproductive Changes

Foetal life – Cervix is larger than body which projects above pelvic brim.

On puberty – Uterus enlarges and descends in adult position. Aborvitae uteri is appear.

On menstruation – Uterus is slightly enlarged and becomes more vascular lips of external os are swollen.

Pregnancy – Uterus is enormously enlarged due to hypertrophy muscle fibres and partly to hyper plasma.

Blood Supply

Arteries – Uterine artery.

Vein – corresponding to artery and drain in to internal iliac vein.

Lymphatic Drainage

Fundus drain in to aortic arches.

Lower part of body – Internal iliac nodes

Corners of body – Inguinal nodes.

Cervix

Upper part – external iliac nodes

Middle and lower part – Internal iliac nodes.

Posterior wall of cervix – Sacrogenital folds.

Nerve Supply

Sympathetic T5-T10 hypo gastric and pelvic plexus.

(Causes vasoconstriction and uterine contraction) the pain in body of uterus (labour pain) travels with sympathetic fibres to lower thoracic segments of cord T11-T12 dermatomes.

Parasympathetic by pelvic splanchnic nerves (S2, S3, S4)

Applied Anatomy

- Uterus comes to lie in straight line with vagina called Retroverted uterus.
- Uterus passes downwards into vagina invaginating it called prolapse of uterus.
- Operation and removal of uterus – Hysterectomy.
- Abnormally mobile uterus – Hysteropexy.

FALLOPIAN TUBE

Uterine Tube (Fallopian Tube)

The female have two uterine tubes or fallopian tubes also called as Oviducts.

Position

They lies in the upper free margin of the broad ligament of uterus and transport the ova from ovaries to uterus.

Definition

These are tortuous duct convey oocytes from the ovary to uterus. When spermatozoa introduced in to the vagina then it passes up in to uterus, from there to fallopian tubes where fertilization takes place on its lateral end.

Dimensions

About 10 cm (4') long, at lateral end uterine end opens in to peritoneal cavity through abdominal ostium (3 cm).

Sub Divisions

Its open is funnel shaped and distal end of each tube called the Infundibulum, is close to ovary . Its end is a fringe of finger like projections called fimbriae, which attached to lateral part of the ovary.

From the infundibulum the uterine tube extends medially, inferiorly attaches to superior angle of uterus called Ampulla which is the widest part marking up to two-third of its length.

The Isthmus succeeds ampulla which is short, narrow and one-third of the tube. The uterine (or) intramural (or) interstitial part of the tube is about 1 cm long within the wall of uterus.

Relations

Isthmus and adjoining part of ampulla are directed posterolaterally in a horizontal plane.

The uterine tube lies in the upper free margin of the broad ligament of the uterus. The upper part of the broad ligament between the attachment of mesovarium and the uterine tube is known as Mesosalpinx.

Histology

Outer serous has serous membrane derived from the peritoneum.

Middle muscularis has muscular coat having smooth muscle and the peristaltic movements of muscularis and Ciliary action of mucousa help to move the uterus, help full for implantation of embryo.

Internal mucosal, lined by ciliated columnar epithelium mixed with non – ciliated secretory cells (or) Peg cells.

Blood Supply

Arteries

Ovarian and uterine artery.

Vein Supply

Ovarian and uterine veins.

Lymph Drainage

Para = Aortic nodes along with
Ovarian lymphatic vessel
Superficial inguinal nodes.

Nerve Supply

Sympathetic nerves – T10 = T2 segments derived from hypogastric plexus.
Para = Sympathetic nerves – Vagus, from the pelvic plexus nerves from S2 , S3, S4.

Function

It produces vasodilation.

STANA - BREAST (MAMMARY GLAND)

• रसप्रसादो मधुरः पाक्वाहारनिमित्तजः ।

कृत्त्वदेहात् स्तनौ प्राप्तः स्तन्यमित्यभिधीयते ॥

(Su. Ni. 10/18)

It is prepared from the essence part of *aahara rasa* and *aahara rasa* leads to formation of *stanya*.

तत्रेयं स्तनसंपत् — नात्यूर्ध्वा, नातिलम्बा, अनतिकृशा, अनतिपीनो युक्त पिप्पलकौ, सुख प्रपानी चेति ॥

(Ch. Sha. 8/53)

The qualities of a good and well developed breast- which is not directed upwards, not more lengthy, not more small, not concave shaped,

It is a modified sweat gland which is situated in the superficial fascia of the pectoral region. It remains rudimentary in the male. In the female, it starts enlarging after the age of puberty and varies in size and shape in different individual and with age and its functional status.

Extent

A well developed female adult breast is hemispherical or conical in shape.

The base of the gland extends from the side of the sternum almost the mid axillary line, and from the second rib to the sixth costal cartilage.

External Features

It is at the level of the fourth intercostal space, the breast is surrounded by nipple, which is placed in the middle of a circular patch of coloured skin known as aerola.

The areola is pink in the nulliparous women, but becomes darker during the pregnancy.

It contains a sebaceous gland which enlarges during pregnancy (Montgomery's tubercles).

From the lower part of the pectoralis major and extends upwards in to the axillary (tail of Spence) and reaches as high as the third rib.

Relations

It lies within the superficial fascia except the axillary tail of Spence. This tail comes to lie under the deep fascia by passing through an opening in the axillary fascia called the foramen of Langer.

Breast lies on the deep fascia which separates it from.

- Pectoralis major (has one third of the breast upon it).
- Serratus anterior (has one third of the breast resting on it).
- External oblique aponeurosis (separates lower medial quadrant of the breast from the rectus abdominus).

Structure of the Breast

These are having suspensory ligaments of cooper which has distinct septa of fibrous tissue pass through the gland from the deep fascia over the pectoralis major to the over lying skin and the hip.

They provide an internal support for the gland. The glandular tissue arranged as lobes which embedded in the fat.

Each lobe is subdivided into lobules. The lactiferous duct one form each lobe converge upon the nipple under the aerolar, each duct expands to form a lactiferous sinus and narrowing again opens independent of the nipple.

Arterial Supply

It receives

Lateral side – lateral thoraco and acromio thoracic branches of the axillary artery.

Medial side – perforating cutaneous branches of the internal thoracic artery (pierces the second to fourth intercostal spaces).

Lateral perforating branches of the second to fourth intercostal spaces.

Venous Drainage

Veins drains in to the axillary, internal thoracic and intercostal veins.

Lymphatic Drainage

- Axillary nodes.
- Internal thoracic or parasternal.
- Intraabdominal nodes.

Nerve Supply

The secreting tissue is supplied by the sympathetic fibers of the second to sixth inter-coastal nerve.

Applied Anatomy

Mastitis – Inflammation of the breast.

Mastectomy – Surgical removal of breast.

Breast cancer – It is more common in between 20-50 age group of women.

ANDAKOSHA – SCROTUM

It is a sac that hangs from the root of the penis and mainly consists of loose skin and superficial fascia. The scrotal sac contains the two testis (right and left), the epididymis and the lower part of the spermatic cord. The scrotal sac is divided into two halves by a septum. The septum consists of superficial fascia and muscle tissue called the dartos which contains bundles of smooth muscle fibers (cells). Dartos muscle is also present in the subcutaneous tissue of the scrotum and is directly continuous with the subcutaneous tissue of the abdominal wall. Under the influence of cold, and in young and robust persons, the scrotum is short and due to the contraction of the subcutaneous muscle of the scrotum, called the dartos.

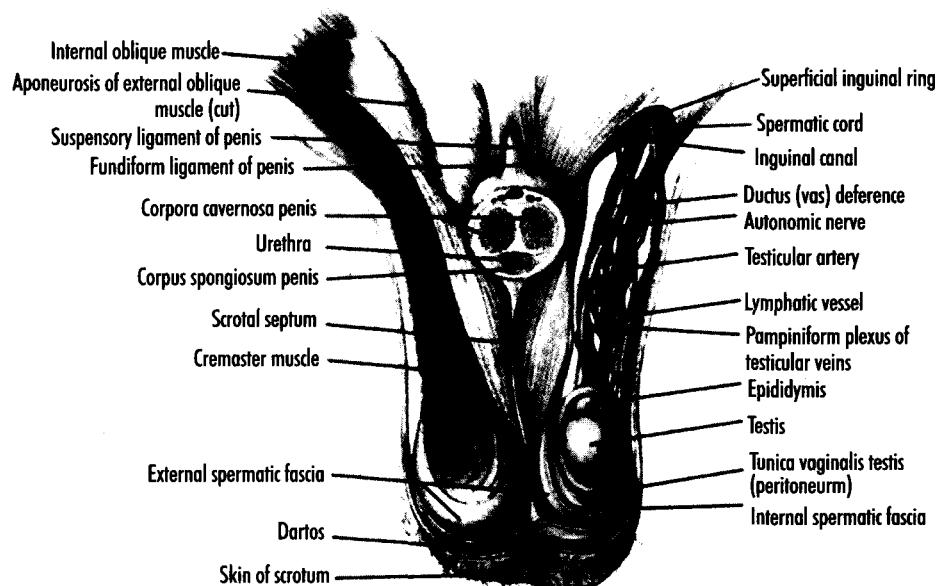
- The temperature of the testis is regulated by the location of the scrotum and contraction of its muscle fibers. Both production and survival of sperm require a temperature that is about 3°C lower than normal core body temperature.
- The left half of the scrotum hangs lower than the right due to the greater length of left spermatic cord.

Layers of the Scrotum

The scrotum has the following layers:

1. Skin
2. Dartos muscle (which replaces the superficial fascia)
3. The external spermatic fascia
4. The cremasteric fascia
5. The internal spermatic fascia
6. Parietal layer of tunica vaginalis

Scrotum, Spermatic Cord & Related Structures



Blood Supply

Arterial Supply

The superficial and deep external pudendal arteries supply the anterior aspect. Scrotal branches from the internal pudendal and cremasteric branch of the inferior epigastric artery supply the posterior aspect.

Veinous Drainage

Veins correspond to the arteries and drain into the great saphenous vein.

Lymphatic Drainage

Medial group of superficial inguinal nodes.

Nerve Supply

Anterior one-third of the scrotum is supplied by

- ilio-inguinal nerve and
- genital branch of the genito-femoral nerve (L1 spinal segment)

Posterior two-third of the scrotum is supplied by scrotal branches of perineal nerve (S3 spinal segment) reinforced laterally by the perineal branch of posterior cutaneous nerve (S2 spinal segment).

Applied Anatomy

1. The scrotal swelling commonly seen in complete inguinal hernia and hydrocele.
2. Cremasteric reflex commonly ends with elevation of the scrotal sac.
3. It is a common site for oedema due to laxity of the skin and its dependant position in the scrotum.

SHUKRAVAHIKA – DUCTUS DEFERENS

Vas deferens is otherwise known as ductus deferens.

It allows the sperms from the testis to the prostatic urethra.

It forms the ejaculatory duct which opens in the prostatic urethra, it begins from the tail of the epididymis and ends by joining with the duct of the seminal vesicle.

It lies in the scrotum, inguinal canal and the pelvis.

At the deep inguinal ring it enters the abdomen, it enters the pelvis by crossing the external iliac vessel by a hooks around the lateral side of the inferior epigastric artery.

Relations

It is always covered by peritoneum and it lies on the obturator foramen which is present on the side wall of the pelvis.

- Umbilical artery.
- Obturator artery.
- Obturator nerve.
- Obturator vein.

The ductus reaches by curving medially and forwards on the posterior surface. (base). It crosses in front of the lower end of the corresponding ureter and turns downwards near the mid line medial to the seminal vesicle. It presence a dialatation known as ampulla before it joins the duct of seminal vesicle to form the ejaculatory duct. These structure are related to the rectum behind, but they are separated from rectum by the Denonvilliers facia.

Arterial Supply

Mainly from the inferior vesicle artery.

Veins Supply

It drains in to the internal iliac vein.

EPIDIDYMIS

It is a mass made up highly coiled tubes that acts as reservoirs of spermatozoa. It lies along the posterior margin of the testis with the ductus deferens to its medial side.

It consists of Head
 Body
 Tail

Head – It is attached to the upper pole of the testis by efferent ductules.

Body – It lies along the posterior border of the testis. It is made up of single duct.

Tail – It is attached to the lower pole of testis and is continuous as the ductus deferens.

Structure

It consist of a single tube about 8x metres long, highly coiled and packed together by fibrous tissue.

The head receives 12-15 efferent tubules from the rete testis and firmly attached to the testis. The body and tail are firmly attached to the testis by fibrous tissue without any communication.

In the tail the duct of the epididymis becomes thicker and straighter and emerges posteriorly at the ductus deferens which passes upwards behind the epididymis through the scrotal sac to the superficial inguinal ring.

It joins with the blood vessels, lymphatics and nerves to form the spermatic cord.

Blood Supply

Artery Supply

A branch of the testicular artery which anastomoses with the artery to the ductus deferens.

Vein Supply

Right testicular vein and left testicular vein drains the blood into inferior vena cava and left renal vein respectively.

Nerve Supply

It is supplied by T11 to L1 segment of the spinal cord.

MEDHRA – PENIS

It comes under male external genitalia. It is a male copulatory organ which is meant for passage of both urine and semen.

Parts

Root of Penis

It is a fixed part and consists of two crurae one on each side and a bulb.

These are the erectile tissues which attach to the inferior surface of the perineal membrane, which are situated in the superficial perineal pouch.

Body or Shaft

It is a free cylindrical and pendulous measuring 7.5 to 10 cm. It consists of three parts, the two corpora cavernosa and one corpus spongiosum, which contains the penile urethra.

The anterior end of corpus spongiosum is expanded dorsally and hollowed out to form glands. A conical cap is present over the blunt ends of corpora cavernosa.

Skin

The skin is thin, delicate, dark and hairless it is loosely connected to a underlining fascia to allow the free movement of the skin over the fascia.

It is folded up on itself to form a hood over the glans called the prepuce (fore skin). Its inner layer continuous with the skin covering the glands at the neck of the penis.

A triangular median sagital septum called the Frenulum , which stretches between the inner layer of the prepuce at the under surface of the glans.

The space between the prepuce and the glands is the preputial sac.

There are preputial glands in the skin of the corona glandis which secrete the smegma which collects in the preputial sac.

Fascia

The coupura fused to gether are loosely surrounded by the fascia of the penis (Bucks Fascia).

Colles fascia is the continuation in to the perineum of the anterior abdominal wall. (scarpas fascia).

Ligaments

There are two ligaments

Fundiform Ligaments

It splits to enclose the root of the penis and finally attached to the median raphe of the scrotum.

Supensory Ligaments

It is a triangular ligament and its base is attached to the symphysis pubis, while the apex attached to the fascia of the penis.

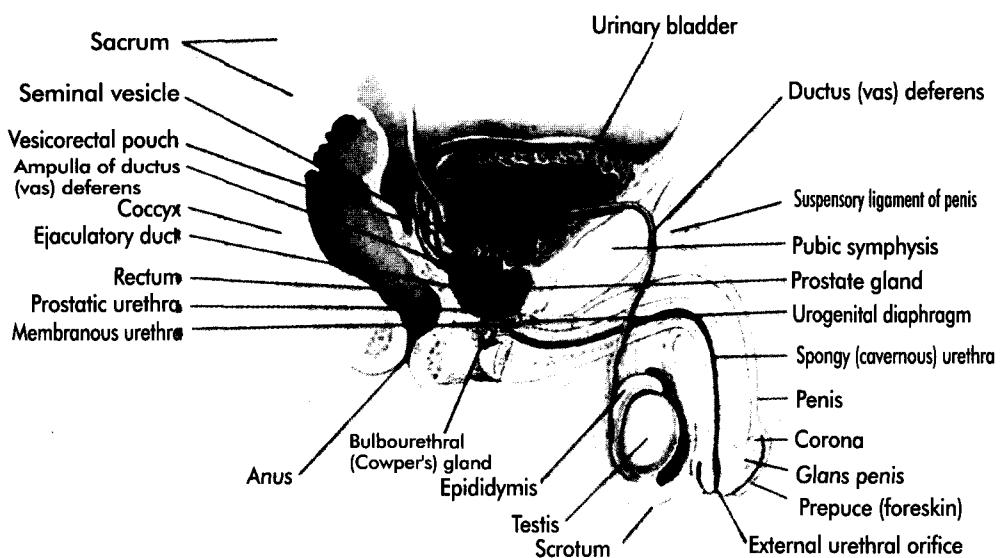
Structure

Corpora Cavernosa

The anterior three fourth is composed of erectile tissue and containing strong fibrous capsule known as Tunica Albugenia.

Posterior one fourth of each corpus diverges as the crus of the penis.

Sagittal Section of Male Reproductive System



Corpus Spongiosa

This contains the urethra and has two expansions.

Glans – The corona gland is widest.

Bulb – It is the proximal enlargement entered by urethra.

Arterial Supply

These arteries arises from the internal pudendal artery.

- Dorsal artery
- Deep arteries
- Artery to bulb.

Venous Drainage

- Superficial dorsal vein
- Deep dorsal vein

Lymphatics

Except glans, all the lymphs vessels of penis drains in to the superficial inguinal nodes. Glans drains in to the deep inguinal lymph nodes (cloquet's gland)and external iliac nodes.

Nerve Supply

Somatic

- Dorsal nerve of penis
- Perineal branch of pudendal nerve
- Ilioingynal nerve.

Autonomic

Para=sympathetic – Pelvic splanchnic (S2, S3, S4) are vasomotor and causes vasodialation of the arteries of the corpora.

Sympathetic – These are necessary for the initial state of ejaculation.

From the superior and inferior hypogastric plexuses (L1) are vaso constrictor.

After ejaculation the parasympathetic stimulate and ceases the stimulation of sympathetic by producing vasoconstriction of their arteries.

ADHIVRISHANA - TESTIS

मांसासृक्कफमेदः प्रसादाद् वृषणौ ।

(Su. Sha. 4/31)

Vrishana are formed by the essence of *mansa, asrika, kapha, medah*.

Testis is the male sex gland, one on each side. It is placed obliquely inside the scrotal sac, its upper extremity is tilted and laterally, possibly by the pull of the spermatic cord which suspends it from its posteromedial aspect.

Anatomical Features

The testes or testicles are oval in shaped about 4cm long, 2.5cm wide and 2cm thick.

Weight about 10 to 15gm.

Each glands has *two poles* – upper and lower

Two borders – anterior and posterior.

Two surfaces – medial and lateral.

Relations

Upper pole

It is related to the head of the epididymis which is connected to it by the efferent tubules of the testis.

Lower pole

It is related to the tail of the epididymis which is connected to it by fibrous tissue.

Anterior border

It is convex and smooth and covered by tunica vaginalis.

Posterior border

It is straight and partially covered by tunica vaginalis.

Between the lateral surface of the testis and the body of epididymis there is an elongated cleft lined with visceral layer of tunica vaginalis known as sinus of epididymis.

Coverings

Testis is covered with three different layers from outside to inside, these are the tunica vaginalis, the tunica albuginae and the tunica vasculosa.

Tunica Vaginalis

- It is a serous membrane having a parietal and a visceral layer with a cavity in between.

- Parietal layer lines the scrotum.
- Visceral layer clothes the testis except on the posterior border.

Tunica Albuginae

It is a dense fibrous membrane immediately surrounding the testis and forming its coat. The posterior border of the tunica albuginae is thickened to form an incomplete vertical septum, called the mediastinum testis which is wider above than below. Numerous septa extend from the mediastinum to the inner surface of the tunica albuginae. They incompletely divide the testis into 200 to 300 lobules.

Tunica Vasculosa

It is a vascular coat, consisting of plexus of blood vessels derived from branches of testicular artery, which lines the inner aspect of the tunica albuginae. It is the most inner one.

Structure of the Testis

- At the posterior border the tunica albuginae projects in to its substance forming an incomplete septum called as mediastinum testis.
- The mediastinum testis contains a number of small channels called the rete testis.
- Numerous fine septa (septula testis) radiate from the mediastinum towards tunica albuginae dividing the testis in to 200 to 250 conical compartments (lobules).
- Each lobules contains two or more highly coiled or convoluted somniferous tubules each of which 60cm long.
- As the somniferous tubules approach the mediastinum they join together to form the straight somniferous tubules.
- When the straight somniferous tubules enters to the mediastinum to form a network known as rete testis.
- The rete testis joins with the head of the epididymis by means of 15-20 efferent ductules.

The tubules end in a single duct which is coiled on itself to form the body and tail of the epididymis. It is continuous with the ductus deferens.

Arterial Supply

Testis is supplied by testicular artery which is a branch of abdominal aorta arising at the level of L3 vertebra. Testicular artery is present at the posterior border of the testis and divided into branches and it pierces the tunica albuginae to supply the blood to tunica vasculosa.

Venous Drainage

The veins coming out of the testis form the pampiniform plexus.

Right testicular vein drains into inferior vena cava. Left testicular vein drains into left renal vein.

Lymphatic Drainage

The lymphatic, from the testis ascends along the testicular vessels and drains into the pre-aortic and para-aortic group of lymph nodes at the level of L2 vertebra.

Nerve Supply

The testis is supplied only by sympathetic nerve from T10 segment of spinal cord. Sympathetic supply is both sensory and motor.

Development

It develops on the posterior abdominal wall from genital ridge situated on the medial side of the mesonephros.

Descent of the Testis

The testis begins to descend in the second month of intrauterine life. It reaches the iliac fossa by the third month. It reaches at the deep inguinal ring between fourth to sixth month. It transverses the inguinal canal during seventh month. It reaches the superficial inguinal ring by the eighth month and the bottom of scrotum by the ninth month.

Undescended testis are found in 4% full term deliveries and 33% premature deliveries. Most of these reach the scrotum within three months of life. Only 0.7% of them remain undescended.

Normally, the testes reaches the scrotum as a result of several factors which are:

- Increased intra-abdominal pressure which squeezes it through inguinal canal.
- *Hormonal factors* – the gonadotrophic hormones of the anterior pituitary bring about the descent.

- Differential growth causing rapid elongation of the parietal peritoneum to which the developing testis is attached and failure of gubernaculum to elongate.

Applied Anatomy

1. *Undescended Testis (Cryptorchidism)* – If the testis not descends with first year of life then it is called as undescended testis.
2. *Hydrocele* – Water accumulates in the processes vaginalis.
3. *Monorchism And Anorchism* – If the testis is absent. On one side (monorchism) or on both sides (anorchism).
4. *Hermaphroditism (Or Intersex)* – It is a condition in which an individual shows some features in male and some of a female. In true hermaphroditism both testis and ovary are present. In pseudohermaphroditism the gonad is of one sex while the external (or internal) genitalia are of the opposite sex.
5. *Ectopic Testis* – (ectopic = deviated from normal place) the testis may be situated from the normal route of descent, either it may be under the skin or the front of thigh, in the femoral canal, under the skin of the penis or it may be present in the perineum behind the scrotum.



ENDOCRINE SYSTEM

Introduction

Functional capacities of all living cells are finally determined by genetic factors, but they are mainly regulated by two systems which are interlocking and interdependent they are described as endocrine system and nervous system. However, the interlocking relationship between the two system happens within the hypothalamus which is described as the head ganglion of them. In case of endocrine system the information is mediated to distal organs through chemical agents in blood. These chemical mediator are termed as hormone. The word hormone had been derived from greek word hormaein which means to excite. It act as a chemical messenger and it is secreted by one group of cells but it acts on other group situated away from the site of secretion. The terminology of hormone was made first by Bayliss and Starling (1902) through a classical experiment during the discovery of first hormone known as Secretin. Classically, cells of endocrine gland (ductless gland) secrete hormone poured directly in to the blood. Histologically, cells of these glands are epithelial in nature.

There are two types of glands present in the body:

1. Exocrine
2. Endocrine

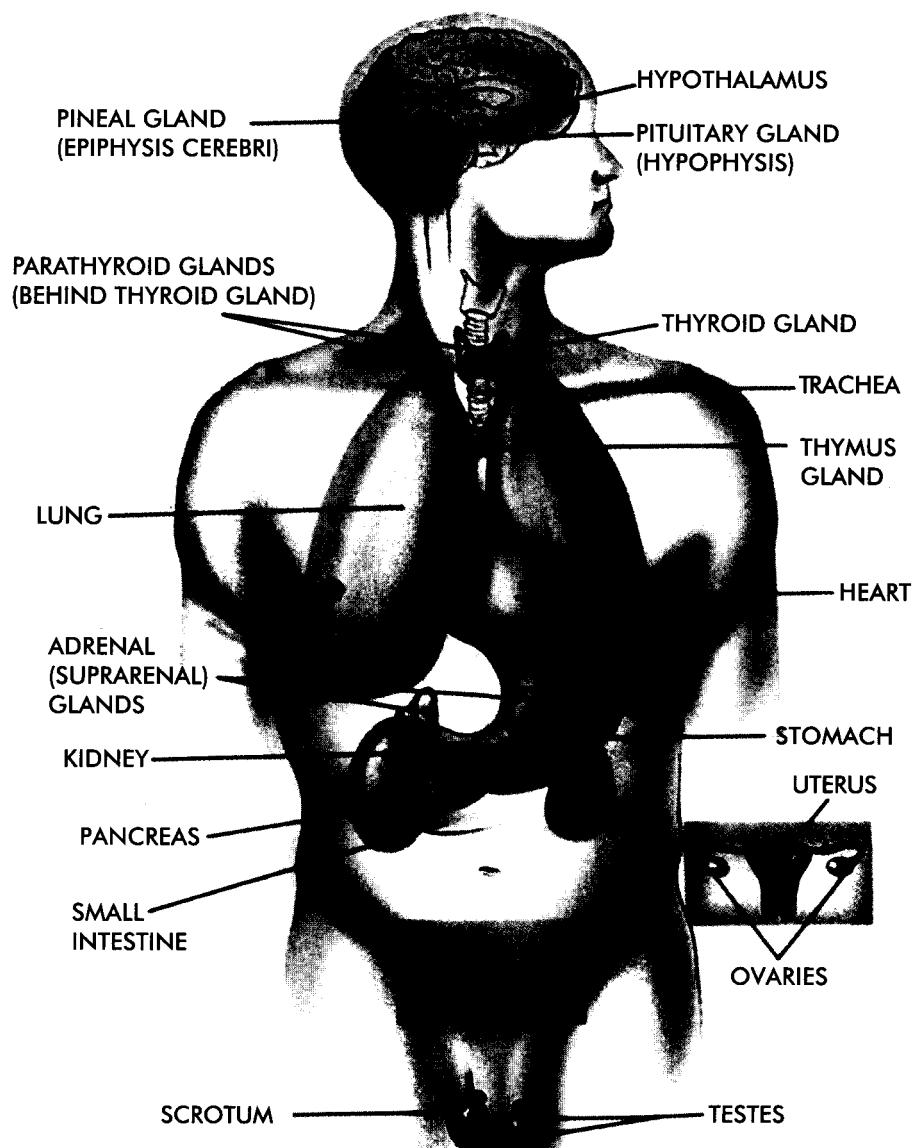
Exocrine (ex = out; krinein = to secrete) glands secrete their products into ducts and the ducts carry the secretions into body cavities, into the lumen of the organ or to the outer surface of the body.

Examples – Sweat (sudiferous) glands

- Sebaceous (oil) glands
- Mucous
- Digestive glands

Endocrine (endo = within) glands secrete their products (hormones) into the extra cellular space around the secretory cells rather than into the ducts. The secretion diffuses into capillaries and is carried away by the blood.

Endocrine System (An Overall View)



ANTERIOR VIEW

The endocrine system consists of the endocrine glands, which include the pituitary, thyroid, parathyroid, adrenal, and pineal glands.

Several organs of the body contain cells, which secrete hormones, but exclusively they are not coming under endocrine glands. These include the hypothalamus, thymus, pancreas, ovaries, testes, kidneys, stomach, skin, small intestine, heart and placenta.

The endocrine system releases its messenger molecules called as hormones into the blood stream. The endocrine and nervous system co-ordinate all as an interlocking super system often referred to as the neuro-endocrine system.

Hormones may promote or inhibit the generation of nerve impulses.

A hormone travels throughout the body in the blood; it affects only specific cells called its target cells. Hormones like neurotransmitters influence their target cells by chemically binding to integral membrane protein or glycoprotein molecules called receptors. Only the target cells for a certain hormone have receptors that bind and recognize that particular hormone.

Thyroid stimulating hormone (TSH) binds to receptors on the surface cells of the thyroid gland, but it does not bind to cells of the ovaries because ovarian cells do not have TSH receptors.

Types of Hormones

Hormones that pass directly into the blood and act on distant target cells are called as circulating hormones or endocrines.

Hormones that act locally without entering into the blood stream are called as local hormones. Those act on the neighbouring cells are called as paracrines. Local hormones that act on the same cell that secreted them are termed as autocrines.

Hormone Chemistry

Chemically hormones are classified into four types:

- | | |
|------------------------------------|---------------------------------------|
| 1. Steroids-Aldosterone | 2. Biogenic amines - Thyroid hormones |
| 3. Peptides and proteins- Oxytocin | 4. Eicosanoids - Arachidic acid |

PIYUSH GRANTHI- PITUITARY GLAND

The hypophysis cerebri is a small endocrine gland situated in relation to the base of brain.

It is otherwise known as pituitary gland. It is often called as master of endocrine orchestra because it secretes several hormones that control other endocrine glands.

Pituitary gland is controlled by Hypothalamus. This gland lies in the hypophyseal fossa which is the small region of the brain interiorly to the two lobes of the thalamus. It is the major integrating link between the nervous and endocrine systems.

It is oval or pea-shaped structure which measures about 7-8 mm antero-posteriorly and 10-12mm transversely.

The weight of the pituitary gland is 500mg. It lies in the sella turcica of the sphenoid bone and is attached to the hypothalamus via a stalk called as infundibulum.

It is divided into two parts – Adenohypophysis (Anterior lobe)
– Neurohypophysis (Posterior lobe)

I Anterior pituitary gland (anterior lobe) accounts for about 75% of the total weight of the gland.

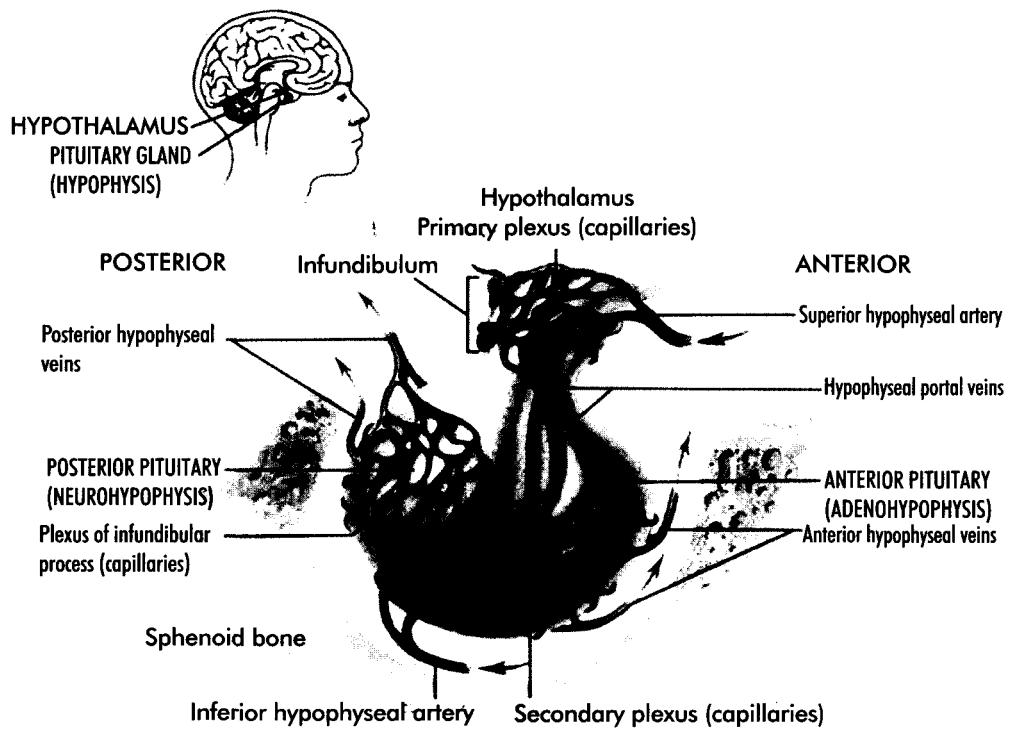
II Posterior pituitary gland (posterior lobe) accounts for about 25% of total weight.

Anterior Pituitary Gland

It contains five types of principal cells which secrete serve major hormones.

1. *Somatotrophs* – (soma = body; tropos = changing) produce human growth hormone (hGH) or somatotrophin. It stimulates the general body growth and controls the anabolism and catabolism.
2. *Thyrotrophs* – it synthesizes thyroid stimulating hormone (TSH) which controls the secretion and other activities of the thyroid gland.
3. *Gonadotrophs* – (gonas = seed) produce two major hormones, follicle stimulating hormone (FSH) and leuteinizing hormone (LH). The FSH and LH stimulate the secretions of estrogens and progesterone and maturation of oocytes in the ovaries and secretion of testosterone and production of sperm in the testis; formation of corpus luteum.
4. *Lactotrophs* – It produces prolactin (PRL). It initiates the milk production in suitably prepared mammary glands.
5. *Corticotrophs* – It synthesizes adrenocorticotropic hormone (ACTH) which stimulate the adrenal cortex to produce glucocorticoids. It also secrete melanocyte – stimulating hormone (MSH) which affects skin pigmentation.

Pituitary Gland with it's Blood Supply



The Secretions of Anterior Pituitary Gland

Mnemonics – Growth Failure Leads to a Miniature Person

1. Human Growth Hormone (hGH)
2. Follicle – Stimulating Hormone (FSH)
3. Luteinizing Hormone (LH)
4. Thyroid Stimulating Hormone (TSH)
5. Adrenocorticotropic Hormone (ACTH)
6. Melanocyte Stimulating Hormone (MSH)
7. Prolactin (PRL)

Human Growth Hormone (hGH)

It is otherwise called as somatotropin which stimulates general body growth and regulates aspects of metabolism.

It is the most abundant anterior pituitary hormone.

It has many effects on metabolism. Generally hGH:

1. Stimulates protein synthesis and inhibits protein breakdown.
2. Stimulates lipolysis, the breakdown of triglycerides into fatty acids and glycerol.
3. Retards the use of glucose (blood sugar) for ATP production.

The one direct effect of hGH is to promote synthesis and secretion of small protein hormones called insulin like growth factors (IGFs), previously called somatomedians.

Applied Anatomy

Hypo secretion of hGH leads to dwarfism.

Hyper secretion of hGH during childhood results in gigantism.

And in adult it causes acromegaly.

FSH (Follicle Stimulating Hormone)

It is transported from the anterior pituitary gland by the blood to the ovaries. There it initiates the development of follicles each month. FSH also stimulates follicular cells to secrete estrogen (female sex hormones) and in case of male it stimulates sperm production in the testes.

LH (Leutinizing Hormone)

In females the LH and FSH stimulate the secretion of estrogen about ovarian cells and brings about the release of secondary oocytes (Future ovum) by the ovary, a process called as ovulation.

It stimulates the production of progesterone by forming the corpus luteum. Estrogens and progesterone prepare the uterus for implantation of a fertilized ovum and help the mammary glands to secrete milk.

Prolactin (PRL)

Together with other hormones, it initiates the milk secretion by the mammary glands. But the ejection of milk is controlled by oxytocin.

Prolactin level rises during pregnancy, because of prolactin releasing hormone.

Dopamine suppresses the secretion of milk by the help of prolactin inhibiting hormone.

Hyper secretion of prolactin causes impotence (inability to have an erection of the penis) in case of male. Amenorrhea (absence of menstrual cycle) in case of female.

Adrenocorticotropic Hormone (ACTH)

Corticotrophs secrete mainly adreno-corticotrophic hormone (ACTH) or adrenocorticotropin.

ACTH controls the production and secretion of hormones called glucocorticoids by the cortex (ureter portion) of the adrenal glands.

Stress related stimuli such as low blood glucose or physical trauma, and a substance produced by macrophages called interlukin-1 (IL-1) also stimulate release of ACTH.

Melanocyte – Stimulating Hormone

It increases the skin pigmentation by stimulating the dispersion of melanin granules in melanocytes in amphibians.

Corticotropin releasing hormone (CRH) stimulates MSH release whereas the neurotransmitter dopamine inhibits MSH release.

Thyroid Stimulating Hormone (TSH)

Thyroid Stimulating Hormone (TSH) also stimulates the synthesis and secretion of

two hormones.

- Tri-iodothyronine (T3) and
- Thyroxine (T4)

Both produced by the thyroid gland.

Blood Supply

Pituitary gland supplied by *hypophyseal arteries* which are the branches of internal carotid and posterior communicating arteries.

The blood drains into *hypophyseal portal veins*.

Hormones of Posterior Pituitary Gland (Neurohypophysis)

It does not synthesize any hormone rather it store and release two hormones. Direct neurosecretory cells are present in posterior pituitary which produce two hormones.

1. Oxytocin (oxytoca = Rapid child birth) or OT
2. Antidiuretic hormone (ADH) or vasopressin (which contracts the blood vessels).

Oxytocin (OT)

During the time of delivery and after parturition the oxytocin has two target tissues the mother's uterus and breasts. During delivery it enhances the contraction of smooth muscle cells in the wall of uterus. After delivery it stimulates milk ejection from the mammary gland in response to mechanical stimulus provided by a suckling infant.

Antidiuretic Hormone

It is a substance, which decreases urine production. It is helpful to retain body water. It does this by decreasing water lost by sweating and by causing the kidneys to return more water to the blood thus decreasing urine volume. At high concentrations ADH also causes constriction of arterioles which increases the blood pressure. Due to this property it is called as vasopressin.

AVATUKAGRANTHI – THYROID GLAND

It is a butterfly-shaped gland located just anterior to the larynx (voice box). It has two lobes e.g. Right and left lateral lobes lies one on either side of the trachea. Both the lateral lobes connected by a mass of tissue called an isthmus which lie anterior to the trachea.

It weighs about 30gm and has a rich blood supply receiving 80-120 ml of blood per minute.

It lies at the level of L5, L6, L7 and T1. Each lobe measures about 5cm x 2.5cm x 2.5cm and the isthmus 1.2x1.2cm.

Microscopic spherical sacs called as thyroid follicles comprise most of the thyroid gland.

However, it is larger in females than in males and further increases in size during menstruation and pregnancy.

Capsules of Thyroid

True capsule – It is the peripheral condensation of the connective tissue of the gland.

False capsule – It is derived from the pretracheal layer of the deep cervical fascia. It is thick on the posterior border of the lobes but thin on the inner surface of the gland. It is connected to cricoid cartilage by the help of suspensory ligament.

The right and left lateral lobes are conical in shape having an apex, base, three surfaces (lateral, medial and posterolateral) and two borders (anterior and posterior).

The apex is directed in upward and lateral direction. It is attached with sternothyroid muscle. The base is on level with the fourth or fifth tracheal ring.

The lateral surface- It is convex and it is covered by sternothyroid, sternohyoid, superior belly of omohyoid and anterior border of sternomastoid.

Medical surface – It is related to trachea, oesophagus, cricothyroid and laryngeal nerve.

Posterior surface – It is related to carotid sheath and overlaps the commoncarotid artery.

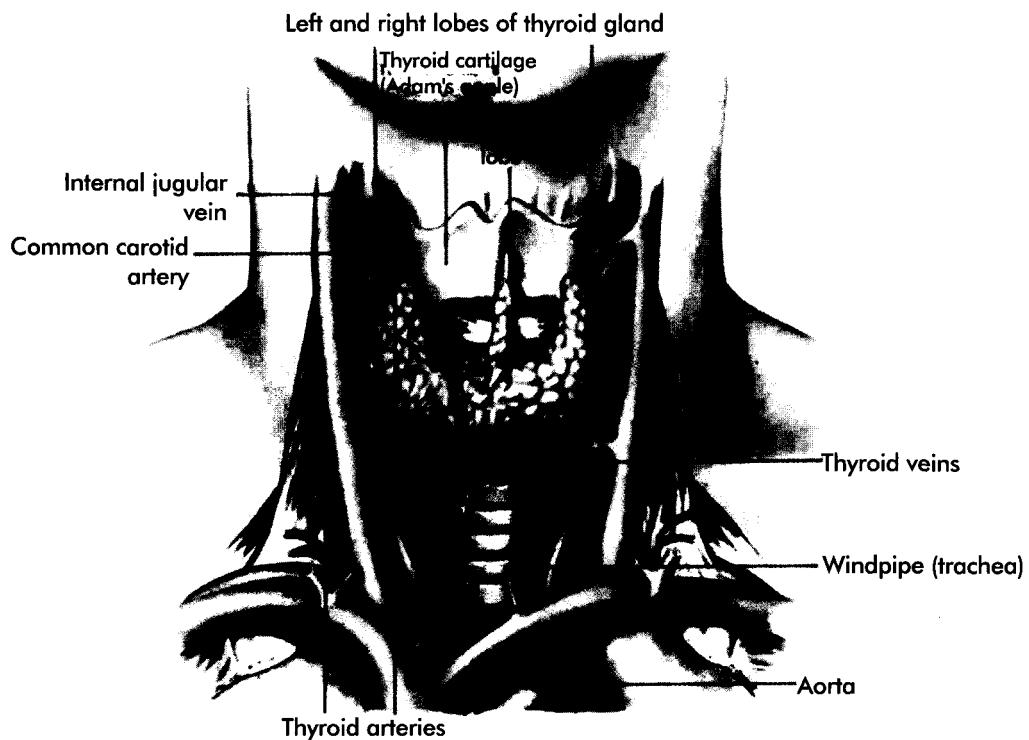
Anterior border – It is thin and related to the anterior branch of superior thyroid artery.

Posterior border – It is thick and rounded. It is related to superior and inferior thyroid arteries parathyroid glands and left thoracic duct.

Secretion of Thyroid Gland

- T3 (triiodothyronine) Secreted by follicular cells
- T4 (tetraiodothyronine or thyroxine)
- Calcitonin (CT) – Secreted by parafollicular cells.

Thyroid Gland



T₃ and T₄ increases the basal metabolic rate, stimulate the synthesis of proteins, increases the use of glucose for ATP production, increase polysis, enhance cholesterol, excretion in bile, accelerate body growth and contribute to normal development of the nervous system.

Calcitonin - It lowers the blood levels of ionic calcium and phosphates by inhibiting bone resorption by osteoclasts and accelerating uptake of calcium and phosphates into bone matrix.

Artery Supply

Thyroid gland is supplied by superior and inferior thyroid arteries.

Superior thyroid artery is the first anterior branch of external carotid artery.

Inferior thyroid artery is a branch of thyroid trunk which arises from the subclavian artery.

Sometimes the thyroid gland is supplied by the lowest thyroid artery which arises from the brachiocephalic trunk or directly it arises from the arch of aorta. It is seen in 3% individual.

Venous Drainage

It is drained by superior, middle and inferior thyroid veins.

Nerve Supply

It is supplied by the nerves of cervical ganglion.

Lymphatic Drainage

Upper and lower group of cervical lymph nodes are supplied to this gland.

Applied Anatomy

1. Enlargement of the thyroid gland is called as goiter and it appears due to deficiency of dietary iodine.
2. *Hyperthyroidism* – Hyper secretion of thyroid hormone increases oxygen use by body cells elevates heat production and increases food intake. The most common form of hyper thyroidism is called as Grave's Disease.
3. *Hypothyroidism* – In the case of adult it is myxedema but in the case of child it is cretinism.

UPAVATKKAGRANTHI – PARATHYROID GLAND

Parathyroid glands are smallest endocrine organs situated on the posterior surface of the thyroid gland. They are four in number but they are arranged in two pairs, one pair is situated behind the upper pole of the thyroid gland close to upper branches of inferior thyroid artery and the second pair lies behind the lower pole of the thyroid gland near inferior thyroid artery.

Developmentally, they are derived from the outgrowth arising from endoderm of 3rd and fourth pharyngeal pouches.

Histologically, it has been found that the gland is packed with epithelial cells arranged in groups or cords. These cells are two in type and chief cells are main of them.

The second type of cells are called as oxyphili.

Chief cells of this gland give endocrine function by secreting a hormone known as Parathormone.

Parathormone

Parathormone is a single hormone consisting of a single polypeptide chain with 84 amino acid residue its molecular weight is 9500. It is secreted from chief cells of parathyroid gland.

Parathormone is one important factor for the maintenance of homeostasis of plasma calcium and after the removal of the parathyroid gland plasma calcium level decreases to about 6 mg (total plasma calcium level is 9mg to 10mg per 100ml).

Function of Parathormone

Its function are found mainly in three sites.

- (a) bone is one of the important sites for the action of parathyroid gland. Actually parathormone stimulates resorption of bone (demineralisation) by osteoclastic activity and also by decreasing pH in micro environment of bone resulting in increased outflow of calcium through the barrier of bone cells.
- (b) Kidney is the second site for the action of parathormone. Parathormone increases the reabsorption of calcium by the tubules of kidney. (98% of filtered calcium of glomerular filtrate is normally reabsorbed within it 60% is done by proximal tubule and 38% is made by distal tubule as well as by ascending limb of loop of Henle.

Parathyroid Gland



- (c) Small intestine is third site for the action of parathormone from the intestine, calcium is absorbed by the action of 1, 25 – dihydroxy cholecalciferol which stimulates the formation of ATPase enzyme by the process of transcription and translation.

BALAGRAIVEYAKAGRANTHI – THYMUS GLAND

It is an important lymphoid organ, situated in the anterior and superior mediastinum of the thorax extending above into the lower part of the neck. It is having function upto the age of puberty, and there after undergoes gradual atrophy and replacement by fat.

It is a bilobed structure made of two pyramidal lobes of unequal size which are connected together by areolar tissue.

It lies on the pericardium.

It weighs about 10 to 15 gm at birth,

30 to 40gm at puberty and only 10 gm after mid-adult life.

It is replaced by fat after puberty.

It produces some hormones thymosin, thymic humeral factor (thf), thymic factor (tf) thymosin, thymopoietin.

It promote and proliferation and maturation of T cells (a type of white blood cell) which destroy microbes and foreign substances. There is also some evidence that thymichormones may retard the aging process.

Blood Supply

Internal thoracic and inferior thyroid arteries supply the thymus gland.

The veins drain into the left brachiocephalic, internal thoracic and inferior thyroid veins.

Nerve Supply

The capsule is supplied by the phrenic nerve and by the descends cervicalis.

Functions

It controls lymphopoiesis and maintains an effective pool of circulating lymphocytes. It also controls development of the peripheral lymphoid tissues of the body during neonatal period.

Applied Anatomy

Myasthenia gravis is often associated with thymic hyperplasia characterized by excessive fatigability of voluntary muscles.

The precise role of the thymus is uncertain. It may influence directly or indirectly the transmission at the neuromuscular junction.

ADRENAL GLANDS

It is a paired gland situated superiorly to each kidney. These glands have 3-5cm in height, 2-3 in width and thickness, it weighs about 3.5-5gm. It consists into two regions. The outer adrenal cortex makes up the bulk of the gland and surrounds the inner adrenal medulla.

Adrenal Cortex

It is subdivided into three zones that secret different hormones:

Outer zone = Zona glomerulosa = mineral corticoids

Because they affect mineral homeostasis

Middle zone = Zona fasciculata = Glucocorticoids

They affect glucose homeostasis.

Inner zone = Zona recticularis = Androgens

They secrete male sex hormones.

Adrenal Medulla

It consists of hormone producing cells called chromatin cells. It surrounds large blood vessels.

Chromatin cells receive direct innervation from preganglionic nervous system (ANS).

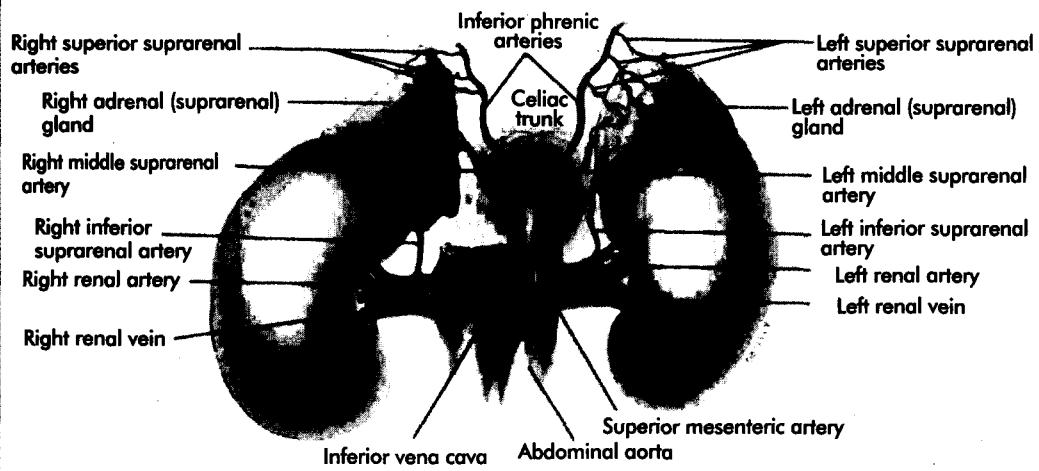
It secret hormones like epinephrine and norepinephrine.

The two principal hormones synthesized by the adrenal medulla called adrenaline and noradrenaline respectively.

Epinephrine constitutes about 80% of total secretion of the gland. Both hormones are sympathomimetic. Epinephrine and norepinephrine increase blood pressure by increasing heart rate and force of contraction and constricting blood vessels.

The adrenal medulla is not essential for life like adrenal cortex but its function is to release hormones at the time of emergency (stress) to tone up the sympathetic system to prepare the individual for flight or fight.

Location and Blood Supply of Adrenal Glands



Norepinephrine, epinephrine and dopamine are the most important members of catecholamines which are chemically known as Dihydroxylated phenolic compound.

Adrenal Cortex

The hormones secreted by the adrenal cortex are steroid in nature and they are under three headings:

1. Glucocorticoid
2. Mineralcorticoids
3. Sex hormones (adrogen)

Functional Anatomy

Supra renal glands are present on the upper poles of both kidneys and they resemble the cocked hat.

Each gland consists of outer cortex and inner medulla. These two zones are totally different developmentally, morphologically and functionally.

Its weight is about 3.5-5gm, 3-5cm in height and 2-3cm in width, 1cm thickness.

General Microscopoic Features of the Cortex of Supra Renal Gland

Externally, the gland has a thick capsule of connective tissue. Parenchymal cells (epithelial in nature) of adrenal cortex are divided into three distinct zones according to the arrangement of cells and first layer is zona glomerulosa immediately beneath the capsule cells of zona glomerulosa tend to be columnar and these cells are arranged in group and in between groups capillaries are present. beneath the zona glomerulosa the second layer is present which is known as Zona fasciculata consisting of polyhedral cells arranged in straight cords which are several in number and blood capillaries are present in between the straight cords. Deep to the layer of zona fasciculata, third layer is present known as Zona reticularis which contains polyhedral cells arranged in cords in various directions and they anastomose with one another. This layer is relatively thin and there are presence of capillaries in interstices between the cords.

The cytoplasm of the parenchymal cells of adrenal cortex does not contain any granule, but their organelles like mitochondria and endoplasmic reticulum (rough and smooth) are highly developed.

Cytoplasm of these cells contain cholesterol which is present in the form of large number of lipid droplets. These lipid droplets are highly concentrated within cells of zona fasciculata and also the cells of zona fasciculata contain considerable quantities of ascorbic acid. However, cholesterol present within cells of adrenal cortex serve as precursor of steroid hormones secreted by the said gland. Adrenocorticotrophic hor-

mone (ACTH) secreted by basophilic cells of anterior pituitary maintains the integrity of cells of zona fasciulata and zona reticularis. ACTH has not role on the integrity of zona glomerulosa.

Experimentally, it has been found that after hypophysectomy, layers of zona fasciulata and zona reticularis are atrophied, but no effect is seen in the layer of zona glomerulosa.

Glucocorticoids – Secreted by Zona fasciulata.

Mineralcorticoids – Secreted by zona glomerulosa.

Sex hormones – Secreted by Zona reticularis.

Adrenocortical steroids structurally are two in type – First group – Glucocorticoid and mineral corticoid containing 21 carbon atoms (C21 steroids) and another group (sex hormone) containing 19 carbon atoms (C19 steroids).

Glucocorticoids – Cortisol, cortisone and corticosterone are the potent glucocorticoid in man. It maintains intermediary metabolism of different food stuffs (carbohydrate, protein and fat); but the nomenclature of glucocorticoid indicates that their actions are mainly on the metabolism of carbohydrates.

The secretion of cortisol is 30 mg per day and 90% of the total amount remains bound with globulin within plasma and this protein is known as cortisol binding globulin but the minor portion of this hormone is bound with albumin and only 2% of the total amount remains in free state.

Normal secretion of cortisol varies from 10-20 mg/100 ml of plasma. During the time of pregnancy and early part of the morning the level of plasma cortisol is increased due to more formation of cortisol binding globulin (CBG) within the liver.

Applied Anatomy

1. Hyperfunction of cortisol leads to *cushing's disease or cushing's syndrome*. In this case excess protein catabolism is found. Due to this fact the skin and subcutaneous tissues are thin as well as muscles are poorly developed.
2. *Adrenogenital syndrome* – Biosynthesis of cortisol requires several important enzymes. Among these, a partial deficiency of 21 hydroxylase enzyme is sometimes found from the birth and it produces common variety of adrenal congenital hyperplasia. Actually congenital adrenal hyperplasia produces precocious puberty *i.e*, early appearance of secondary sex character without spermatogenesis due to high concentration of androgen in blood.

In the case of female, there is development of pseudohermaphroditism and progressive virilisation will happen. In this case the uterus remains in female, ovaries become

rudimentary, breast fail to develop, clitoris is hypertrophied, menstruation is absent. The patient develops masculine body. Constitution like deep voice, appearance of body hair, beard, mustache, baldness, receding hairline on the forehead and distribution of pubic hair will be male pattern. Early growth is accelerated, but there is early closure of epiphyseal growth centers.

Aldosterone

It is highly potent mineral corticoid. It maintains mineral metabolism (Na^+ and K^+) of the body. It is secreted by zona glomerulosa.

Functions

It causes the retention of Na and excretion of K and this function is mediated through Kidney. Sodium reabsorption and potassium excretion through distal tubules of the kidneys are done by the action of aldosterone. It is known to all that by retaining Na^+ within the body there is increased blood volume which makes high blood pressure. In addition to these aldosterone enhances water diuresis by antagonising the action of ADH hormone directly at the site of renal tubule.

Regulation and Secretion of Aldosterone

ACTH has no role in the secretion of aldosterone,

1. Plasma level of K^+ is very much important factor to regulate the secretion of aldosterone. High concentration of plasma K^+ increases the secretion of aldosterone. Similarly, the secretion of aldosterone is decreased by low level of plasma K^+ .
2. Plasma level of Na^+ is another important factor for the secretion of aldosterone. Low plasma level of Na^+ increases the secretion of aldosterone and vice-versa.
3. Intravascular fluid volume also has an important role for the regulation of secretion of aldosterone through renin-angiotensin axis. Actually, low volume of blood within the vascular system due to heart failure or due to any other cause produces less perfusion of blood to kidney – tissue which stimulates the secretion of renin from juxtaglomerular cell of juxtaglomerular apparatus.

Applied Anatomy

Hyper function of zona glomerulosa produces primary aldosteronism (Conn's disease), which will produce hypertension and hypokalaemia. Again due to hypokalaemia it causes alkalosis.

Assessment of the Function of Adrenal Cortex

Kepler's water excretion test is done to see hypofunction of adrenal cortex (Addison's disease).

PINEAL BODY

It is attached to the roof of third ventricle. (it just looks like a pine cone = pinealis) it is covered by a capsule formed by pia mater and consists of neuroglia and some secreting cells called as pinealocytes.

Sympathetic post ganglionic fibres from the superior cervical ganglion terminate in the pineal gland.

It is having some anatomical features, but its physiological role is still unclear.

The pineal gland secretes one hormone named as melatonin.

Melatonin secretion is less wherever there is sunlight. When the light enters the eyes, it strikes the retina and stimulates the photo receptors. After that the retinal neurons activated by photoreceptors transmit impulses to the suprachiasmatic nucleus of the hypothalamus.

In sunlight, norepinephrine released by the sympathetic fibres inhibits secretion of melatonin by cells of the pineal gland resulting in sleepiness.

Thus the release of melatonin is governed by the diurnal (daily) dark-light cycle.

SEX ORGANS

The meanings of sex is expressed in terms of chromosomal sex, gondal sex and genital sex. Actually, sex is determined by the presence of a single pair of endocrine organ and they are named as testes in the case of a male and as ovaries in the case of a female.

Gonads give two functions. One is the process of gametogenesis (spermatogenesis or ovulation) and the second function of gonad is the secretion of sex hormones (testosterone from testis and estrogen, progesterone from ovary). Again it is said that testosterone is masculinizing in action and estrogen feminizing in action. These sex hormones are responsible for development of secondary sex characters in both sexes. Again, pituitary gonadotrophins (FSH and LH) control the gametogenic as well as secretory functions of testis and ovary. Sex hormones of both sexes begin to secrete from puberty onward and the secretion of sex hormones in the case of female happens in a cyclic fashion, which is necessary for the occurrence of menstruation, preg-

nancy and lactation. However, at a certain age, the secretion of female hormones is ceased (menopause) due to regression of the activities of ovaries and at this stage ovarian sensitivity to gonadotrophines decreases.

But the differentiation of gonads into either testis or ovary begins from seventh week of intrauterine life. So, before this time, the determination of sex is made through the help of sex chromosome. In the array of sex chromosome, the presence of Y-chromosome determines the male pattern. This determining factor appears at the time of gametogenesis during the formation of zygote. So, Y-chromosome is responsible for sex differentiation. At the time of fertilization, there is process of cell division by meiosis, as a result each gamet contains 23 chromosome, of which one is sex chromosome which is either X or Y in the case of a male. Again, a spermatozoa containing sex chromosome either X or Y is fertilized with one matured ovum containing sex chromosome, *i.e.*, 46 number, of which the pair of sex chromosome becomes either XX or XY. This pair of sex chromosome will say whether the zygote will be male or female.

Puberty (Adolescence)

It is the age when a man and a woman have developed a power of reproduction (spermatogenesis or ovulation) with the appearance of secondary sex characters. The average age for the onset of puberty is twelve years, by the minimal age for the onset of puberty may be 10 years and its maximal age may be sixteen years. Before the onset of puberty, gonads (testes or ovaries) remain silent. But at this side age (age of puberty), endocrine and gametogenic functions of gonads are first developed. However puberty may appear without the power of reproduction and it is described as pseudopuberty. Sometimes, puberty may appear before the scheduled age *i.e.*, before the age of ten and it is called precocious puberty. This happens due to the congenital adrenal hyperplasia. Again, puberty may appear beyond the age of sixteen and it is described as delayed puberty.

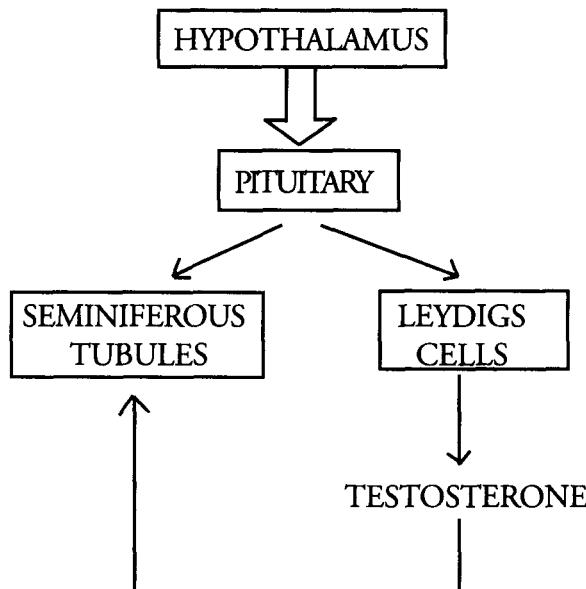
Functional Anatomy of Male Gonad

Male gonad (testis) is two in number and they are located within the scrotum. The outer covering of testes is fibrous known as tunica albuginae.

Gametogenesis

It means the formation of gamet (male or female). The process through which it happens in the case of a male is known as spermatogenesis. Actually, spermatogenesis means the formation and maturation of male gamete (spermatozoa).

The process consists of several steps. Final steps of spermatogenesis comprise the alteration of a single spermatid morphologically in to a spermatozoa. The initial step of spermatogenesis is the transformation of spermatogonia in to primary spermatocyte by the help of mitosis. Then each chromosome splits longitudinally to form ninety two numbers of chromatids which are distributed equally in to two daughter cells. So each, daughter cell contains ultimately forty six number chromosomes. Afterwards each primary spermatocyte undergoes meiotic division where each daughter cell contains haploid number of chromosomes (23 chromosomes). Ultimately, each primary spermatocyte is turned in to four spermatids.



The control of testicular function is mediated through the interrelationship between anterior pituitary, hypothalamus and plasma concentration of androgen.

The level of testosterone in body fluid always maintains a negative feedback mechanism with the pituitary (short loop system) and also with the hypothalamus (long loop system).

Androgen (Testosterone)

Pregnenolone is the precursor for the synthesis of androgen. Again pregnenolone is produced from cholesterol. The main site for the synthesis of androgen is Leydig's cells which appear at the age of puberty.

Androgen is synthesized also in the suprarenal cortex (zona reticularis). The rate of secretion of testosterone is 4 to 9 mg/day in the case of normal young adult male.

Functions

Androgen has different functions which appear normally at the age of puberty.

(i) Spermatogenesis

It has been already discussed in connection with the formation of male gamet. However, spermatogenesis requires optimum temperature which is considerable below the core temperature of the body. So, when the testes remains within the scrotum, they are kept cool to maintain spermatogenesis by the spermatogenesis is impaired in the case of undescended testis.

(ii) Anabolic Action (Growth Promoting Effect)

It is done by the process of transcription and translation. But, the mode of action of testosterone at cellular level for its anabolic action is probably expressed like such that the testosterone enters in to the target cells by the process of diffusion and it combines with specific receptor present with in cytosol to produce receptor complex which comes in contact with nuclear membrane of the cell to stimulate the formation of messenger RNA (transcription) which does the process of translation at the site of ribosome for the synthesis of protein by which the growth of the target organ increases.

(iii) Testosterone

Maintains secondary sexual characters (body changes) of male which begin at the onset of puberty and these body changes are described under the following headings:

(i) *Genitalia*

External genitalia

Penis, scrotum are fully matured.

Internal genitalia

- (i) Seminal vesicles are enlarged and they begin to synthesize fructose.
- (ii) Prostate and bulbourethral gland enlarge and are fully matured. At the age of puberty, both seminal vesicle and prostate begin to secrete semen.

(ii) *Voice*

Vocal cords are thickened and the voice becomes deeper and husky.

(iii) *Mental Status*

Aggressive attitude appears with interest on opposite sex.

(iv) *Hair Growth*

Appearance of hair in axilla, pubis and chest. In addition to these, there is appearance

of beard and moustache. The distribution of hair on the surface of body increases.

(v) Body Stature

Shoulder girdle is expanded and the pelvic girdle is narrowed and the whole body becomes masculine in character.

There is appearance of acne due to increased secretion of sebaceous gland and the secretions is not cleared from the gland due to thickening.

The normal plasma level of testosterone (free and bound) in the case of normal young adult male is 0.65 microgram/100 ml. But in the case of female it is 0.02 microgm/100 ml of plasma.

The source of testosterone in case of female is adrenal cortex (zona reticularis). The major portion of testosterone is bound with plasma protein, mainly globulin known as gonadal binding (Gbg) globulin.

But a small portion of testosterone is converted in to oestrogen with in the body. So, source of oestrogen in the case of male is probably From testosterone.

Functional Anatomy of Female Gonad

Female gonad (ovary) is two in number and they are located with in the upper part of pelvic cavity, but they are fixed to the broad ligament by the mesovarium. The medial end of the ovary is attached to the lateral and outer part of the uterus by ovarian ligament, and the lateral end of the ovary is attached to infundibulum by another ligament known as infundibulopelvic or suspensory ligament of the ovary.

Functions of Ovary

1. Gametogenesis (ovulation)
2. Endocrine

The Ovulation is Controlled by Following Hormones:

1. Fsh (Follicle Stimulating Hormone)

It acts on the ovary to increase growth, maturation of the its primordial follicle leading to the formation of graffian follicle.

2. Estrogen

High plasma concentration of estrogen secreted by graffian follicle causes the surging of LH (Leutinising Hormone) secretion from the anterior pituitary through the mechanism of positive feed back (LH surge).

The leutinsing hormone makes the formation of corpus luteum by facilitating the process of ovulation.

Time of Ovulation

The date of ovulation varies between the 12th and 16th day of menstrual cycle. So, it is assumed that the approximate time of ovulation is mid portion of the 28 day cycle. i.e., 14th day of the cycle. Usually, this time is calculated by 14th day prior to the first day of next menstruation because the preovulatory or follicular phase of the cycle is more liable in relation to post ovulatory phase or secretory phase of the cycle.

By the detecting the time of ovulation, two things are evaluated:

1. To see whether the mother is sterile or not.
2. To see the safe period to avoid conception during coitus.

Endocrine Functions of Ovary

1. Estrogen, progesterone and relaxin are the hormones of ovary.

Estrogen

The common sites of synthesis of estrogen are ovary (cells of theca interna of follicle), corpus luteum and placenta. Usually the secretion of estrogen begins from the onset of puberty and it is secreted throughout the menstrual cycle and actually, there are presence of two peaks in the secretion of estrogen, one is at the time of ovulation and another is in the mid point of luteal phase.

- Estrogen increases the growth of ovarian follicle in absence of follicle stimulating hormone. Estrogen takes an important role in the process of ovulation.
- At puberty of a girl, estrogen mainly induces ductal development of the breast. As a result the breast is largely enlarged. Similarly, the enlargement of the breast is found also at the time of pregnancy due to the effect of many hormones, of which estrogen is one which is primarily responsible for proliferation of ducts and ductules of the breast.
- Onset of menstruation, narrowing of the shoulder and broadening of hips and thighs, voice becomes high pitched.
- Appearance of axillary and pubic hairs, sexual desire dilation of skin capillaries.

Progesterone

It is mainly secreted by corpus luteum. But at the time of pregnancy additional source of progesterone is from placenta.

Progesterone is metabolized mainly in the liver and it is converted into pregnandiol which is excreted in urine in the form of glucuronide and sulphate of pregnandiol and the peak urinary excretion occurs on 20th or 21st day of menstrual cycle.

Urinary excretion of pregnandiol indicates plasma level of progesterone within the plasma it remains bound with globulin. Its peak level in plasma occurs about one week after ovulation (the rate of secretion of progesterone by corpus luteum is 25 to 30 mg/day). But its level in plasma becomes almost nil about 2 days before menstruation. On the other hand, plasma level of progesterone increases also in the later part of pregnancy.

Actions of Progesterone

1. Follicular phase of menstrual cycle is turned into secretory phase of this said cycle by the action of progesterone. In the secretory phase, progesterone actually prepares the endometrium for implantation of blastocyst (to be discussed in the heading of pregnancy). Progesterone inhibits the contractility of myometrium by increasing the resting potential of uterine musculature. As a result uterus becomes calm and quite maintain pregnancy.
2. After the ovulation luteal phase begins and the action of progesterone is found on the cervix of uterus where the secretion of cervical mucus is scanty and thick.
3. In the follicular phase of menstrual cycle there are presence of irritability and rhythmic contraction of fallopian tube due to the action of estrogen. But fallopian tube is relatively silent in the luteal phase of the cycle by the action of progesterone leading to facilitation in the transport of the fertilized ovum to the uterine cavity.
4. Progesterone suppresses the secretion of LH hormone and increases the basal body temperature in the luteal phase of menstrual cycle.

Relaxin

It is a third variety of hormones secreted by ovary, but a little amount of the said hormone is secreted by placenta.

It causes

1. Softening of cervix.
2. Relax pelvic ligaments and symphysis pubis.

Miscellaneous Hormones (Local Hormones)

These hormones are secreted locally and they give their effects in both local and its

surrounding. The local hormones include prostaglandin, histamine, serotonin, bradykinin, noradrenaline, adrenaline, melatonin, secretin, CCK, gastrin.

Prostaglandin

It is derived from unsaturated fatty acid containing 20 carbon atoms and it is known as arachidonic acid.

It is present in high concentration within human seminal fluid where it is discovered at first. But it is found in many other tissues in a smaller concentration. The tissues are brain, lungs, kidneys, heart, uterus, placenta, testes, stomach, gut etc.

In minute concentratin gives striking pharmacological action. On all main systems of the body. In the reproductive system it increases the contraction of pregnant uterus. It increases the motility of spermatozoa. In the case of stomach, it increases its motility, but decreases gastric acidity and increases mucosal barrier of the stomach. It also increases renal blood flow.

However, prostaglandin of different varieties give different action on heart, blood vessels, bronchial muscle etc.

As for example, some may produce dilation of bronchial muscles. But some may produce constriction of them.

However, prostaglandins are neurotransmitter within CNS. So, they are sufficiently present within the brain. It also increases capillary permeability.

Histamine

It is produced by the decarboxylation of histidine aminoacid in the mast cells of the tissues. It increases the capillary permeability. It makes contraction of bronchial muscle, smooth muscle of intestine and also it increases the secretion of gastric glands. Histamine takes part in the secretion of HCl within the stomach of a normal health. However, the action of histamine on different organs are mediated through H₁ and H₂ receptors. Histamine may act as neurotransmitter. During the antigen antibody reactions, profuse amount of histamine comes to blood stream and it produces hightened and frightened reactions which are described as hypersensitivity. So histamine can produce bronchial spasm, skin rash (urticaria) etc.

Serotonin (5-Hydroxy Tryptamine)

It is released from damaged platelets. It is a strong vasoconstrictor. It is a neurotransmitter within CNS. So, its presence in brain remains in high concentration. In the

mechanism of sleep, serotonin has some role. Serotonin is derived from aminoacid known as tryptophan. The depletion of serotonin from brain cause retardation of mental faculty.

Bradykinin

It is degraded by ACE (angiotensin converting enzyme) also called as kininase enzyme. It causes vaso dialatation during the process of inflammation. It is one of the pain producing substances. Accumulation of bradykinin can cause cough. ACE inhibitors, which are used for hypertension can cause severe cough.

Secretion, CCK- Pz and Gastin

In response to fatty acids and amino acids, some enteroendocrine cells secrete cholecystokinin (CCK) in to the blood. In response to acidic chyme, other enteroendocrine cells in the small intestinal mucosal liberate secretin in to the blood.

Secretin stimulates the flow of pancreatic juice that is rich in bicarbonate ions.

Cholecystocynin (CCK)

Stimulates pancreatic secretion rich in digestive enzymes.



Kala reflects the structural and functional boundaries of organs. As far as *ashayas* are concerned, they are separated from other organs mostly by the help of membranes. The membranes, which is carrying the typical corresponding structural qualities of the organs. *Dhatus*, which are continuously transforming will also show the basic structural identity, which is seen just before it gets transformed into the next *dhatu*. This is very similar to the tissues at the structural level.

The *kala* can be compared with the membrane or fascia which is a covering for the viscera.

Definition of Kala

कला: खल्वपि सप्त भवन्ति धात्वाशयान्तरमर्यादा: ॥ (Su. Sha. 4/5)

The space occupied by a matter present in between *dhatu* and *ashaya* is called *Kala*. They are seven in number. By looking at its configuration and structure it is compared with the membrane.

यथा हि सारः काष्ठेषु छिद्यमानेषु दृश्यते ।
तथा हि धातुर्मासेषु छिद्यमानेषु दृश्यते ॥
स्नायुभिष्ट प्रतिच्छन्नान् सन्तातांष्ट जरायुणा ।
लेघ्मणा वेष्टितांश्टापि कलाभागांस्तु तान् विदुः ॥ (Su. Sha. 4/6-7)

धात्वाशयान्तरं कलेदो विपक्वः स्वंस्वमूष्मणा ।
लेघ्म स्नायु अपराछन्नः कलाख्यः काष्ठ सारवत् । (As. Hr. Sha. 3/9-10)

Dhatu which is present in the *ashaya* contains some *medaha amsha*. Due to its own *agni* (*dhatvagni*) the *ushma* from the *pitadasha* help in the digestion of *medaja sneha*. Lastly, the *medaja sneha* is converted to *kala*. The *kala* is like a membrane.

धात्वान्तरेषु याः सप्त कलाः संपरिकीर्तिताः ।
ताखेकैकामतिक्रम्य वेगंप्रकुरुते विषम् ॥

They usually affects all the seven *dhatus* and *kalas* by its *rooksha* and *ushna* nature.

Functions of Kala

- (1) Absorption (*shoshana*) of the nutrients. e.g. the absorption of water in the intestine.
- (2) Secretion (*sravana*)
- (3) Selectivity (*vivechana*)
- (4) Protection (*samrakshana*)

According to Ayurveda there are seven *Kalas*

- (1) *Mansadhara Kala*
- (2) *Raktadhara Kala (Asrikdhara kala)*
- (3) *Medodhara Kala*
- (4) *Shleshmadhara Kala*
- (5) *Purishadhara Kala (Maladhara Kala)*
- (6) *Pitadhara Kala*
- (7) *Shukradhara Kala*

These *Kalas* are described by *acharya* as *Samanya Kala*.

Vishishta Kala

- (1) *Udaravavan Kala* (peritoneum)
- (2) *Phupphusavavana Kala* (pleura)
- (3) *Hridayavarana Kala* (pericardium)
- (4) *Mastishkavarana Kala* (meninges)
- (5) *Sandhyavarana Kala* (synovial membrane)

1. Mansadhara Kala

तासां प्रथमा मांसधरा, यस्यां मांसे सिरा ऋग्युधमनीस्रोतसां प्रताना भवन्ति ॥

(*Su. Sha. 4/8*)

According to *Sushruta* the first *Kala* is called *Mansadhara Kala*. In this *Kala* the *srotas*, *sira*, *dhamani*, *snayu* are present.

यथा बिसमृणालानि विवर्धन्ते समन्ततः ।

भूमौ पंकोदकस्थानि तथा मांसे सिरादयः ॥

(*Su. Sha. 4/9*)

The *Visamrinalani* (lotus associated with stem or stalk) which is present in the mud water of the pond and the root of the lotus flower is situated in the water.

Comparison:

- (1) The *Visamrninalani* is complex or the ramification of the *srotas* or the *dhamani*.
- (2) The *bhumi* is the *mansadhatu*.
- (3) The *pankodaka* is the *mansadhabra kala*.

Looking at the structure and the composition of the *mansadhabra kala*, it can be compared with membrane of fascia which is present just below the dermis and just above the muscle fibres. These are the structures present in the various muscular nerves and lymphatic nerve. The main function of the deep fascia is to separate the muscle tissues and dermis. It acts as a cushion or a shock absorber for the muscle fibres and by the help of deep fascia the muscle can work independently.

2. Raktadhara Kala (asrikdhara kala)

द्वितीया रक्तधरा मांसस्याभ्यन्तरतः, तस्यां शोणितं विशेषतया सिरासु यकृत्प्लीडोषा भवति।
(Su. Sha. 4/10)

वृक्षाद्यथाभिप्रहतात् क्षीरिणः क्षीरमावहेत्।
मांसादेवं क्षतात् क्षिप्रं शोणितं संप्रसिच्यते॥

(Su. Sha. 4/11)

The second layer of *kala* is *raktadhara kala*. It is present inside the *mansa*. This *kala* contains blood and it is generally found in *sira*, *yakrit* (liver) and *pliba* (spleen).

The blood which is supplied to the *mansadhabra kala* is from *raktadhara kala*. In the body the blood circulates by three types of channels they are:

1. *Sira* (Veins),
2. *Dhamani* (artery) and
3. *Srotasa* (raktavahasrotas).

When there is an injury to the cactus (*snuhī*) tree then some milk like scretion will come out. Similarly the blood oozes out immediately form the *mansa* when it is injured.

Considering the above reference this *raktadhara kala* can be compared with the endothelial lining of the blood vessel. The blood vessel measures more than 1 mm in diameter. They are present with the endothelial lining. Each blood vessel contains three types of structures.

They are:

1. Tunica Intima
2. Tunica Media
3. Tunica Externa.

Endothelium is present in the tunica intima. The capillaries which are measuring less than 1 mm in diameter are composed of single layer of endothelium. The main function of the capillary is the transportation of the blood (exchange of intracellular and extracellular fluids), (exchange of oxygenated blood and deoxygenated blood).

3. Medodhara Kala

तृतीया मेदोधरा, मेदो हि सर्वभूतानामुदरस्थमण्वस्थिषु च, महत्सु च मज्जा भवति ॥

(Su. Sha. 4/12)

स्थूलास्थिषु विशेषेण मज्जा त्वभ्यन्तराश्रितः ।

अथेतरेषु सर्वेषु सरकं मेद उच्यते ।

शुद्धमांसस्य यः स्नेहः सा वसा परिकीर्तिता ॥

(Su. Sha. 4/13)

The third *kala* is called as the *medodhara kala*. The *meda* is found in *udarabhati* (abdominal wall), *anvasthi* (small bones) of all human beings. The bone marrow is present in the long bones. The *maja* (bone marrow) is specially found in the *sthulasthi* (long bone) *medodhara kala* is made up of *prithvi mahabhuta*.

Functions of the Bone

1. Supports the body.
2. Protection
3. Movement
4. The mineral homeostasis which is important in the muscle contraction and nerve activities.
5. The sites of blood cell production within certain parts of a bone a connective tissue called as red bone marrow produces blood cells, this process is called as the erythropoiesis or haemopoiesis. The red bone marrow produces RBC, WBC platelets and adipose tissues.
6. *Storage of energy* – Lipids stored in cells of a second type of bone marrow is called as yellow bone marrow and it is the important source of energy. The yellow bone marrow consists of adipose cells and bone cells.

The substance found inside the other bones is *meda* mixed with the *rakta*. The *sneha* (fat or oily substance of the pure mansa) is called as *vasa*.

The peritoneum is the largest membrane of the body. This membrane consists of a single layer of squamous epithelium. But just below this layer, a connective tissue is present. the peritoneum is of two types parietal and visceral peritoneum.

The parietal peritoneum lines the walls of the abdominal cavity.

The visceral peritoneum covers some of the organs (internal organs).

The peritoneal space is present between the parietal peritoneum and visceral peritoneum and it is called as peritoneal cavity. It contains little amount of serous fluid. In certain diseases the peritoneal cavity may be distended as (in case of ascites).

The peritoneum contains large fold waves between the viscera. The fold binds the organs to each other and to the walls of the cavity. Some folds are attached to the posterior abdominal wall. The mesentery binds the small intestine to the wall. A similar fold of parietal peritoneum binds the large intestine to the posterior abdominal wall. The examples of the peritoneal folds are lesser omentum and greater omentum.

The lesser omentum helps in the suspension of the stomach, duodenum and falciform ligament.

The greater omentum is the largest peritoneum fold. It gives support to the transverse colon and coils of the small intestine.

Composition of Greater Omentum

It contains large amount of adipose tissue; that is why it is called as fatty apron. Greater omentum is also called as omentum majus and omentum minus.

4. Shleshmadhara Kala

चतुर्थी लेष्मधरा सर्वसन्धिषु प्राणभृतां भवति ॥

(Su. Sha. 4/14)

स्नेहाभ्यक्ते यता हाक्षे चक्रं साधु प्रवर्तते ।

सन्धयः साधु वर्तन्ते संलिष्टाः श्लेष्मणा तथा ॥

(Su. Sha. 4/15)

The fourth *kala* is called as the, *shleshmadhara kala*.

This *shleshmadhara kala* is present in all the joints (*chaliasandhi*). It is compared to a wheel that is moving with the help of an axle without producing any sound, similarly the movable joint is moving smoothly by the help of synovial fluid.

Asthi is continuously dried up by vayu.

The amount of the synovial fluid present in each joint is sufficient only to form a thin film over the surface within an articular capsule where the synovial fluid reduces the friction and supplies nutrients and removes the metabolic wastes from the cartilage cells of the articular cartilage.

Applied Anatomy

1. Synovitis (Inflammation of synovial membrane).
2. Synovial arthritis (This is mainly due to the infection of synovial fluid).
3. Osteo arthritis (when the synovial fluid is very less)s produces a critical sound crepitus on movement.

5. Purishadhara Kala (Maladhara Kala)

पञ्चमी पुरीषधरा नाम, या अन्तःकोष्ठे मलमभिविभजते पक्षाशयस्था ॥ (Su. Sha. 4/16)

यकृत्समन्तात् कोष्ठं च तथा आन्त्राणि समाश्रिता ।

उण्डुकस्थं विभजते मलं मलधरा कला ॥ (Su. Sha. 4/17)

The fifth *kala* is *purishadhara kala* (*maladhara kala*). It is present in *annavaha srotas* (G.I. tract) *antahkoshtha*. The main function of this *kala* is the *malavibhajana karma* (to form the faecal matter). It takes place in *pakvashaya* (large intestine).

In the *koshtha*, *yakrit* (liver) is present. The liver has some role in the digestion particularly in the digestion of fat.

Small Intestine

1. Bolus
 2. *Segmentation phase* – This is 12-14 times/minute.
 3. *Peristalsis Phase* – From the food bolus it is converted to chyme. The chyme is propelled through the intestinal tract (movement is 1cm/min). The food will remain for 3-6hrs in small intestine.
 4. *Water absorption in small intestine* – The total volume of the fluid that enters the small intestine is nearly about 9 lits/day. This fluid is derived from the ingestion of the liquids and various GI secretion (pancreatic juice, hepatic juice and intestinal juice) is about 7.5 lts. Roughly 8-8.5 lits of fluid is absorbed in the small intestine. The absorption of water by the small intestine occurs by osmosis from the lumen of the small intestine (epithelial cells and blood capillaries present in the villi). The normal rate of absorption is nearly about 200-400 ml in an hour.
1. Water
 2. Electrolytes absorption
 3. Vitamin absorption like Vitamin A, Vitamin B, Vitamin C etc.

Large Intestine

1. Completion of absorption.
2. The manufacture of certain vitamins.
3. Formation of the faeces.
4. Expulsion of the faeces or faecal matter.

Chyme

The chyme will remain in the large intestine for 3-10 hours. After that the water absorption takes place. Then the chyme will be transferred to solid or semisolid material (stool).

Constituents of Faeces

1. Water
2. Inorganic salts.

Epithelial Cells

It comes from the mucosa of the G.I. tract, bacteria and undigested food.

6. Pittadhara Kala

षष्ठी पित्तधरा, या चतुर्विधमन्नपानमामाशयात् प्रच्युतं पक्वाशयोपस्थितं धारयति ॥
 (Su. Sha. 4/18)

अशिंतं खादितं पितं लीढं कोष्ठगतं नृणाम् ।
 तज्जीव्यति यथाकालं शोषितं पित्ततेजसा ॥
 (Su. Sha. 4/19)

This is an attempt by the Acharyas to describe the structural unit of the body in the form of *kala*. Which is reflecting the same qualities and characteristics of the corresponding *dhatus*.

Sixth kala is *pittadhara kala*. The main function of the *pittadhara kala* is *jirya* (digestion) and *shoshana* (absorption) of *chaturvidha annapana* i.e., (eating, licking, sucking and drinking). These four types of food get digested due to the *Jatharagni* (*pachakapittam*).

According to Ayurveda, digestion, absorption and secretion are controlled by *agni* (*pachakagni* and *jatharagni* or *kayagni*) and it is described that the *pittasthana* is the *pachyamanashaya* which is situated in between the *pakvashaya* and *amashaya*. *Pachyamanashaya* is where the digested food is redigested and absorbed. All digestion and absorption takes place in *pachyamanashaya* with the help of the *jatharagni*.

Physiology of Digestion

I Phase

Whenever we take food, the food is mixed with saliva (ptyalin). The food is changed in to a soft flexible mass called as bolus. The salivary gland secretes salivary amylase which breaks down the carbohydrates (disaccharides).

II Phase

It goes to osopharynx and this is controlled by the tongue.

III Phase

From the oropharynx it goes to the laryngo pharynx. In this phase it is involuntary and the food goes to the oesophagus. It has two sphincters, upper oesophagus sphincter and lower oesophagus sphincter. Oesophagus does not secrete any enzyme and hormones. By the peristaltic movement of the oesophagus the food goes to the stomach.

Stomach

1. *Zymogenis peptic cell* which secretes pepsin helps in the digestion of proteins.
2. *Parietal cell* – It secretes HCl it helps for the digestion of protein. It converts pepsinogen in to peptide and does the absorption of Vitamin B12.
3. *Mucus Cell* – Which secretes mucus.
4. *Entero endocrine cells* – Which secretes a hormone called as gastrin hormone. It stimulates the gastric secretion.

Then from the stomach the food enters the duodenum. Duodenum is controlled by two hormones.

1. Secretin
2. Cholecystokinin.

Both are present in the intestinal mucosal. The hormones increase the secretion of the pancreatic juice.

1. *Achlorhydria* – HCl is absent in the stomach.
 2. *Hyperchlorhydria* – Excess of HCL in the stomach. Hyperchlorhydrea is called as *Zollinger Ellison Syndrome*.
- 7. Shukradhara Kala**

सप्तमी शुक्रधरा नामः, या सर्वप्राणिनां सर्वशरीरव्यापिनी ॥ (Su. Sha. 4/20)

यथा पर्यसि सर्पिस्तु गूढष्टेक्षी रसो यथा ।
शरीरेषु तथा शुक्रं नृणां विद्याद्विषग्वरः ॥

(Su. Sha. 4/21)

The seventh *kala* is called as the *shukradhara kala*. Which is present all over the body of all human beings.

Co-relation

The *shukra* is found in whole of the body just like the *ghrita* is present in the milk. It is also co-related with sugar of the sugarcane.

The *shukradhara kala* is present below the opening of the *basti* (urinary bladder) particularly it is present two fingers on the right side of the *basti*. *Shukra* comes out through the *Mutravaha srotas* during the act of sexual intercourse with a female.

Male Genital Organs and Female Genital Organs

Male

- 1. Penis 2. Two testis 3. Vas deferens 4. Seminal vesicle.

Female

- 1. Vagina 2. Clitoris 3. Uterus 4. Fallopian tube
- 5. Ovary

Associated sexual organ is breast.

I Stage

Errection

In case of male

The stiffening and hardening of the penis due to the tactile sensation, visual sensation and some anticipating tale with the female partner.

In case of female

Excitation and loosening of the perineal muscles.

II Stage

Lubrication

Male

Mucus like secretion coming out from the urethral opening *i.e.*, from the bulbourethral gland and prostate gland secretion.

Female

Some fluid material comes out from the vaginal orifice *i.e.*, from the bartholin gland. The dilation of the vaginal orifice.

VISHISHTA KALA

Phupphusavarana Kala (Pleura)

The pleura is a serous membrane which is lined by mesothelium. There are two pleural sacs, one on either side of the mediastinum.

The cavity of the thorax contains right and left pleural cavity which are completely invaginated and occupied by the lungs. Both the pleural cavities are separated by mediastinum. Heart lies in the mediastinum.

Structurally the pleura is composed of two layers.

1. Parietal pleura (outer layer). It is attached to the wall of the thoracic cavity.
2. Visceral pleura or pulmonary pleura. It is the inner membrane of the pleura. It is attached to the lungs. The visceral pleura is closely adherent to the lungs. Between the visceral pleura and the parietal pleura there is a small potential space which contains a lubricating fluid secreted by the membrane. This fluid prevents the friction prevents the friction between the membranes and allows them to move easily on one another during breathing.

Parital Pleura

It is thicker compared to the pulmonary pleura. It is divided in to four parts:

- | | |
|-------------------------|------------------------|
| 1. Cervical Pleura. | 2. Costal Pleura |
| 3. Diaphragmatic Pleura | 4. Mediastinal Pleura. |

Visceral Pleura

It covers all the surfaces and the fissure of the lung except hilum and it is closely adherent to the lung and it cannot be separated.

Cervical Pleura

It extends in to the neck nearly two inches above the first costal cartilage and one inch above the medial one third of the clavicle and it covers the apex of the lungs. It is attached anteriorly to the sub clavian artery and scalenus artery.

Posteriorly is attached to the neck of the first rib. Laterally to the scalenus medias and medially to the large basals of the neck.

Costal Pleura

It lines the thoracic wall (ribs and intercostals spaces). It is attached to the thoracic wall by a loose areolar tissue. (The areolar tissue is called as the endothoracic fascia).

Diaphragmatic Pleura

It is present over the diaphragm. In some individuals it is not continuous over the diaphragm.

Mediastinal Pleura

It lines the corresponding surface of the mediastinum. This mediastinal pleura is closely attached to the pulmonary pleura around the hilum of the lung.

Blood Supply

The pleura is supplied by

1. Intercostal artery
2. Internal Thoracic artery
3. Musculo-Phrenic artery.

Vein Supply

The veins drain into the azygous and internal thoracic vein.

Nerve Supply

Inter costal and phrenic nerve.

The parietal pleura is very sensitive to pain.

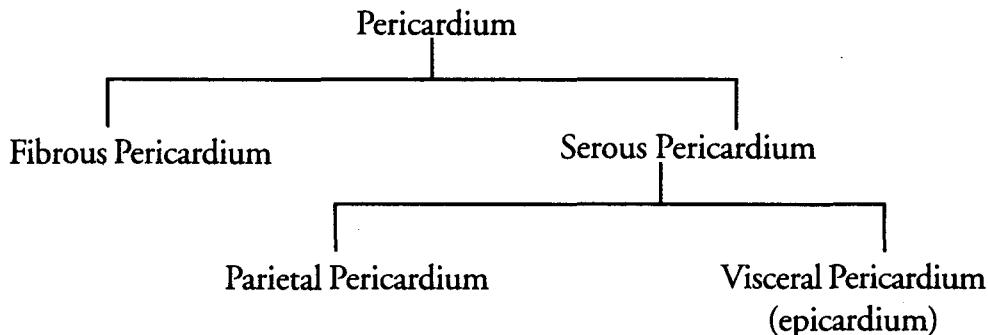
The costal pleura is supplied by inter costal pleura. Mediastinal pleura and diaphragmatic pleura is supplied by phrenic nerve.

Applied Anatomy

- | | |
|--|-----------------|
| 1. Inflammation of the pleura <i>i.e.</i> , Pleurisy | 2. Dry pleurisy |
| 3. Wet pleurisy (pleural effusion) | 4. Haemothorax |
| 5. Hydrothorax | 6. Pneumothorax |
| 7. Pyrothorax | 8. Emphysema |
- (i) The pus is accumulated in the thoracic cavity.
(ii) The alveoli lose their elasticity.

Hridayavarana Kala(Pericardium)

It is a fibroserous sac which encloses the heart and the roots of the great vessels. It is situated in the middle mediastinum. It consists of fibrous and serous pericardium.



Fibrous Pericardium

It is a conical sac made up of fibrous tissue. The parietal layer of the serous pericardium is attached to its deep surface.

Important Features of Fibrous Pericardium

1. The apex is blunt. And it lies at the internal angle (angle of louis). It is fused with the roots of the great vessels and with the pretracheal fascia.
2. The base is broad and it is attached with the central tendon of diaphragm. In lower mammals it is separated from the diaphragm by the infra cardiac bursae.
 - The relation of the fibrous pericardium to the roots of the great vessels, to the diaphragm and to the sternum.
3. Anteriorly it is connected to the upper and lower ends of the body of the sternum by two ligaments.
 - (a) Superior ligament
 - (b) Inferior ligament
4. Posteriorly it is related to the principal bronchi, oesophagus and the descending thoracic aorta.
5. On each side it is related to the mediastinal pleura, mediastinal surface of the lung, the phrenics nerve and pericardio phrenics vessels.

Serous Pericardium

It is a thin double layered serous membrane lined by mesothelium. The parital pericardium is attached with the fibrous pericardium. The visceral pericardium is attached to the heart. The two layers are continuous with each other at the roots of the great vessels ascending aorta, pulmonary trunk, two venacava and four pulmonary veins.

Pericardial cavity seen after the removal of the heart.

The Contents of the Pericardium

1. The heart with cardiac vessels and nerves
2. Ascending aorta.
3. Pulmonary trunk.
4. Lower half of superior venacava
5. Terminal part of inferior venacava
6. Terminal part of the pulmonary veins.

The pericardial cavity is a potential space present in between the parietal pericardium and visceral pericardium. It contains a thin layer of the serous fluid which lubricates the opposed surfaces and allows the heart to move smoothly.

Arterial Supply

Fibrous and parital pericardium are supplied by the branches of internal thoracic.

1. Musculo thoracic aorta.
2. Descending thoracic aorta.

Nerve supply

Fibrous and parietal pericardium are supplied by phrenics nerve which is very sensitive to pain.

The pericardium is supplied by autonomous nerve of the heart and it is not sensitive to pain.

Applied Anatomy

- (a) Pericardial effusion (excess of fluid).
- (b) Pericardial rub (rub sound is produced due to the friction).
- (c) Pericarditis (inflammation of the pericardium).
- (d) Angina Pectoris – it is a type of cardiac pain and this is mainly due to the lack of blood supply angina means chocking sensation.

Udaravarna Kala (Peritoneum)

The largest serous membrane lining the abdominal cavity and covering the abdominal organs and pelvic organs is called as peritoneum. This peritoneum is composed of two words *i.e.* peri and tonus. Peri means around and tonus means tension. The serous membrane are also associated with the heart and lungs. The serious membrane

consists of two layers. The first is the layer of simple squamous epithelium or mesothelium. The second layer is the supporting of the connective tissue.

Types of Peritoneum

There are two types of peritoneum:

1. Parietal peritoneum (pain sensitive)
2. Visceral peritoneum (pain insensitive)

There is a space between the two peritoneum and is called as peritoneum cavity. It contains some amount of serous fluid which help for the free movement of the two peritoneum.

This serous fluid helps to glide easily with the abdominal wall or viscera. Some organs are not covered by peritoneum *i.e.*, retroperitoneal organs. They are kidney and pancreas.

The peritoneum consist large folds that weave between the viscera. The folds binds the organs to each other and it contains blood vessels, lymph vessels and nerves.

Function of Peritoneum

1. Movement of Visera

The peritoneum provides a slippery surface for the free movement of the abdominal viscera. This permits the peristaltic movement of the stomach, intestine and the abdominal movement during respiration.

2. Protection of Visera

It acts a barrier for the entry of any foreign body. The peritoneum contains some phagocyte cells which guard against infection. The peritoneal fluid also maintains the body immunity due to presence of lymphatic follicles.

Greater omentum is also called "*Police Men of the Abdomen*".

3. Absorption and Dialysis

- (a) Water (b) Crystalloids

These are absorbed directly in to the blood capillaries and the blood capillaries passes in to the lymphatic channels present in the peritoneum.

Peritoneal Dialysis

Urea can be removed by the blood by artificially circulating fluid through the peritoneal cavity so peritoneal dialysis is indicated in the renal failure.

4. Storage of Fat

The peritoneum folds are capable of storing large amount of fats particularly in obese person.

5. Helps in Healing

The mesothelial cells of the peritoneum promotes the healing of the wounds by the production of fibroblast.

Sex Difference in Relation to Peritoneal Cavity

In the male the peritoneum is a closed sac lined by mesothelium (flattened epithelium). But in female

- (a) The peritoneum cavity is communicates with the uterine tube (fallopian tube).
- (b) The peritoneum covering the ovaries lined by the cubical epithelium.
- (c) The peritoneum which covers the fimbria is lined by columnar ciliated epithelium.

Peritoneal Cavity

It divides into two parts

1. larger part (greater sac)
2. smaller part (Lesser sac).

The two sacs communicate with each other through the epiploic foramen (foramen of Winslow).

Constituents of the Peritoneum

- | | |
|--------------------------|-----------------------|
| 1. Greater Omentum | 2. Lesser Omentum |
| 3. Mesentery | 4. Meso Appendix |
| 5. Transverse Meso Colon | 6. Sigmoid Meso Colon |

Greater Omentum

It is the large fold of peritoneum which hangs down from the greater curvature of the stomach. It covers the loops of the intestine and it is like an apron for the abdominal visera.

Contents of the Greater Omentum

1. The right and left gastro epiploic vessels.
2. It contains all the parts of the intestine except duodenum.

Attachments

It is made up of four layers anteriorly two layers and posteriorly two layers.

Functions

1. Store house of fat.
2. It protects the peritoneal cavity against infection.
3. If also limits the spread of infection by moving to the site of the infection and sealing it from the surrounding area.

Lesser Omentum

This is the fold of peritoneum which extends from the lesser curvature of the stomach and the first two cm of duodenum to the liver. The portion of the lesser omentum between the stomach and liver is called as hepato-gastric ligament and the portion between the liver and duodenum is called hepato-duodenum ligament. Behind the lesser omentum the lesser sac is present.

Attachment

Inferiorly – The lesser curvature of the stomach.

Superiorly – With liver

The shape of the lesser omentum is inverted L shaped.

Contents of Lesser Omentum

- | | |
|------------------------------------|--|
| 1. Hepatic artery | 2. Portal vein |
| 3. Bile duct | 4. Nerves originated from the hepatic plexus |
| 5. Right and left gastric vessels. | 6. Gastric group of lymph nodes. |
| 7. Branches of gastric nerves. | |

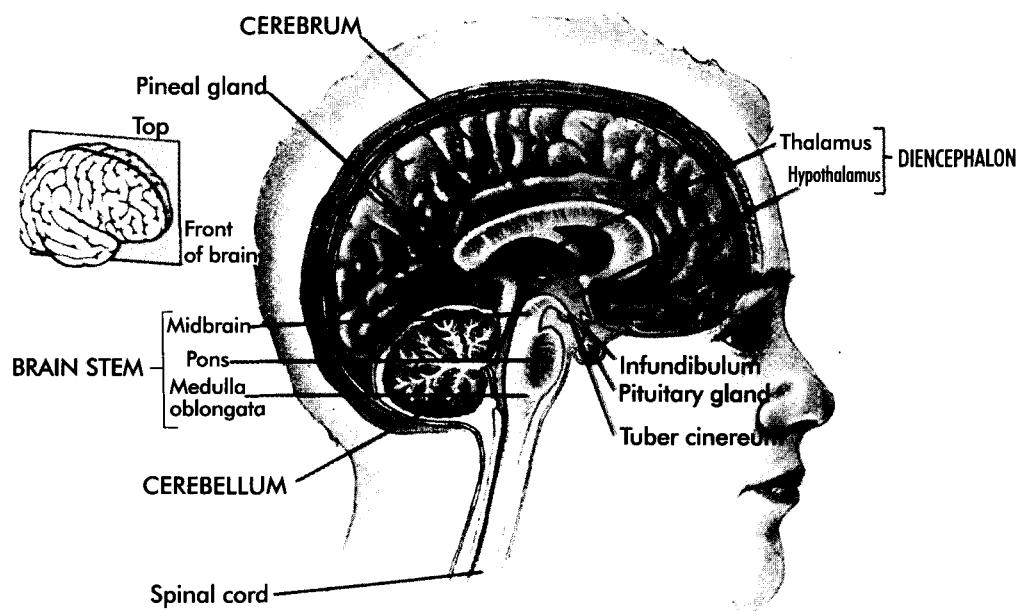
Mesentry

The mesentry of the small intestine is a broad fan shaped fold of peritoneum which suspends the coils of jejunum and liver from the posterior abdominal wall.

Contents

1. Jejunum and ileal branches of superior mesenteric artery.
2. Some accompanying veins (mesentery veins)

Sagittal Section of Brain in Medial Aspect



(a) Medial aspect of brain in sagittal section

3. Autonomic nerve plexus.
4. Lymphatics

Meso Appendix

It is a small triangular fold of peritoneum which suspends the vermiform appendix. The posterior surface of the lower end of the mesentery close to the ileo ceacal junction. Usually the fold is extended upto the lip of the appendix. Some time it fails to reach the distal one third of the appendix. It contains blood vessels nerves and lymphatics.

Transverse Meso Colon

This is a broad fold of peritoneum which suspends the transverse colon from the upper part of the posterior abdominal wall. The root of the transverse meso colon is attached to the anterior surface of the head of the pancreas. It contains the colic vessels, nerves, lymph nodes and lymphatics.

Sigmoid Meso Colon

This is a triangular fold of peritoneum which suspends the sigmoid colon from the pelvic wall. It contains the sigmoid and superior rectal muscles, nerves, lymph nodes and lymphatics.

Applied Anatomy

1. *Ascites* – excessive amount of serous fluid is accumulated in the peritoneal cavity (*jalandara*).
2. *Peritonitis* – Inflammation of the peritoneum. It is secondary complication of the other diseases. Intestinal bowel sound (IBS) will be absent.
3. Haemoperitoneum.
4. Pneumoperitoneum.
5. Paracentesis means to remove the peritoneal fluid form the peritoneal cavity by the help of the any instrument.
6. Exploratory laparotomy.

Mastishkavarana Kala (Meninges)

The brain is covered by

- Bony covering of the cranium.
- Three membranous covering.

Duramater (pachymeninx)

Arachoid mater (Leptomeninx) — (together known as leptomeninges)

Pia mater (Leptomeninx)

Cerebro-Spinal Fluid

It fills the space between the archnoid and piamater. This space is otherwise called as sub-archnoid space. The space between duramater and archnoid is called as sub-dural space. The space between the duramater and cranium is called epidural space. The sub-dural space contains serous fluid. Sub-archnoid space contains cerebro spinal fluid.

Duramater

The cranial dura mater consist of two matter

- (a) Endosteal layer
- (b) Meningeal layer

1. The endosteal layer is thicker and it is the outer layer. It is tightly adherent to the other layer and it serves as periosteum of the cranium.
2. Meningeal layer is the inner and thinner layer includes a mesothelial layer on its smooth surface.

Arachoid Layer

The arachoid is a thin transparent membrane that loosely surrounds the brain excluding the interior of the sulci. It is an irregular structure.

Relations

It is attached with duramater by sub dural space.

It is attached with piamater by sub archnoid space.

Functions

It provides a water cushion for the cranium.

It provides sheath for the cranial nerves.

This archnoid mater contains some villi, which has some following functions:

- (a) It absorbs cerebro-spinal fluid.
- (b) With advancing age the archnoid also enlarges and it forms pendulated tufts. Later the pendulated tufts produce depression in the bones (cranial bones).

Piamater

The piamater is a thin vascular membrane and it is closely related to the brain.

Funciton

1. It provides sheath for the cranial nerves.
2. It also provides perivascular sheaths for the minute blood vessels *i.e.*, those blood vessels that are entering and leaving the brain.

Subarachnoid Space

This is the space between the arachnoid and piamater.

It is extended from the brain to the second sacral vertebra (the spinal cord ends just below the L1 vertebra).

The nerve which continues as is called as Cauda equina.

It contains:- (a) cerebro-spinal fluid (b) large blood vessles
 (c) through the sub arachnoid space.

Relations

It relates with the ventricular septum of the brain.

1. A median foramen (of mangedia).
2. Two lateral foramina (of luschka). This two lateral foramina are present on the roof of the fourth ventricle.

Importance

1. This sub archnoid space is directly connected with I, II and VIII cranial nerves.
2. The cerbro spinal fluid comes to direct contact with the nerve cells.

Cerbro Spinal Fluid (CSF)

It is a modified tissue fluid.

Amount

The total quantity of CSF is about 150 ml. It is formed at the rate of 200ml per hour.

Normal Pressure of CSF

The CSF pressure is about 10-60 mm of water and 140-200 mm of mercury.

Circulation of CSF

It passes from each lateral ventricle to the third ventricle through the help of inter ventricular foramen (Foramen of Monro).

From the third ventricle it passes through fourth ventricle through the cerebral aqueduct.

From the fourth ventricle it passes through the sub arachnoid space through the medial and lateral aperture of fourth ventricle.

Functions

1. Protective (to the viseras of the brain).
2. Nutritive (all the nerves and nerve fiberous).
3. CSF acts as a pathway for the CNS.

Formation

1. The CSF formation takes place in the choroid plexuses of lateral ventricle and little amount of the CSF is formed by the choroid plexuses of the third and fourth ventricle.
2. The CSF is also formed by the capillaries present in the brain and spinal cord.

Absorption of CSF

1. Archnoid villi present in the sub archnoid space.
2. The little amount of CSF is absorbed by the peri nural lymphatics present in the I, II, VIIth and VIII cranial nerves.
3. A little amount of CSF is also absorbed by the veins related to the spinal nerves.

Applied Anatomy

1. *Spinal anaesthesia* – It is also known as lumbar anaesthesia.
2. *Meningitis* – (common in small children, fatal disease, neck rigidity).
3. *Bio chemical analysis of CSF* – It is a diagnostic value in various diseases.
4. *Myelitis* (Inflammation of spinal cord)
5. *Hydrocephalus* – When the amount of CSF is not properly absorbed and when there is a obstruction in the flow of CSF, it causes rise in the intracranial pressure and subsequently produces hydrocephalus.



UTTAMANGIYA SHARIRAM— NERVOUS SYSTEM

प्राणः प्राणभूतां यत्र श्रिताः सर्वेन्द्रियाणि च ।

यदुत्तमाङ्गमङ्गानां

शिरस्तदभिधीयते ॥

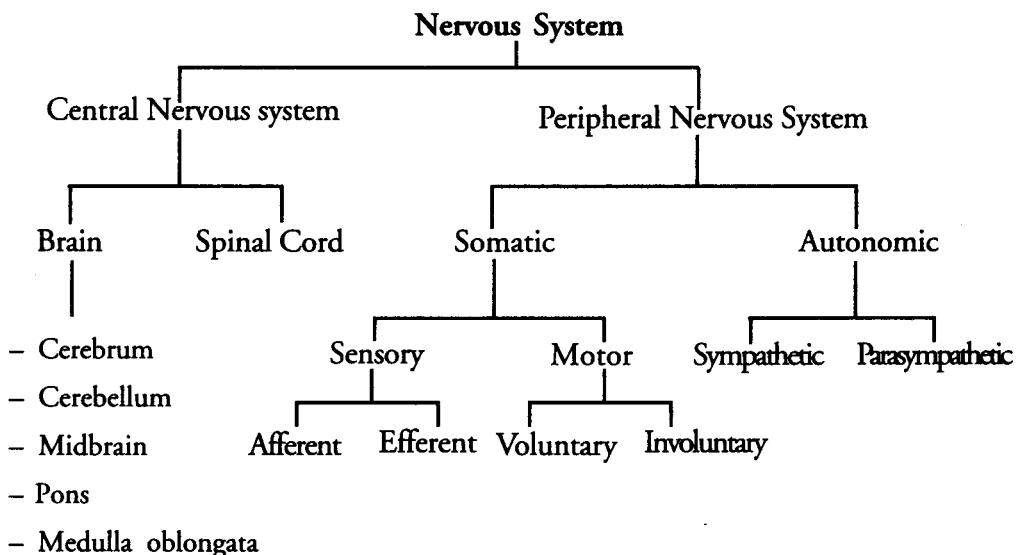
(Ch. Su. 17/12)

The *shira* is considered to be the “*uttamanga*” as all the sense organs are present with *shirasah*: as all the sense organs (*indriya*) are present with *shirasah*. Hence, any injury to the *shirasah*: can affect also other parts of the body. It is the seat of life also and hence, it is considered the most superior of all other *anga*.

In comparison with other system of the body, the nervous system is said to be more complex because it consists of many billions of interactive cellular units (neuron) whose constantly changing patterns of activity are reflected in each and every aspect of human behavior and experience. In association with the endocrine system it controls the body function and maintains homeostasis.

Divisions of the Nervous System

For descriptive purpose the nervous system is divided into



Cellular Nature of the Nervous System

For the organization of the nervous system it is essential to understand something of its cellular composition as the immense complexity of its organization is due to its vast population of intercommunicating cells. These nerve cells are called as neuron, which encodes the information, and it transmits to other neuron, which is effected by the help of neurotransmitters at special junctions (Synapses). The neurotransmitters are present within and outside of the neurons.

Neurons are the specialized cells, which constitute the functional units of the nervous system. These neurons are supported by a special kind of connective tissue called as neuroglia.

Each neuron consists of a cell body, which gives off a variable number of processes. Most neurons give off a number of short branching processes called dendrites and one longer process called as axon. Dendrites terminate near the cell body. Dendrites branch repeatedly and are irregular in thickness, whereas the axon has a uniform diameter. Dendrites and axons act differently. In a dendrite the nerve impulse travels towards the cell body, whereas, in an axon the impulse travels away from the cell body.

Most axons are surrounded by a myelin sheath. This sheath is formed by schwann cells in the case of peripheral nerves and by a type of neuroglia cells called as oligodendrocytes in the case of axons lying within the central nervous system.

Those axons are covered by a myelin sheath are said to be myelinated and without covered by myelin sheath are said to be unmyelinated.

Axons and dendrites are the extended part of cell bodies and form the white matter of the nervous system.

Axons are found deep in the brain and at the periphery of spinal cord.

Cell bodies form the grey matter of the nervous system and are found at the periphery of the brain and in the center of spinal cord.

Outside the brain and spinal cord the axons and dendrites are referred as nerves or nerve fibres.

The shape of a neuron depends on the number of processes arising from it.

Multipolar Neuron – Those neurons give off several dendrites and one axon.

Bipolar Neuron – Those neurons give off only one axon and one dendrite.

Unipolar Neuron – Those neurons give off only one process.

Functionally the neuron is bipolar. Within the central nervous system the axon

always terminates by meeting another neuron. The junction between the two neurons is called as synapse.

Outside the central nervous system the axon may end in relation to a muscle or to gland or may end by synapsing with neurons in a peripheral ganglion.

White and Grey Matter

The white matter of brain is white in colour and Consists of Myelinated fibres.

Grey matter consists of Axons and dendrites. This grey matter contains unmyelinated sheath (or) fibres.

SPINAL CORD

External Features

It is lower elongated, cylindrical part of C.N.S., and it is the downward continuation of medulla oblongata.

Occupation

From the vertebral column of spinal canal it occupies upper two-third and extend from the level of superior border of atlas to level of lower border of first lumbar body.

At birth in infants the lower limit of cord lies opposite to L3 vertebral below the vertebral column starts elongated faster than the cord from the third month of intra uterine life.

The lower end extends to lower limit of spinal duramater at the level of sacral second vertebrae at early development.

Length

It varies from height of individual but averagely

45cm – men

42cm – Women

Shape

It is slightly flattened anteroposteriorly and cylindrical

Two fusiform swellings are present, one in cervical region, one in lower thoracic and lumbar region. The cervical enlargement is opposite to the attachments of roots of brachial plexus (C5 – T1) and lumbar enlargement opposite to roots of the lumbar plexus (L2-S3) But cervical enlargement is the larger of two.

- Cord is tapered by inferior end called conus medullaris.
- In the subarachnoid, below the conus medullaris from cauda equina, Motor and Sensory roots (L2 – CO₃) are found, where they exist in vertebral canal, the lumbar inter vertebral and sacral foramen.

Surface

Dorsal	}	Divided by longitudinal furrows
Lateral		
Ventral		

Anterior Aspect

A deep anterior median fissure, which extends the full length of spinal cord and formed during foetal life by expansion of the anterior grey horns.

One pair of indistinct antero-lateral sulci and attachment appears as irregular longitudinal series of ventral roots of spinal nerves.

Posterior Aspect

A shallow postero-median sulcus are present. The attachment of dorsal roots is marked by postero-lateral sulcus of spinal nerves, which enter the cord in a single linear series.

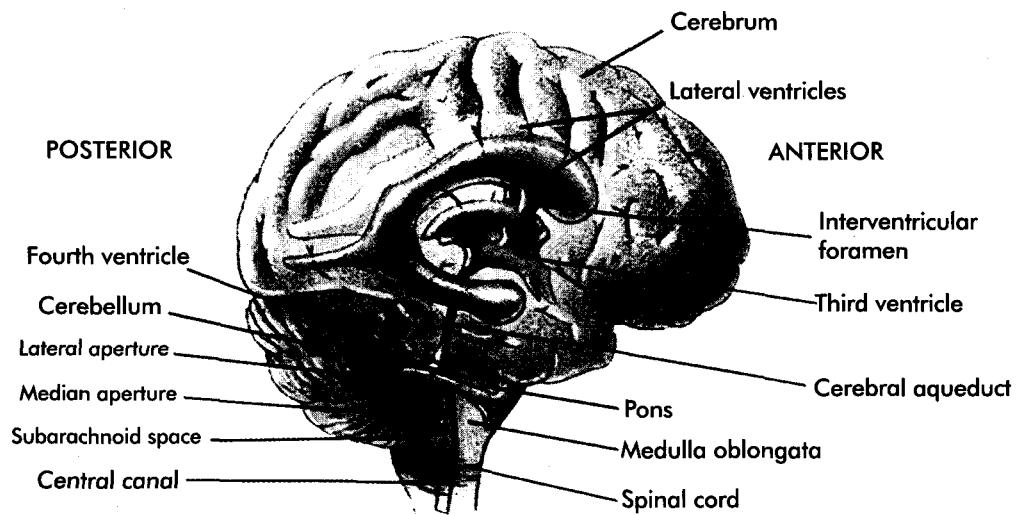
Internal Features In transverse it shows H-shaped internal mass of grey substance and it is surrounded by white matter.

Grey Matter

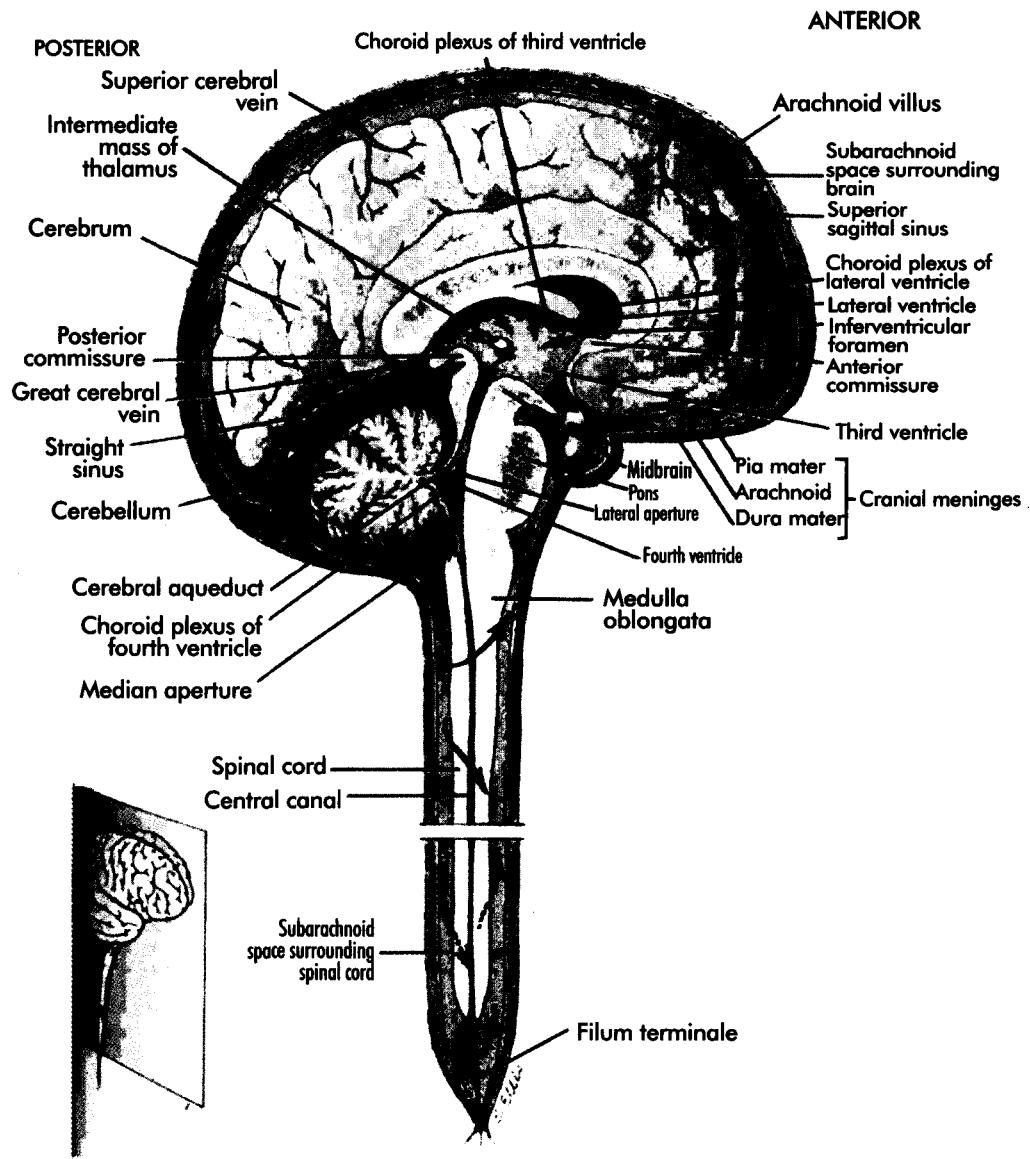
By the transverse section, two symmetrical halves of grey matter is joined across the mid line known as grey commissure, it is traversed by minute central canal.

- A posterior median septum extends forward up to grey commissure; a narrow white commissure lies anteriorly to grey commissure because the anterior fissure does not completely separate the white column.
- The dorsal part of H-shaped formation of grey matter constitutes the posterior grey columns and the ventral part are as Anterior – Grey columns (Anterior Horn).

Meninges & Ventricles of Brain



Meninges and Ventricles of Brain



- The posterior horns are known as substantia gelatinosa.
- The anterior horns contain motor cells for innervations of muscles. There is a mid way between anterior and posterior grey columns, from segments T1 – L2 an intermediolateral column of grey matter (lateral horn). There is an absence of lateral column existing in S2 – S4.
- There is a central canal of H-Shaped is continuous superiorly with central canal which traverse the lower half of medulla oblongata and open out in to the IVth ventricle of brain, it ends inferiorly blindly in filum terminale, a slight expansion in conus medullaris known as terminal ventricle.

Nuclear Groups

Anterior Horn

It is formed by basal lamina, which contains motor neurons. They are grouped as follows.

Medial Nuclear group

It extends through out the cord and innervates the axial muscle of body. The spinal accessory muscle is present from (C1-C6) to supply the sternocleidomastoid and trapezius.

Lateral Nuclear Group

Central Group

Confined to upper cervical segments, it innervates the diaphragm (C7 – C6) forms the phrenic nucleus.

For innervating limb muscles

Antero lateral (Shoulder, arm / gluteal region, thigh)	Postero – lateral (fore arm / leg)	Post. Postero lateral ((dorsal leg) (hand, foot))
--	--	--

Lateral Horn

From T1-L2 segments of spinal cord it is present.

Inter – Medio Lateral

It containing all the cell bodies of pre-ganglionic sympathetic neurons, they project laterally to form horn.

Cilio Spinal Centre of Budge

From (T1-T2) mediates the sympathetic innervations of eye.

Intermedio – Medial

It contains the cell bodies of all sacral pre-ganglionic Para – sympathetic neurons.

It reappears in (S2 = S4) segments, does not bulge later to form lateral horn.

Nuclei In Posterior Horn

It is formed by alar lamina, which contains nucleus formed by sensory cells and concerned with reception of sensory impulse through the post roots of spinal nerves.

These nuclei occupy the middle and base of posterior horn. They include from apex to base from following groups.

Postero – Marginal Nucleus

Thin layer of neurons are present and it receives some of incoming dorsal root fibres.

Substantia Gelatinosa

It acts as filter (or) gate controlling the admission of impulse from afferents to spinothalamic transmission cells. So, it acts a prominent role in perception of pain.

Nuclear Proprius

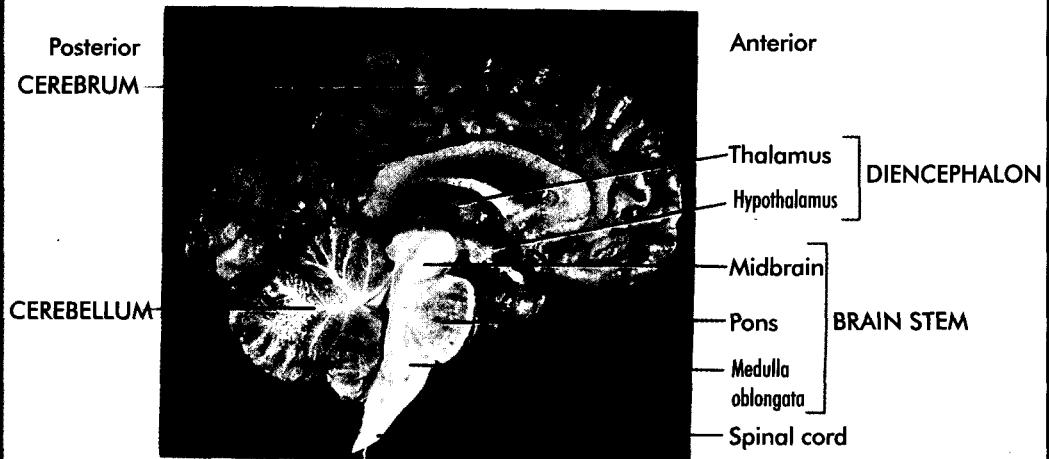
Ascending tracts are formed in the lateral white column of spinal cord.

Nuclear Dorsalis

It is known as thoracic (or) Clarkes nucleus is present in thoracic segments, but also extends in lowest cervical segments (L2 - L2) below. It receives proprioceptive stimuli & relays them to cerebellum by spino – cerebellar tracts.

General visceral afferent nucleus from (T1-L2) and (S2 - S4) of Visceral sensations.

Sagittal Section of Brain in Medial Aspect



(b) Medial aspect of brain in sagittal section

White Matter

On each side, the white matter is divided into three main columns (or) funiculi, which enter in posterior roots and emerge in anterior roots by the horns of grey matter.

- In between anterior and posterior horns, lateral white column is present.
- In between the posterior horn and the posterior median septum a posterior white column is present.
- In between the anterior horn and anterior median fissure, anterior white column is present.
- Ascending and descending tracts are occupying the three columns of white matter, as follows.

Anterior Column

Ascending Tracts

- Ventral spinothalamic – Conveys touch and pressure impulse

Descending Tracts

- | | |
|--------------------------|---|
| Ventral corticospinal | – Controls skilled voluntary movements |
| Vestibulospinal | – Concerned with the balance reflex |
| Tectospinal | – Concerned with visual and auditory reflex |
| Ventral reticular spinal | – Controls muscle tone and ordinary activities. |

Lateral Column

Ascending Tracts

- | | |
|-----------------------------|--|
| Lateral spinothalamic | – transmits pain and temperature impulse |
| Spinotectal | – Controls reflex movements of head |
| Ventral spinocerebellar and | |
| Dorsal spino cerebellar | – Convey proprioceptive information to the Cerebellum. |

Descending Tracts

- | | |
|------------------------|--|
| Lateral Cortico spinal | – Controls skilled voluntary muscles. |
| Rubrospinal | – Controls muscle tone and synergy. |
| Lateral reticulospinal | – It has an <i>inhibitory</i> effect on the motor activities of anterior horn cells. |

Posterior Column

Ascending Tract

Fasciculus gracilis and Fasciculus cuneatus, they transmit muscle, joint, sense vibration. Conscious proprioception.

Descending Tracts

Fasciculus septomarginalis – In the lower half of cord adjacent to dorsal septum
 Fasciculus inter fascicularis – In the upper half of cord between Fasciculus gracilis and cuneatus.

They are concerned with association and integration.

MENINGES OF SPINAL CORD

Protection for the cord is provided not only by vertebrae and their ligaments but also by meninges and by cerebrospinal fluid.

Meninges

Duramater, Arachnoid, Pia mater

Duramater

It encloses spinal cord and cauda equina below it. This is a tubular sheath of tough inelastic fibrous tissue. It is very loosely present in vertebral canal.

It is separated from walls of vertebral canal by Epidural space.

It is separated from the smooth external surface of Arachnoid by sub-dural space.

Arachnoid Space

It is separated from the cord by a relatively wide interval by the sub-arachnoid space, which contains cerebrospinal fluid.

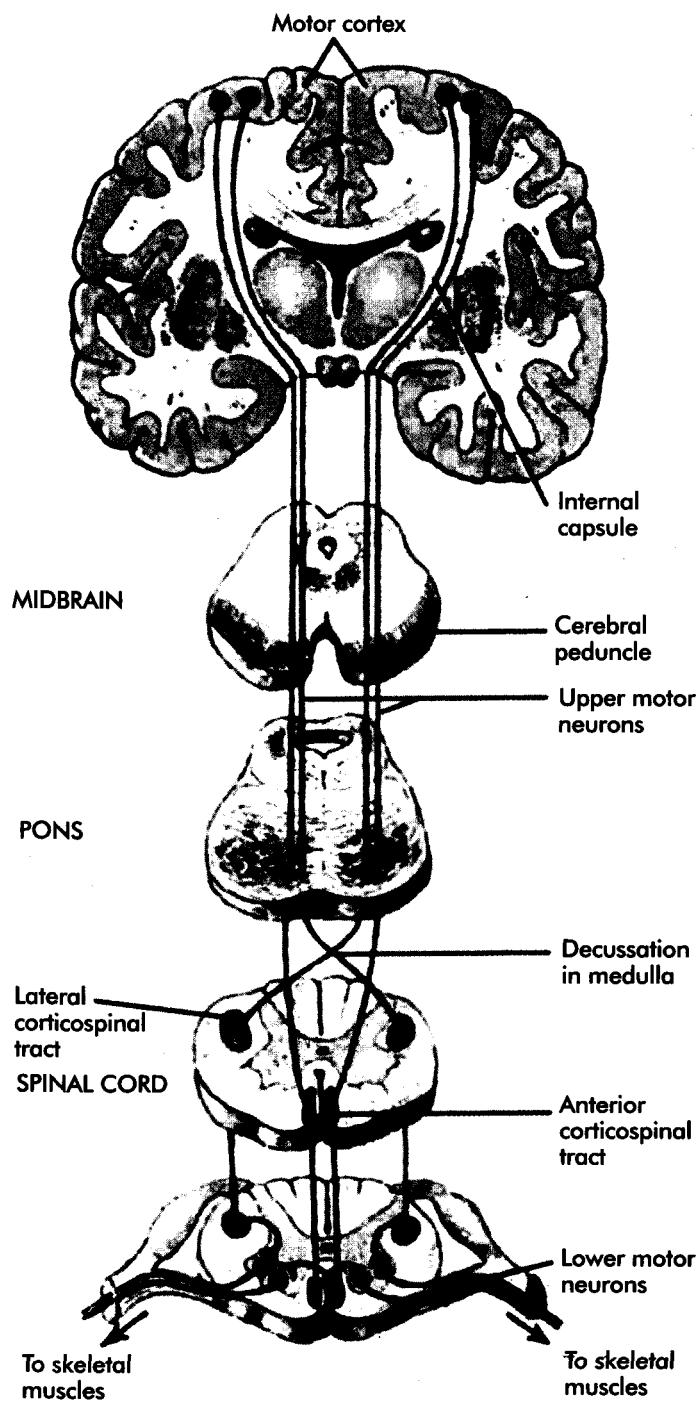
It is extremely thin and transparent that lays duramater.

The sub-Arachnoid space terminates at the level of second and third sacral vertebrae.

Piamater

- It crosses sub-Arachnoid space.
- It is continued at the lower end of spinal cord into the filum terminale.
- The cord is suspended by the attached Piamater on the lateral side and in the

Pyramidal Pathways



middle of its dural sheath, midway between the ventral and dorsal spinal nerve roots. This is termed as ligamentum denticulatum.

- The highest tooth is at level of foramen magnum.

Blood Supply

Arteries present around spinal cord are

Arteries

- Anterior spinal artery
- Posterior spinal artery (2)
- Radicular arteries
- Radiculo spinal arteries (Many)

In Radiculo spinal arteries the largest is the arteria radicularis magna (**artery of Adamkiewicz**) arises from 10th, 11th, 12th posterior intercostal arteries and descends to supply the lumbar enlargement and conus medullaris.

Veins

Six longitudinal venous channels around cord embedded in piamater.

- One in antero median fissure
- One in postero median sulcus
- One pair behind posterior nerve roots
- One pair behind anterior Nerve roots.

All they drain into radicular veins, which empty into lateral sacral, lumbar, posterior, inter costal and vertebral veins.

Applied Anatomy

1. Lumbar Puncture

Lumbar puncture is performed to tap the cerebrospinal fluid from the subarachnoid space for diagnostic purposes or as a therapeutic measure to inject medicines. It is done below the level of spinal cord to avoid injury to it. The cord ends at the level of L1 and L2 vertebra and the subarachnoid space ends at the level of S2 vertebra. The needle can therefore, be inserted anywhere between these two points as the subarachnoid space here contains only the cauda equina and filum terminale.

The usual spot chosen is between the L3 and L4 vertebra where the lumbar puncture needle is inserted. The spine of L4 can easily be located as it corresponds to the level of the line connecting the highest points of the iliac crest.

2. Syringomyelia

In this condition cavities filled with fluid and surrounded by glial cells develop near the center of the spinal cord and may communicate with the central canal.

3. Spinal Cord Compression

Acute spinal cord compression is one of the commonest neurological emergencies encountered in clinical practice 80% of spinal cord compression arises due to vertebral cause and the most common cause for this is the trauma and Intervertebral disc prolapse.

THE CEREBRUM (TELENCEPHALON)

It is made of two cerebral hemispheres, which are incompletely separated from each other by the median longitudinal fissure.

Corpus callosum is the connection between the two cerebral hemispheres, each hemisphere having a cavity called lateral ventricle. It has three poles, three borders and three surfaces.

Poles

- A pole is situated at the anterior region of frontal lobe is frontal pole.
- A pole is situated at the posterior region of occipital lobe is occipital pole
- A pole is situated at the anterior region of temporal lobe is temporal pole.

Surfaces

- Superolateral surface is convex and is related to cranial vault. Medially it is separated from supero medial border and Inferiorly separated from Infero lateral border
- Medial surface is flat and vertical by dividing the corpus callosum and other structures in the medial plane. Then the two hemispheres are get separated, then Medial surface is seen.
- Inferior surface is irregular varies in its anterior, posterior and irregular parts.
- Anterior third (or) orbital surface, which is concave downwards.

- Middle third is separated from other hemispheres by diencephalon and the mid brain.
- Posterior third lies on tentorium cerebelli, which separates it from the cerebellum.
- The posterior and middle third of inferior surface are referred to as tentorial surface.
- The inferior and posterior part is divided by a cleft called lateral sulcus.

Borders

- The border which separates the superolateral surface from medial line and which connects the frontal and occipital bone is superomedial border.
- A border, which intervenes between the superolateral and inferior surfaces, is called Inferolateral border and it has a small distance from occipital pole called pre-Occipital notch. The anterior part of this border is called superciliary border. The medial surface is separated from the inferior surface by medial border. It is divided into medial orbital hippocampal and medial occipital border from before backwards.

Surface Markings of Brain

- First point just superolateral to the inion
- Second point just superolateral to the nasion.
- Third point at zygomatic process of the frontal bone (Just above eyebrow)
- Fourth point at the pterion.
- Fifth point at the middle of the upper border of the zygomatic arch.

Superomedial Border

Marked by joining (superolateral to inion and superolateral to nasion) point 1 and 2 by a paramedian line.

Superciliary Border

Marked by first joining (zygomatic process and pterion) points 2 and 3 by a line arching upwards just above the eyebrow & then extends into pterion.

Inferolateral Border

Marked by joining of pterion and middle of the upper border of zygomatic arch by a convex line forwards and by then joining the same upper border of zygomatic arch with superolateral to the inion by a convex upward line, passing just above the external acoustic meatus.

Central Sulcus

- First point 1.2cm behind the midpoint of a line joining he nasion with the inion.
- Second point 5cm above the preauricular point.
- This sulcus is marked by joining these points by a continuously curved line running downwards & forwards makes 70° angle with medial line.

Lateral Sulcus

- First point at the pterion.
- Second point 2cm below the parietal eminence.
- Third point 2cm above the pterion.
- Fourth point 2cm in front of the pterion (pteron also called as sylvian point) here lateral sulci stems divides into three ramii.
- Ramus *i.e.*, anterior ascending ramus is marked by joining the pterion with the part, which is present above the pterion.
- Anterior horizontal ramus is marked by joining the pterion with the part, which is 2cm in front of pterion.

Superior Temporal Sulcus

It is marked parallel line, which is 1 cm below the posterior ramus of the lateral sulcus.

Sulci and Gyri of Cerebrum

- The folded surface with intervening fissures is seen in the surface of the cerebral hemisphere.
 - The folds (or) convulsions are gyri and intervening fissures are sulci.
 - More than half of the cerebral cortex occupies the walls of sulci, which are given below.
- (a) **Limiting sulcus** separates at its floor in to two areas, which are different functionally & structurally.
- Example:* Central sulcus between motor and sensory areas.
- (b) **Axial sulcus**, which develops from the long axis of rapidly growing homogeneous areas.

Example: Post calcarine sulcus in the long axis of striate area.

- (c) **Secondary sulcus**, other than exuberant growth in the adjoining areas of the cortex, they are produced from other factors.

Example: Lateral and parieto-occipital sulcus.

- (d) **Complete sulcus**, is deep to cause elevation in the walls of the lateral ventricle.

Example. Collateral and calcarine sulci.

Lobes

Each cerebral hemisphere is divided into four lobes:

- | | |
|-----------------|---------------|
| (i) Frontal | (ii) Parietal |
| (iii) Occipital | (iv) Temporal |

These are mostly seen in superolateral surface. The sulci separating the lobes as follows:

- Occipital lobe lies behind the line joining the parieto-occipital sulcus to the deepest part of the pre-occipital notch.
- A line joining the central sulcus and the lateral sulcus has frontal lobe, which lies in front and above these two sulci.
- The temporal lobe is outlined by lateral sulci.
- The parietal lobe lies behind the central and lateral sulci.

Lobes on Medial Surface

- Frontal lobe envelops the anterior part of corpus callosum and is bounded posteriorly by an imaginary line drawn between central sulcus and corpus callosum.
- Parietal lobe is bounded by frontal lobe, corpus callosum, calcarine sulcus and parieto occipital sulcus.
- Temporal lobe is bounded posteriorly by a line joining between anterior end of the calcarine sulcus and pre-occipital notch. Anteriorly by temporal pole.
- Occipital lobe is separated from parietal lobe by parieto-occipital sulcus and from temporal lobe.
- Anteriorly, a line joining the anterior end of calcarine sulcus and pre-occipital notch.
- Posteriorly, it is limited by occipital lobe.

Sulci and Gyri on Superolateral Surface

Lateral Sulcus

Begins on inferior surface, on reaching the lateral surface it divides into three ramii out of these posterior one is largest ramus which turns upwards into temporal lobe the other two ramii which are extends into the lower part of frontal lobe is antero horizontal ramii and postero ascending ramii.

The frontal lobe further divided into following sulci.

Central Sulcus

It is also called Tissue of Rolando, which begins at the superomedial border, midway between frontal and occipital poles. In its upper part it turns on the peripheral part of medial surface also for about 1 cm.

Precentral Sulcus

It runs parallel to the central sulcus, a little in front of it. The Precentral gyrus lies between the two sulci.

Area in front of Precentral sulcus

Superior Frontal gyri

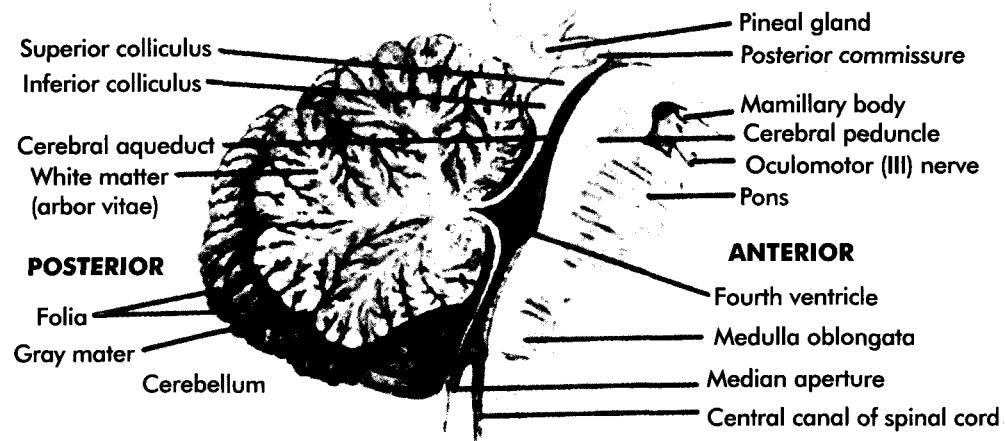
Middle Frontal gyri } by superior and inferior
Inferior Frontal gyri } frontal sulci

Anterior horizontal and Anterior ascending ramii	}	Pars orbitalis
Of lateral Sulci subdivides into	}	Pars triangularis
		Pars opercularis

The Parietal Lobe is further Sub Divided by the Following Sulci

- (i) Post-central sulcus, it runs parallel to central sulci and the post central gyrus lies between the two sulci.
- (ii) Area behind the post central gyrus
 - Superior parietal lobules
 - Inferior parietal lobules by Intra parietal sulcus.
- (iii) The inferior parietal lobe is invaded by upturned ends of posterior ramus of the lateral sulcus, of the superior and inferior temporal gyri.
- (iv) Inferior temporal gyri
 - Anterior or Supra marginal gyrus
 - Middle (or) Angular gyrus
 - Posterior.

Cerebellum and it's Relationship



- (v) Superior and Inferior temporal sulci divides the temporal lobe into
 - Superior temporal gyri
 - Middle temporal gyri
 - Inferior temporal gyri
- (vi) Occipital lobe
 - Lateral occipital sulcus divides into superior occipital and inferior occipital gyri.
 - Lunrate sulcus which separates from occipital pole.
 - Parieto occipital sulcus (which ends in upper part of supero lateral surface).

Blood Supply

Arteries	Veins
Middle cerebral artery	Superior cerebral veins (8-12)
Anterior cerebral artery	Superficial middle cerebral vein (Via)
Posterior cerebral artery	Superior anastomotic vein Inferior anastomotic vein The inferior cerebral veins.

Sulci and Gyri on Medial Surface

Corpus callosum, which is occupied by hemispheres of the medial aspect of the central part.

Corpus callosum (made of nerve fibres)

- The Genu (Anterior End)
- The Body
- The Splenium (Posterior End)

Below the corpus callosum there are septum pellucidum, the fornix and thalamus. In the remaining of medial surface identify as the following sulcus:

Cingulate Sulcus

It starts in front of genu and one finger breadth outer and parallel to the callossal sulcus. A small sulcus from it ascends into supero-medial border. The gyrus between small sulcus and sulcus cinguli is called paracentral lobule.

The sulcus cinguli intervenes between gyrus cinguli and medial frontal gyrus.

Suprasplenial Sulcus

It is one finger above the splenium of corpus callosum. Where, the supra splenial gyrus lies behind it & posterior part of colossal sulci.

Calcarine Sulcus

Begins a little below the splenium and runs towards the occipital pole, which gives off parieto occipital sulcus. On backside it divides into two sulci:

- (i) Parieto occipital sulcus
- (ii) Post calcarine sulcus extend into superior lateral surface.

Below genu there are two small anterior and posterior olfactory sulci which lies below the rostrum and in front of lamina terminalis. The para terminal gyrus lies between the posterior Para olfactory gyrus and lamina terminalis. Para olfactory gyrus between the anterior and posterior para olfactory gyrus. The Para terminal gyrus and post Para olfactory gyrus gives septal area.

Cuneus

It is a triangular wedge shaped area of medial surface, which is bounded by parieto occipital and posterior calcarine sulci.

Precuneus

Bounded anteriorly by upturned posterior end of cingulate gyrus superiorly by superomedial border of hemisphere inferiorly by supra-splenial sulcus.

Blood Supply

Arteries	Veins
Anterior cerebral artery	An upper set of superior cerebral veins
The middle cerebral artery	A lower set of veins
The posterior cerebral artery (It supplies to visual cortex)	Veins on posterior part drains into great cerebral vein. Anterior cerebral vein.

Sulci and Gyri on Inferior Surface

(a) Orbital part of inferior surface has following sulci

Olfactory sulcus, which is parallel to medial orbital border, where it lodges on the olfactory bulb and tract. The area medial to it is the gyrus rectus.

Orbital sulcus (H-Shaped) on lateral part of the surface.

- Anterior orbital gyri
- Posterior orbital gyri
- Lateral orbital gyri
- Medial orbital gyri

(b) Temporal part of this surface shows following sulci:

Occipito – temporal

Which is antero-posteriorly situated laterally lying between medial and lateral occipito temporal gyri.

Collateral Sulcus

It is medially situated antero-posterior sulcus. Parahippocampal gyrus is medial to it.

Rhinal Sulcus

It is shallow on parahippocampal gyrus and a part of this gyrus is separated by rhinal sulcus, which is hook like known as Uncus.

Blood Supply

Arteries	Veins
The posterior cerebral artery	Inferior cerebral vein of the orbital part of Inferior surface.
Middle cerebral artery	Infero cerebral veins of the tentorial part of inferior cerebral artery surface.

Insula (Island of Reil)

It is a pear shaped area of cortex. The interior of insula is surrounded by continuous circular sulcus and it is marked by three short gyri in front and one (or) two long gyri

behind. Antero-posteriorly a narrow portion is seen on hemisphere in the depths of the stems of lateral sulcus. This narrow part is termed the limen insulae.

The parts of hemisphere above and below the sulcus from lids (or) opercula which covers the insulae, The opercula are four types:, (i) Orbital operculum (ii) Temporal operculum (iii) Frontal Operculum, and (iv) parietal operculum.

Cortico Functional Area

Sensory Motor area (functions are afferent)

Primary somato motor area (or) motor Area (4)

Supplementary somato motor area (Area 6) or (Pre-motor area)

Primary somato sensory area 3, 1, 2 (Sensory area)

Supplementary somato sensory area area 43

On primary somato motor area lying in the posterior part of the middle frontal gyrus has a frontal eyelid: Area 8

Auditory Areas

(i) Auditory sensory area: Area 41 and 42

(ii) Auditory psychic area: Area 22

Visual Areas

These are three adjacent cortical areas

(i) Visuostrate Area : Area 17 (Visuosensory)

(ii) Peristriate Area : Area 18

(iii) Para striate Area : Area 19, Constitute Visuo-psychic areas

Speech Areas

Function Muscular activity inherent in speech.

(i) Anterior area (Broca's area) Area 44,45

Function : Movement of structures, responsible for production of voice & articulation of speech

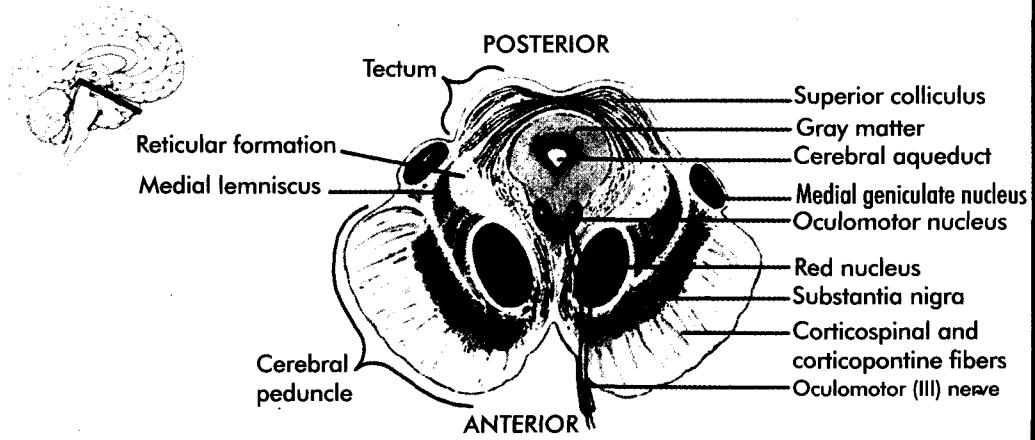
(ii) Area 40 - occupies the supra marginal gyres

Function : Auditory word image

(iii) Area 22 Wernicke's area is sensory speech

Function : Comprehension of spoken language

Dorsal Aspect of Brain Stem



- (v) Sensory area (Posterior area)
- (vi) Area 39 : Occupies the angular gyres.

Function : Visual word image

Smell Area:

Area 28:

- (i) Olfactory area (ii) Taste area
- (iii) Pre-frontal cortex (frontal association cortex)

CEREBELLUM (METENCEPHALON)

Description

It is the largest part of hindbrain, which consists of two lateral parts called cerebellar hemispheres connected in the middle by narrow central regions called vermis.

Relations

It occupies most of the posterior cranial fossa.

Anteriorly	—	IVth ventricle, Pons and medulla
Posteriorly	—	Concavity of occipital bone
Laterally	—	Sigmoid sinus, mastoid antrum I mastoid aircells.
Superiorly	—	Tentorium celebrete.

External Features

It has the two hemispheres which are united each other through media vermis.

Two surfaces

- Superior – Convex – from this two hemispheres are continued
- Inferior – shows media-notch called “Vallecula”.

It separates right and left hemispheres

Pons and medulla are lodged on anterior aspect of the cerebellum which is marked by a deep notch.

Falx cerebelli lies on the deep notch which lies on posterior aspect.

Lobes

There are three lobes in the cerebellum.

Anterior Lobe

It lies on the anterior part of superior surface which is separated from the middle lobe by fissure prima.

Middle Lobe (or) Post Lobe

It is the largest of three lobes, which is limited in front by fissure prima (on superior surface) and by postero-lateral tissue on inferior surface.

Flocculo Nodular Lobe

It is the smallest lobe of cerebellum. It lies on the inferior surface in front of the postero-lateral tissues.

Floccules

Irregular shaped masses present on each side lie on the middle cerebellum peduncle which is completely separated from the rest of cerebellum.

Parts of Cerebellum

The vermis and cerebellar hemispheres are divided by tissues into narrow sheets of tissue called folia.

Primary Tissue

It is V-Shaped and separates the anterior lobe from the middle lobe on superior surface of cerebellum.

Horizontal Fissure

It separates superior surface from Inferior surfaces. Function is not known.

Postero lateral Fissure

It separates the middle lobe from flocculo nodular lobe on the inferior surface

Surfaces

Two surfaces

Superior Surface

It separates the occipital lobes of fore brain by tentorium cerebelli, which is related to superior surface.

Inferior Surface

Related to occipital bone, the fold of the falx cerebelli containing the occipital sinus is tucked in the middle ear.

Vermis

The boundaries are ill-defined.

Parts of Superior Vermis

It extends to a tongue like process lying on the superior medullary velum and known as lingual which does not have any corresponding lateral extension in to the cerebral hemisphere.

Central lobule.

Culmen

It is behind the primary fissure. These three constitute Anterior lobe parts.

Post Lobe

Declive

Folium

It is present behind the horizontal fissure which separates it from the inferior vermis.

Inferior Vermis

Vallecula is present it consists of four parts.

Post Lobe

Tuber }
Pyramid } Inferior vermis

Uvula

Connected by furrowed band to the tonsil.

Flocculonodular Lobe

Nodule

Separated from the uvula by post nodular (or) postero-lateral fissure.

A slender rudimentary lobule known as para folliculus lies beneath the floccules.

Medullary Vela

These are thin layers of white matter and are two in number

- Superior Medullary velum
- Inferior medullary velum

Internal Features

A series of parallel fissure divide the cerebellum in to narrow leaf like bands called folia.

A tree like appearance is seen on cerebellum called *Arbor Vitae*.

A white matter of four sets of cerebellar nuclei is within the internal core, which lies in close relationship with the roof of the IVth ventricle and known as roof nucleus.

- Nucleus dentatus
- Nucleus emboliformis
- Nucleus globosus
- Nucleus fastigii.

Morphological and Functional Divisions (Phylogenetical Condition)

It is the elaborated area of Brain stem. It has three subdivisions.

Archi Cerebellum

It is the oldest part, which is made up of flocculo-nodular lobe and lingual which is chief vertebral connected for controlling the axial musculature and maintenance of equilibrium, Maintenance position of body in space by reacting to gravity (or) sudden changes.

Palaeo Cerebellum

It is seen in next part to appear

It consists of

- Anterior lobe except lingual

- Pyramid
- Uvula
- Nuclear inter positrons

Function

Posture of limb muscles and co-ordinates the activity of limbs in relation of each other and the trunk.

Neo-Cerebellum

It is the newest part because it is last to develop. It has Cortico-cerebellar connections

It consists of

- Whole of posterior lobe, except pyramid and Uvula.
- Nucleus dentatus (effector nucleus).

Function

Smooth performance highly skilled voluntary movements of all kinds.

Connections of Cerebellum

The fibres entering (or) leaving the cerebellum are grouped to form three peduncles which connect the cerebellum to midbrain the pons and medulla.

It receives information from the following sources:

- Vestibular part of VIII nerve
- Spinal cord
- Tectum of mid brain
- Cerebral cortex.

Superior Cerebellar Peduncle

It connects the cerebellum to the back of the midbrain and is chiefly formed by efferent pathways.

(a) Afferent Pathways

Anterior Spinocerebellar Tract

It is the major efferent pathway which enters the anterior lobe and carry proprioceptive information.

Tectocerebellar Tract

Inferior and Superior Colliculi formed by the auditory and visual impulse.

(b) Efferent Pathways

It cross in to the tegmentum of the midbrain to end in the red nucleus, thalamus and cortex. These chiefly arise from dentate nucleus.

- Dentato – rubral
- Dentato – thalamic : It is the major out put from cerebellum it projects to the motor cortex and regulate the motor mechanism.

Middle Peduncle Cerebellar

Cerebellum is connected to the dorsum of the pons. These fibres are chiefly afferent.

(A) Afferent Pathways

Pontocerebellar Fibres

These are a part of Cortico-ponto-cerebellar tract which arises from the opposite pontine nucleas.

The fibres descend through the internal capsule and parts of crus cerebri to end in the pontine nuclei. Cerebral cortex and cerebellum work in close co-operation in order to effect the proper co-ordination of muscular action in voluntary movements.

Inferior Cerebellar Peduncle

It connects the cerebellum to the dorso lateral aspect of medulla.

Afferent Pathways

(clinically afferent and efferent pathways)

(a) Vestibulo-Cerebellar Tract

It arises from the ipsilateral Vestibular nucleus and ends in nucleus fastigii in the flocculonodular lobe.

Function – concerning the position and movements of head.

(b) Posterior Spinocerebellar Tract

It arises from the ipsilateral Clarke's column of cells and ends in the nucleus interpositus in ant lobe (Palaeocerebellum)

Function – Carries proprioceptive information from the greater part of the body.

Efferent Pathways

Cerebello – Vestibular

It is also called Hook Bundle of Ruvel. It extends from cerebral cortex and fastigial nucleus to vestibular nucleus of same side.

Clinically less important afferent and efferent tracts are follows:

(a) *Dorsal External Arcuate*

It arises from the ipsilateral accessory cuneate nucleus and ends in anterior to be (palaeo-cerebellar).

(b) *Ventral External Arcuate*

It arises from the arcuate nucleus of medulla and ends in the posterior lobe (neo- cerebellum).

(c) *Olivo-Cerebellar*

It arises from the olfactory nucleus of the opposite side and ends in the posterior lobe (neo-cerebellum)

(d) *Reticulo Cerebellar*

It arises from reticular end and ends in the anterior lobe (palaeo-cerebellum).

(e) *Par-Olivo Cerebellar*

It arises from the medial and dorsal accessory olfactory nuclei and ends in the posterior lobe.

(f) *Cerebello-Olivary*

It extends from cerebellum to olfactory nucleus.

(g) *Cerebello Reticular*

It extends from cerebellum to reticular nuclei.

Grey Matter of Cerebellum

It consists of cerebellar cortex and the cerebellar nuclei. There are four pairs of nucleus

- The nucleus dentatus is neocerebellar
- The nucleus globosus
- The nucleus emboliformis are palaeocerebellar.
- The nucleus fastigii is archicerebellar.

Functions

It controls same side of the body The other functions are as follows:

(i) *Muscular Co-Ordination*

It forms smooth contraction of striated muscles and for the smooth relaxation of antagonists. This is the chief function of Neo cerebellum and is also done by archi-cerebellum.

(ii) *Maintenance of Equilibrium*

Each cerebellar hemisphere is involved in controlling movements of same side in contrast to cerebral motor cortex which initiates movements on opposite.

Maintenance of Muscle tone.

Blood Supply

The brain stem and cerebellum are supplied by the *vertebral and basilar arteries* which constitute the vertebro-basilar system.

Basilar artery gives the following branches:

- Pontine branches are numerous slender twigs.
- Labryrinthine (or) internal auditory.
- Anterior inferior cerebellar artery.
- Superior cerebellar artery.
- Posterior cerebral arteries.

Anterior supply of the individual parts of brainstem and cerebellum is under:

Mid Brain

- Central branches of posterior cerebral artery.
- Posterior communicating artery.
- Basilar artery.

Pons

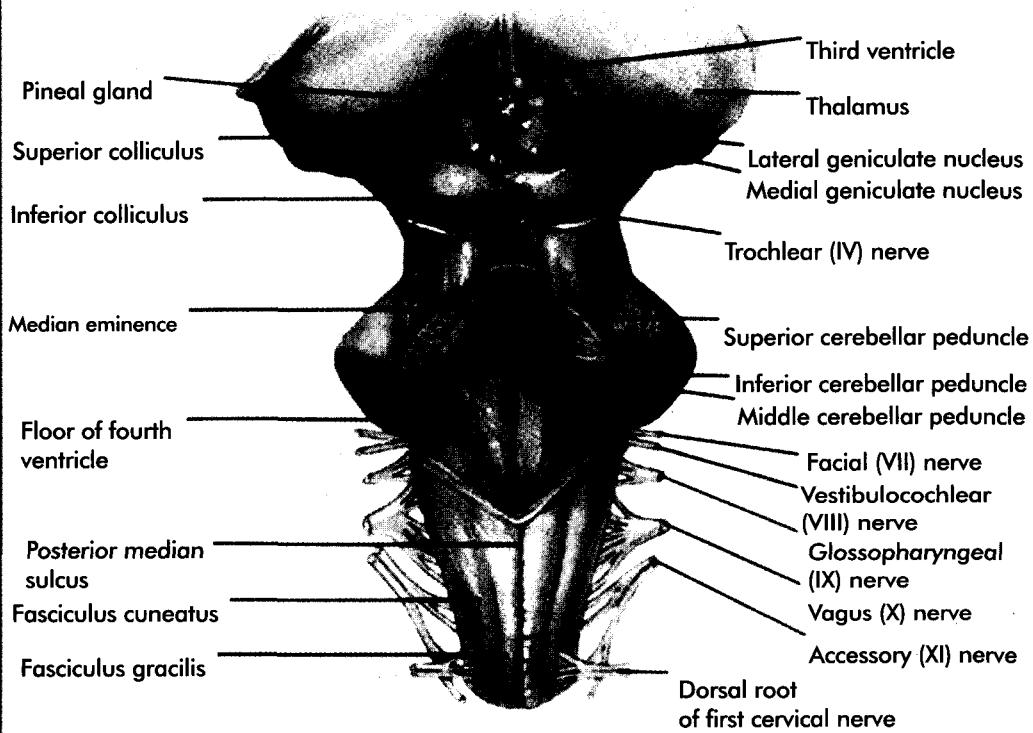
- Pontine branches of basilar – base of the pons.
- Superior cerebellar – dorsolateral tegmentum of rostral pons.

Medulla Oblongata

Ventro-Medial part is supplied by Medullary branches of vertebral artery.

Dorso lateral part by Medullary branches of the posterior inferior cerebellar artery.

Dorsal Aspect of Brain Stem



Cerebellum

Superior surface is supplied by one artery ie., Superior cerebellar artery.

Internal Surface

Supplied by two arteries.

- Anterior inferior cerebellar artery.
- Posterior inferior cerebellar artery.

PONS (BRIDGE)

The part of hind brain, which lying in front cerebellum and between the midbrain and medulla oblongata is pons, which is separated from the medulla by a transverse groove in which lies the exist of abducent, facial and vestibulo cochlear nerves from medial and lateral side.

External Features

Two Surfaces

- Ventral aspect
- Dorsal aspect

Ventral

The “Basilar sulcus”, which lodges in the basilar artery as a shallow longitudinal groove in the middle on ventral surface lateral, a cylindrical middle cerebellar peduncles are continued the pons.

At the junction of pons with peduncle trigeminal nerve exit having a small medial motor root and a larger lateral sensory root.

Dorsal

It is overlapped by cerebellum. The floor of the upper half of the IVth ventricle is formed from the posterior surface of pons in below the superior cerebellar peduncles.

Internal Features

In transverse sections P ons

- ventral part
- dorsal part

Ventral part is continuous inferiorly with pyramids of medulla, on each side with cerebellum through middle cerebellar peduncle. Dorsal (or) tegmental part is directed upward continuation of medulla.

Grey and White Matter

Grey matter represented by pontine nucleus, plays an important (role) part of Cortico ponto cerebellar path way scattered among longitudinal and transverse fibres. Fibres from all these nuclei go to opposite half of cerebellum.

The sixth nerve nucleus lies beneath facial colliculus. The VIIth nerve nucleus lies in reticular formation of pons. The vestibular nuclei lies in relation to the inferior cerebellar peduncle, in the floor of fourth ventricle partly in medulla and pons. These are divisible into four parts superior, Inferior, medial and lateral, which receives fibres of vestibular nerve.

Cochlear nuclei lies in relation to inferior cerebellar peduncle which lies on dorsal and ventral which receives fibres of cochlear nerve. These fibre form the trapezoid body on lateral part, trigeminal nerve lies on spinal nucleus.

White Matter

- Longitudinal includes:
 - (a) Cortico spinal and Cortico nuclear (Pyramidal tract)
 - (b) Cortico pontine fibres ending in pontine nuclei.
- Transverse includes pontocerebellar fibres, through middle cerebellar peduncle it goes to opposite half of cerebellum through middle cerebellar peduncle and it goes to opposite half of cerebellum through pontine nuclei.
- Trapezoid body is a transverse band of fibres which lies behind the ventral part of pons, which is a part of auditory pathway. The medial lemniscus forms a transverse band on either side of thalamus, lateral spinothalamic tract is present lateral to floor of IVth ventricle inferior cerebellar peduncle lies. The cerebellar peduncles lie dorso-lateral to IVth ventricle.

MEDULLA OBLONGATA

The lowest part of brain stem, which extends from lower border of pons in continuation with spinal cord is medulla, which lies anterior part of the posterior cranial fossa, extending down to foramen magnum.

Relations

Anteriorly – Clivus and meninges.

Posteriorly – Vallecula of cerebellum.

External Ventral Aspect

An anterior median sulcus, which is marked by anterior surface, it expands at lower border of pons to form the foramen caecum. On either side of Anterior median sulcus lies a swelling called pyramid. In between pyramid and lower border of pons Abducent nerve emerges.

The antero-lateral aspect of upper half of medulla is occupied by an oval swelling called olive. It is separated from pyramid by longitudinal antero-lateral sulcus, to which hypoglossal nerves attaches both the olive and pyramid are crossed by anterior external arcuate fibres.

Olive is separated from thick cylindrical ridges by a Postero-Lateral sulcus, the inferior cerebellar peduncle, extends upwards and laterally. Attached to this sulcus, glossopharyngeal, vagus and cranial part of accessory nerves are present.

Attachment of facial and vestibulocochlear nerves are seen in between the lower border of pons and upper aspect of inferior cerebellar peduncles.

Dorsal Aspect

Lower closed part and upper open part of medulla is observed:

- A shallow posterior median sulcus continues upward from spinal cord to lower angle of IVth ventricle is shown by lower half of medulla.
- Medially gracile tubercle, laterally cuneate tubercle, are two small elevations on either side of upper end of sulcus.
- The inferior cerebellar peduncle is seen on lower part of IVth ventricle.
- The lower half of floor of IVth ventricle is formed by the open upper part of medulla.

Internal Features

It can be studied by examining transverse sections.

Grey Matter

Anterior horn is separated from central grey matter by decussating pyramidal fibres.

The separated anterior horn forms the spinal nucleus of accessory nerve laterally.

Spinal nucleus of accessory nerve – Laterally.

Supra spinal nucleus for motor fibres of first cervical nerve – Medially.

Laterally the central grey matter is continuous with nucleus of spinal tract of trigeminal nerve. The central part is pushed backward in lower part of medulla, but in middle of medulla the central grey matter contains.

- (a) Hypoglossal nucleus (in a Para median position)
- (b) Dorsal nucleus of vagus (lateral to 11% nerve nuclear)
- (c) Nucleus of tractus solitarius (Ventro lateral – Dorsal nucleus of vagus). Along with this the upper part of medulla contains inferior and medial Vestibular nuclei, medial to inferior cerebellar peduncle (The dorsal and ventral cochlear nuclei lie on this surface to receive fibres cochlear nerve).
 - The nucleus gracilis and nucleus cuneatus are continued with central grey matter. These are much larger and get separated from central gray matter in middle of medulla. The nucleus of spinal tract of trigeminal nerve also separate from central grey matter.
 - The lower part of inferior olfactory nucleus is seen.
 - The nucleus ambiguus lies deep in reticular formation of medulla.
 - The arcuate nucleus lies antero medial to pyramidal tract.

Visceral centre are:

- (i) Respiratory centers.
- (ii) Cardiac centre for regulation of heart rate.
- (iii) Vasomotor centre for regulation of B.P.

White Matter

The pyramids, anteriorly, pyramidal tracts also anteriorly.

The fibre of each pyramid seen backward and laterally to reach the lateral white column of spinal cord where they form the lateral Cortico spinal tract.

The fasciculus gracilis and fasciculus cuneatus occupy the broad posterior white column but in middle of medulla the fasciculus gracilis and fasciculus cuneatus give rise to internal arcuate fibres.

The medial longitudinal bundle lies posterior to Medial lemniscus. The spinocerebellar and lateral spinothalamic tracts lie on the antero-lateral area

- The inferior cerebellar peduncle occupies the posterolateral part, lateral to IVth ventricle.
- The olivo cerebellar fibres are seen prominently and these fibres emerge at hilum of inferior olfactory nucleus and pass opposite to inferior cerebellar peduncle.
- On the floor of IVth ventricle stria medullaris is seen and on the antero-lateral part of the medulla, various ascending tracts of spinal cord lie.

VENTRICLE

Lateral Ventricle

Lateral ventricles are the telencephalic part of the ventricular system. The two ventricles are separated by the ependymal cells which form the septum pellucidum. It is communicate with the IIIrd ventricle and are separated by the Interventricular foramen (of monroe).

Parts

Each having central part, three diverticula (or) horns *i.e.*, anterior, posterior and Inferior.

Central Parts

It is triangular in coronal section lies within the parietal lobe posterior part of frontal lobe. It extends from the interventricular foramen upto level of splenium of corpus callosum.

Boundaries

Roof

Undersurface of the body of corpus callosum.

Floor

It is formed from lateral to medial side by

- (a) Body of caudate nucleus
- (b) Stria terminalis
- (c) Thalamostriate vein
- (d) Lateral portion of upper surface of thalamus

Medially it is formed by

- (a) Septum pellucidum
- (b) Body of fornix.

Anterior Horn

It lies in front of the interventricular septum (or) foramen.

It is roughly triangle in cross section.

Boundaries

Roof

Under surface of body of corpus callosum.

Floor

Upper surface of rostrum of corpus callosum.

Anterior Wall

Posterior surface of genu & rostrum of the corpus callosum.

Medial Wall

By septum pellucida.

Infero-Lateral Wall

Head of caudate Nucleus.

Posterior Horn

It lies behind the splenium of corpus callosum and extends into occipital lobe. It is variable in size and may be absent.

Boundaries

Roof

Tapetum of corpus callosum.

Lateral Wall

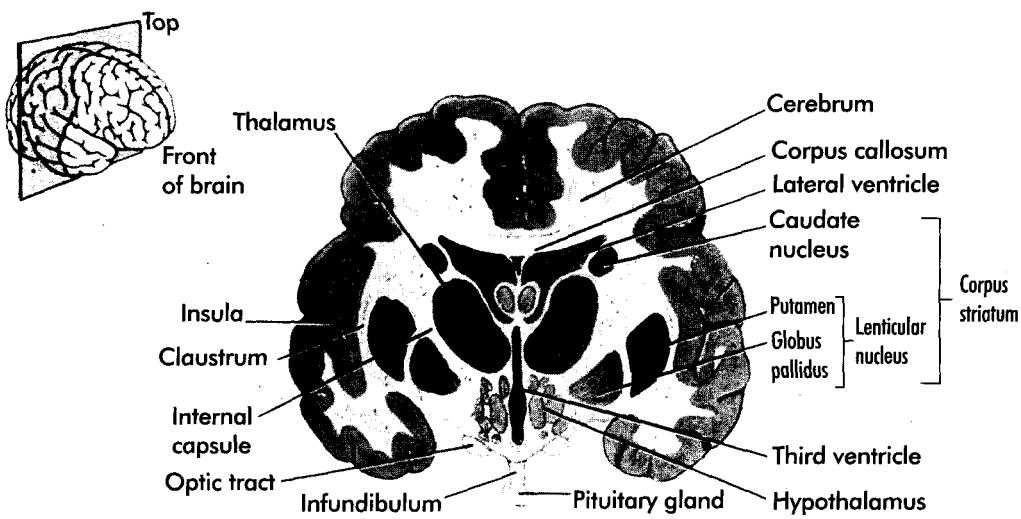
Tapetum of optic radiation.

Medial Wall

Show two elevations:

- Bulb of posterior horn raised by forceps major
- Calcar avis, raised by anterior part of calcarine sulcus.

Thalamus and Associated Structures



Inferior Horn

This is the largest horn of lateral ventricle which begins at the junction of the central part with the posterior horn of the lateral ventricle and extends into temporal lobe. The area where inferior and posterior horn diverge called collateral trigone.

Boundaries

Roof

- (a) Tapetum of corpus callosum (Chiefly)
- (b) Tail of caudate nucleus
- (c) Striae terminalis
- (d) Amygdaloid body.

Floor

- Collateral eminence laterally caused by collateral sulcus.
- Hippocampus medially covered by white matter called alveus. The anterior end expand into notch like cat's paw called pes hippocampi.
- *Fimbria*: A band of white fibres lying on hippocampus Anteriorly, the tail of the dentate gyrus is continuous with uncus posteriorly, near the splenium of corpus callosum it is continuous with the gyrus fasciolares through which it connected with the longitudinal striae in the indusium griseum on the corpus callosum.

Choroidal Fissure : (C-Shaped slit on medial hemisphere).

- The line which the choroids plexus invaginates into the lateral ventricle called choroidal fissure.
- The medial surface of cerebral hemisphere consists of a peripheral part and a central part.
- Anteriorly, the ependyma of choroidal fissure is continuous with the ependymal roof of interventricular foramen.
- The choroidal plexus is highly vascular fringe of Piamater.
- Through the choroidal fissure it is seen projecting between the fornix and the thalamus in the control part of ventricle.
- Through the interventricular foramen, it enters in to the tela choroidea of IIIrd ventricle.

- Posteriorly it rounds the posterior end of thalamus and extends along the medial wall of inferior horn up to level of pes hippocampi.
- The plexus contains the anterior choroidal branch of internal choroidal artery and the posterior choroidal branch of posterior cerebral artery.
- Choroidal plexus is a groove between the thalamus and caudate nucleus. It covers the superior surface of the thalamus of its medical parts.

Third Ventricle

Def : A communication which is present below with the IVth ventricle through the cerebral aqueduct of sylvius in the midbrain.

- The IIIrd ventricle is the diencephalic part of ventricular system.
- It is narrow, slit like median cavity below the two thalami and part of hypothalamus.
- In front, the lateral ventricles opens into it through interventricular foramina of Monro lined by ependyma, contains choroids plexus secreting cerebrospinal fluid.

Communications

Anterosuperiorly

On each side, it communicates with the lateral ventricle through the interventricular foramen (or) foramen of Monro, which is anteriorly bounded by column of fornix and posteriorly by tubercle of thalamus.

Postero-Inferiorly

In the medial plane, it communicates with IVth ventricle through the cerebral aqueduct.

Recess

These are short diverticula (or) Extensions of cavity, as follows:

- (i) An angular recess, above the optic chiasma at the junction of anterior wall and floor of the ventricle is supra-optic recess.
- (ii) A recess, which is present into the stalk of pituitary body called Infundibular recess.
- (iii) A recess, which projects backwards into pineal stalk called as pineal recess.

- (iv) A family capacious blind diverticulum which extends back wards below the tela choroidea, immediately above and in front of pineal recess is Supra pineal recess
- (v) A triangular recess which extend forward called vulva of the ventricle.

Boundaries

It has a roof, floor, Anterior and posterior wall and 2 lateral walls.

Roof

Under surface of the tela choroidal of the third ventricle is lined by ependyma lying, which forms Roof.

- From the roof, the choroid plexus of the IIIrd ventricle projects downwards.
- Interventricular foramen is present at the junction where the roof is attached with anterior and lateral walls.
- The lateral margins of ependymal roof are attached to stria medullaris thalami. The medial surfaces of thalami expand posteriorly as habenulae trigones.
- Anteriorly, the roof is attached to anterior columns of fornix and the anterior commissure.

Floor

From the anterior to posterior end is formed by

- (i) Optic chiasma
- (ii) Infundibulum
- (iii) Tuber cinereum
- (iv) Mamillary bodies
- (v) Posterior perforated Substance
- (vi) Sub-thalamus which is upward and forward continuation of tegmentum of mid brain.

Anterior Wall

It is formed from above downwards by

- | | |
|-------------------------------|--------------------------|
| (i) Anterior column of fornix | (ii) Anterior commissure |
| (iii) lamina terminalis. | |

Posterior Wall

It is formed by

- (i) Superior lamina of stalk of pineal body with habenular commissure.
- (ii) Pineal body with pineal recess.
- (iii) Inferior lamina of stalk of pineal body with posterior commissure.
- (iv) Commencement of cerebral aqueduct.

Lateral wall

Thalamic }
Hypothalamic } by curved hypothalamic sulcus.

It is covered by ependymal epithelium.

Thalamic Part

Most of lateral ventricular wall above this sulcus is formed by

- (i) The medial surface of the anterior two-third of the thalamus.
- (ii) Anterior pole of the thalamus lies just behind the interventricular foramen.
- (iii) Posterior pole of thalamus known as pulvinar projects backward beyond the ventricle.
- (iv) The interthalamic adhesion is the cavity which joins the ventricular surface of two thalamus.

Hypothalamic Part

The hypothalamic sulcus which separates the thalamus from hypothalamus. This sulcus extends from the interventricular foramen to cerebral aqueduct,

- In the part, the anterior column of fornix passes downwards and backwards from the interval between the interventricular foramen and the anterior commissure towards the mamillary body.
- The lateral walls of IIIrd ventricle are normally closed. So, in coronal section, the cavity of IIIrd ventricle appears as median vertical slit

Fourth Ventricle

DEF: In front of cerebellum and behind the lower part of the pons and the upper part of the medulla there is a tent like cavity called IVth ventricle. This cavity of IVth ventricle remains completely lined by layer of ependyma.

Communications

Superiorly – Communicates with IIIrd Ventricle through cerebral aqueduct (or) Aqueduct of Sylvius.

Inferiorly – Continuous with central canal of Medulla and of spinal cord.

Dorsally – Foramen of Magendi (or) median aperture is present on the lower part of the roof which communicates with subarachnoid space (cisterna Magna). Through two lateral apertures (or) foramina of luschka on either side it communicates with sub-archnoid surface.

Recesses

Deep in to white core of cerebellum from the middle of roof one median dorsal recess passes. It extends side by side into lateral recess.

On each side at the lateral angles there are two lateral recess opens into lateral end through foramen of luschke.

Boundaries

On either side above and laterally it is bounded by Superior Cerebellar peduncles.

Inferolaterally

By gracile tubercle the fasciculus cuneatus, the cuneate tubercle and the inferior cerebellar peduncle.

Superiorly

By superior cerebellar peduncle.

Roof

The roof (or) posterior cerebellar peduncle is having three parts:

- (i) The upper third is formed by triangular superior medullary velum. A slung between superior cerebellar peduncle. It lies linguae of superior vermis of cerebellum.
- (ii) The central third of roof consists of
 - A continuation, which is inferiorly with upper part of nodule there is the white core of cerebellum is present.
 - The inferior medullary vela and
 - The floccular peduncle.

by cuneiform groove so the posterior aspect of brain stem trigeminal nerves attached on postero-lateral aspect of midbrain medial and Lateral geniculate bodies are preset. From superior and inferior colliculi, two ridges inferior and superior brachium arises.

Grey Matter and Inferior Colliculi

The central grey matter contains:

- (a) Nucleus of trochlear nerve in Ventromedial part.
- (b) Mesencephalic nucleus in trigeminal nerve in lateral part. (Made of unipolar cells) receive proprioceptive impulse.
- Inferior colliculi receives afferent from lateral lemniscus and gives efferent to medial geniculate body it has been center for auditory reflex but recently help localizing source of sound.
- Deeply pigmented nerve cells are substantia nigra, concerned with muscle tone.

Superior Colliculi

Central grey matter contains.

- (a) Nucleus of oculomotor nerve. These nuclei fused in medial plane.

It receives afferent from retina, efferent (gives) to spinal cord. It controls reflex movements of eye, head-neck. Pretectal nucleus also present and provides pathway for light reflex and consensual reflex.

White Matter of Inferior Colliculi

Crus cerebri contains:

- (a) Cortico spinal tract
- (b) Fronto pontine fibres in medial one-sixth.
- (c) Temporo pontine, parieto pontine and occipito pontine on lateral one-sixth.
 - The tegmentum contains lemnisci on trigeminal, medial and spinal, lateral.
 - The decussation of superior cerebellar peduncles on medial plane
 - Middle longitudinal bundle close to trochlear nucleus.
 - The tecto spinal tract and rubro spinal tract. (trochlear nerve passes laterally, dorsally, decussate in superior medullary velum).

Superior Colliculi

- (a) Lemnisci on medial, trigeminal and spinal but lateral is absent.
- (b) The decussation of tecto spinal and tecto bulbar tracts forms dorsal tegmental decussation.
- (c) The decussation of Rubrospinal tracts forms ventral tegmental decussation.
- (d) Medial longitudinal bundle.
- (e) Emerging fibres of oculomotor nerve.

The tegment shows posterior commissure connecting the two superior colliculi.

Applied Anatomy

Most of the ascending and descending tracts are present at all levels of the brain stem and their involvement will produce the following signs and symptoms.

- Contra lateral hemiplegia (Cortico spinal tract).
- Contra lateral loss of pain and temperature in trunks and limbs. (spinal lemniscus).
- Involuntary movements of the limbs (rubro spinal tract).
- Progressive cerebellar ataxia (cerebellar tract).
- Drooping of eye lid (ptosis).

CSF (Cerebrospinal Fluid)

The brain is a delicate and important organ which is protected by the following coverings:

1. Bony covering by the cranial bones.
2. Three membranous coverings
 - Duramater
 - Arachnoid
 - Piamater
3. The cerebrospinal fluid which is present between the arachnoid and piamater and it acts as a water cushion.

The brain as well as the rest of the central nervous system is further protected against injury by cerebrospinal fluid (CSF). It circulates through subarachnoid space around the brain and spinal cord and through ventricles of brain.

The cerebrospinal fluid is mainly formed by the choroid plexuses of the cerebral ventricles.

Amount

The amount present is about 150 ml. But the production of C.S.F. is about 5000 ml per day. Circulation – C.S.F. formed in the lateral ventricles passes through the interventricular foramina (foramen of monro) into the third ventricle. Then the fluid flows into the fourth ventricle by the help of cerebral aqueduct (aqueduct of Sylvius). Again it leaves by the median aperture of the fourth ventricle (foramen of magendi) and two lateral apertures of the fourth ventricle (foramina of luschka) to reach the subarachnoid space and there after extends superficially over the whole surface of brain and spinal cord. As the fourth ventricle is continuous with the central canal of spinal cord, most of the C.S.F. escapes into the subarachnoid space surrounding the brain and cord through the apertures of the fourth ventricle.

Absorption

After bathing the surfaces of the spinal cord and the base of he brain, the C.S.F. passes to reach the supra tentorial subarachnoid space over the both cerebral hemispheres, where absorption normally occurs by the help of arachnoid villi in to the intracranial venous sinuses.

Function of C.S.F.

1. Provides protection for the central nervous system by acting as a “*water jacket*” as it absorbs shock in the event of a blow.
2. Transports hormones and hormone releasing factors.
3. It provides a stable chemical environment for the neurons of the central nervous system.
4. It removes all the waste products of brain metabolism.

Examination of Cerebrospinal Fluid

I. Physical

1. **Appearance** – Normal C.S.F. is clear and transparent. The cloudy appearance of fluid observed, when cell content is above 400 per cumm smoky appearance of C.S.F. observed due to the presence of large number of red cells.
2. **Pressure** – Pressure of the C.S.F. is raised in space occupying lesions of the brain, meningitis, encephalitis, meningism and in hypertensive encephalopathy.

II. Cytological Examination

The cells must be counted as soon as the fluid is removed normally there are 0.5 lymphocytes per cumm.

III. Chemical Examination

1. **Glucose** – Normally C.S.F. glucose represents 70-75% of blood glucose. Sugar is decreased in meningitis as it is consumed by the infecting organism.
2. **Chloride** – Normal value is 700-750 mg per 100 ml it is reduced in meningitis it is when associated with vomiting.
3. **Protein** – Normal value varies between 20-40 mg per 100 ml. A raised protein over 100 mg per 100 ml are usually seen below a complete spinal block in Gullian – Barre syndrome.
4. **Enzymes** – S.G.P.T. is raised in cerebral infarction and multiple sclerosis.

AUTONOMIC NERVOUS SYSTEM

The autonomic nervous system mainly helps in the regulating the activities of cardiac, smooth muscles and certain glands. This is the extension of peripheral nervous system. This system is not controlled by the central nervous system so it is called as autonomic nervous system.

There are two principal division of A.N.S.

They are: 1. Sympathetic 2. Para sympathetic

The first of two autonomic motor neurons is called as pre-ganglionic neuron whose cell is part of brain or spinal cord. The next neuron is called post-ganglionic neuron.

Sympathetic (Thoraco-Lumbar)

Cell body of pre-ganglionic neuron are part of all lateral grey horns of thoracic segment and second or third lumbar segment of spinal cord. So, it is called as thoraco-lumbar division, and the fibres come from it is called as Thoraco-lumbar out flow. The pre-ganglionic axon are myelinated which enter into a short pathway called white ramus. The white ramus which is originated only in thoracic and lumbar region which moves downwards.

The paired sympathetic trunk lies anterior and lateral to spinal cord on either side.

There are 22 ganglion-3 cervical, 11 thoracic, 4 lumbar and 4 sacral.

Cervical – It is located in the anterior neck of the pre-vertebral muscle. It is divided into superior, middle and inferior.

Superior

It is present posterior to the internal carotid artery. The post ganglionic fibres supplies to the head, sweat gland, smooth muscle of eye, blood vessels of face, nasal mucosa and salivary gland. Grey rami communicated to 2-4 cervical spinal nerve.

Middle

It lies near sixth cervical vertebra at cricoid cartilage. Post-ganglionic fibres innervate the heart.

Inferior

It is located near the first rib, anterior, transverse seventh cervical vertebra. It supplies to the heart.

Thoracic

This portion receives most pre-ganglionic fibres. The post-ganglionic fibres supply to the heart, lung, bronchi and other thoracic viscera. In skin to sweat gland, blood vessels and hair follicles.

Lumbar

They lie on either side of lumbar vertebrae.

Sacral

They lie in pelvic cavity on medial side of sacral foramina.

Unmyelinated post ganglionic fibres from lumbar and sacral ganglia is called grey ramus. These grey ramus leads to each of 31 pairs of spinal nerves.

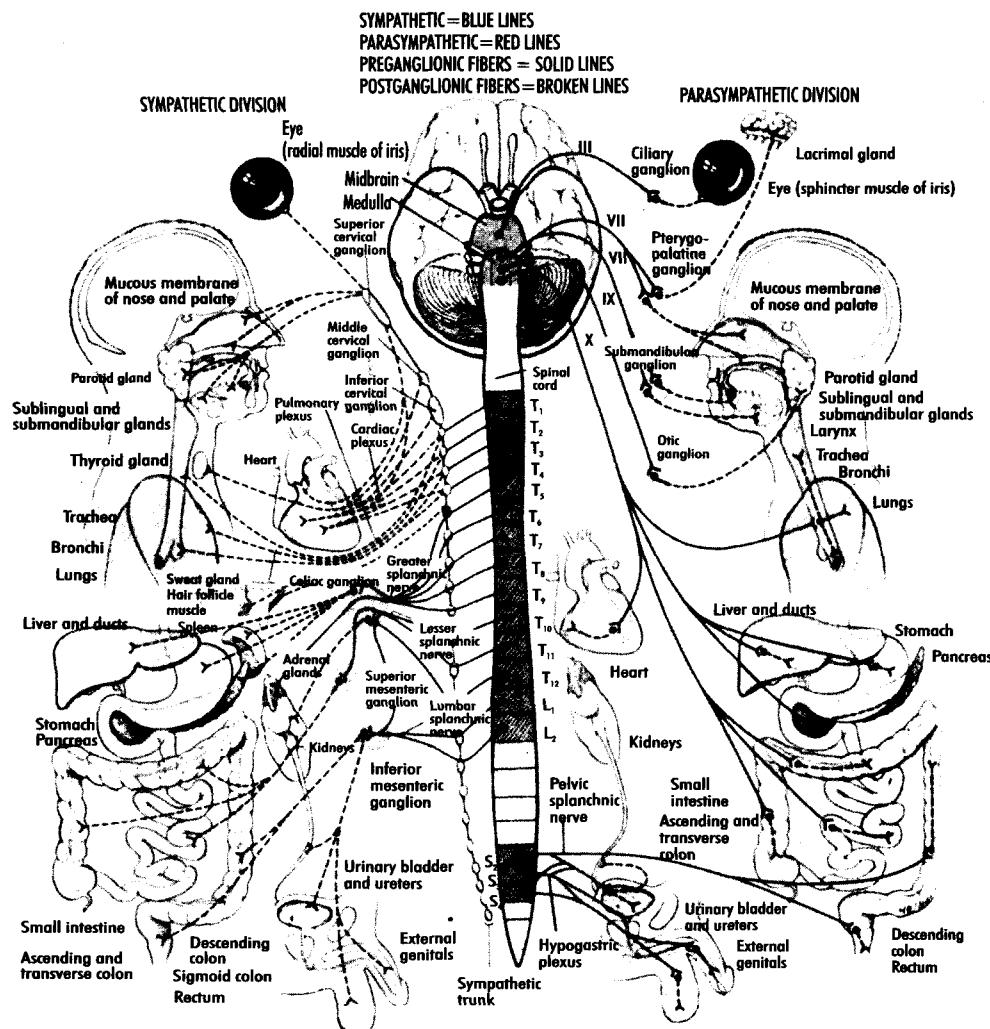
Parasympathetic Division (Cranio – Sacral)

The cell bodies are found in nuclei of brain stem mainly in 3rd, 7th, 9th, 10th cranial and lateral grey horns of second through 4th sacral segments. They are also called as cranio-sacral division and the fibers of pre – ganglionic neurons are called as cranio – sacral out flow.

The cranial parasympathetic outflow consist of fibers from brain stem in four cranial nerves.

The sacral para sympathetic outflow consist of fibers of second through 4th sacral nerve.

Autonomic Nervous System



Cranial Parasympathetic

The cranial outflow consist of five component

four pairs of ganglia

plexus with vagus nerve

the four pair of ganglia supplies to the head and related organs.

1. Ciliary Ganglia

They lie lateral to optic nerve near the back of the orbit. The post-ganglionic fibers from ganglion innervates smooth muscle cells in the eye ball.

2. Pterygopalatine Ganglia

They are lateral to sphenopalatine foramen. It receives the pre-ganglionic fibers from facial (7th) nerve and send post-ganglionic fibers to nasal mucosal, palate, pharynx and lacrimal glands.

3. Sub-Mandibular Ganglia

They are found near the duct of sub mandibular salivary gland. They receive from the facial nerve and send to sub-mandibular and sub-lingual salivary glands.

4. Optic Ganglia

Each pre-ganglionic fibers receives from the glossopharyngeal nerve and send to the parotid salivary gland.

Vagus

This nerve carry nearly 80% of total cranio sacral out flow. This nerve mainly supply to the heart and air ways of lungs. In abdomen it supply to liver, gall bladder, stomach, pancreas, small intestine and part of large intestine.

Sacral Parasympathetic

This nerve out flow through anterior root of the second through fourth cranial nerve. They forms the pelvic splanchnic nerve.

From the ganglion, post ganglionic fibers innervates smooth muscles and glands in the wall of colon, uterus, urinary bladder and reproductive organs.

CRANIAL NERVES

Mnemonics

OOOTTAFAGVAH : (One of Our Trained Teacher asked for a Good Vehicle and Horse)

1,2,8,S, 5,7,9,10 Both, Rests Are Motor

O – Olfactory

O – Optic

O – Oculomotor

T – Trochlear

T – Trigeminal

A – Abducent

F – Facial

A – Auditory

G – Glossopharyngeal

V – Vagus

A – Accessory

H – Hypoglossal.

These are twelve pairs of cranial nerves, all leave the skull through foramina of the skull but ten originate from the brain stem.

The cranial nerves are designated with roman numerals and with name, which indicate the distribution (or) function.

Sensory fibres are present in some cranial nerves called as Sensory nerves.

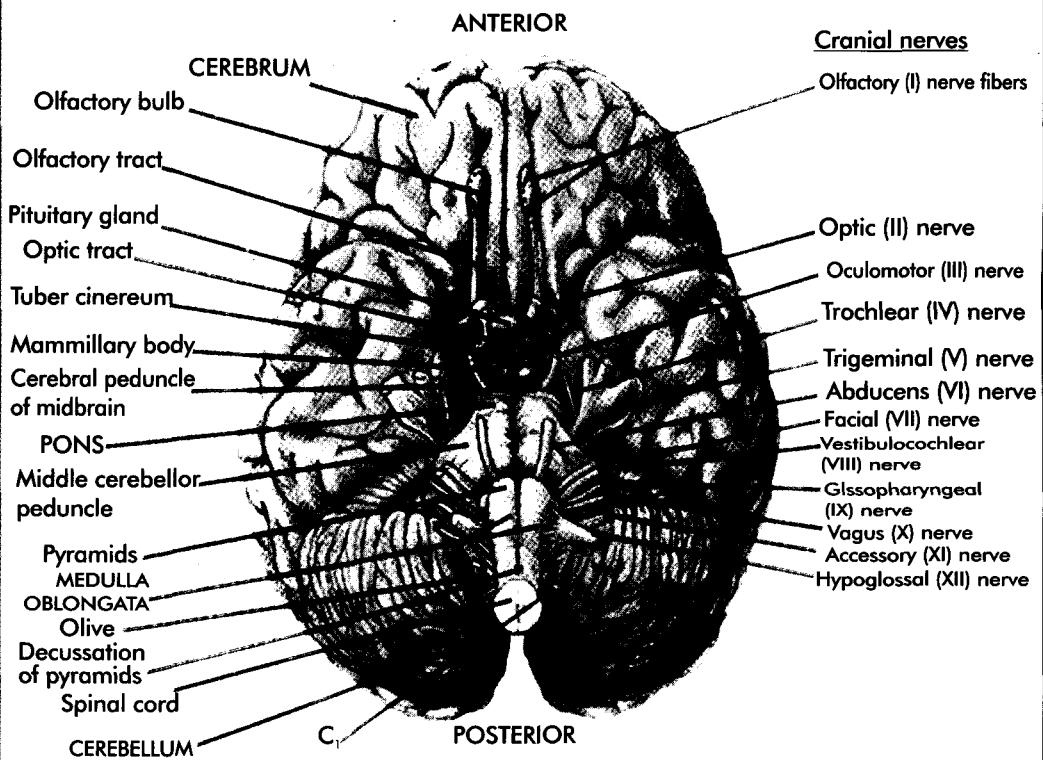
Remaining contain both sensory and motor fibres called as Mixed nerves.

Some motor fibres control sub conscious movements , yet the somatic nervous system has been defined as a conscious system.

Mixed nerves

Sometimes, the cranial nerves such as oculomotor, trochlear, abducent, accessory & hypoglossal were entirely motor. These cranial nerves also contain some sensory fibres from proprioceptors which innervate in muscles. Although these nerves are mixed they are primarily motor in function for serving to stimulate skeletal muscle contraction.

Brain Stem in Relation with Cranial Nerves



Sensory fibres contains cell bodies which are found outside the brain, whereas motor fibres also contains some cell bodies which entirely lie in nuclei within the brain. Somatic nervous system is defined as conscious system because some motor fibres control subconscious movement. The reason for this apparent contradiction is, that some fibres of autonomic nervous system leave the brain, bundled together, with somatic fibres of the cranial nerves in the case for spinal nerves.

Therefore, these subconscious functions transmitted by the autonomic fibres, which are described along with the conscious functions of the somatic fibres of the cranial fibres.

Types of Nerves, its Location and Function

(1) Olfactory Nerve

This is the first cranial nerve, which is sensory.

Location : it arises in olfactory mucosa through cribriform plate of ethmoid bone, which inturn passes through olfactory bulb and olfactory tract and terminates in primary olfactory area of cerebral cortex.

From olfactory tract stria is pyriform lobe which comprise uncus and anterior part of parahippocampal gyrus.

Medial olfactory stria is having septal nuclei. Some impulse from uncus and septal nuclei travel via reticular far to the dorsal nucleus of vagus.

Dorsal nuclei of the vagus where it may increase or decrease gastric secretion according to the type of smell.

Function: smell.

2) Optic Nerve

This is the second cranial nerve which is sensory.

Location : It arises from the eye, which passes through optic foramen forms optic chiasma, which inturn passes through optic tract, lateral geniculate nucleus terminates in the visual areas of cerebral cortex.

Function: Vision.

(3) Oculomotor Nerve

Third cranial nerve which is mixed but primarily motor in function.

Motor portion: It originates in mid brain, which pass through superior orbital fissure and is distributed to levator palpebrae superiosis of upper eye lid and four extrinsic eyeball muscle (superior rectus, Medial rectus, inferior rectus and inferior oblique).

Superior division supplies the nerves to superior rectus and superficially faced levator palpebrae superiosis.

Inferior division, divides into three divisions

- Medial rectus
- inferior rectus
- inferior oblique branch for Ciliary ganglion.

parasympathetic innervations to the Ciliary muscle of eye ball and rectus muscle of eye.

Function : Movements of eyelids and eye ball, accommodation for lens for near vision and constriction of pupil.

Sensory portion: It consist of afferent fibers from proprioceptors in eye ball muscle that passes through superior orbital fissure and terminates in midbrain.

(4) Trochlear Nerve

The 4th cranial nerve mixed but primarily motor in function. This nucleus is inferior colliculus of midbrain.

Motor portion: It originates in midbrain and passes through superior orbital fissure and is distributed to superior oblique muscles and extrinsic eyeball muscles.

Function – Movement of eye ball.

Sensory portion: It contains afferent fibres from proprioceptors in superior oblique muscles that pass through superior orbital fissure and terminates in mid brain.

(5) Trigeminal Nerve

This is the fifth cranial nerve, which is mixed in nature.

Motor portion: It originates in pons and passes through foramen ovale and terminates in muscle mastication ,anterior belly of digastric and mylohyoid muscles.

Function: chewing.

Sensory portion: It consist of three branches ophthalmic, maxillary, mandibular

Ophthalmic – It consists of sensory fibres from skin eyelid, eyeball, lacrimal glands, nasal cavity, side of nose, forehead and anterior half of scalp and passes through superior orbital fissure.

Maxillary – It consists of sensory fibres from mucosa of nose, soft palate, parts of pharynx, upper teeth, upper lip, and lower eyelid and passes through foramen rotundum.

Mandibular – It consists of sensory fibres from anterior two-third of tongue, lower teeth, skin over mandible.

The three branches terminate in pons. Sensory portion also consists of afferent fibres from proprioceptors in muscles of mastication.

Function: It conveys sensation for touch, pain and temperature from structures supplied.

(6) Abducens Nerve

This is the sixth cranial nerve, which is mixed, primarily motor in function.

Motor portion: It originates in pons and passes through superior orbital fissure and is distributed to lateral rectus muscle and extrinsic eye ball.

Function: movement of eye ball.

Sensory portion: It consist of afferent fibres from proprioceptors in lateral rectus muscle that pass through superior orbital fissure and terminates in pons.

(7) Facial Nerve

This is the seventh cranial nerve, which is mixed in nature.

Motor portion: It originates in pons, passes through stylomastoid foramen, and is distributed to facial, scalp, neck muscles, parasympathetic distribution to lacrimal, sublingual, sub mandibular, nasal and palatine glands.

Function: Facial expression, secretion of saliva and tears.

Sensory portion: On anterior two third of the tongue and from taste buds it arises and passes through stylomastoid foramen, passes through geniculate ganglion in nucleus in pons sends fibers to thalamus for relay to gustatory areas of cerebral cortex. Also consists fibres from proprioceptors in muscles of face and scalp.

(8) Vestibulocochlear Nerve

This is the eighth cranial nerve which is sensory.

Cochlear branch: It arises in the spinal origin forms spinal ganglion passes through nuclei in medulla and terminates in thalamus – it sends impulses to auditory areas of cerebral cortex.

function: Associated with hearing.

Vestibular branch: It arises in he semi circular canals saccule and utricle and forms Vestibular ganglion and terminates in thalamus.

Function: Associated with equilibrium.

(9) Glossopharyngeal Nerve

This is the ninth cranial nerve, which is mixed.

Motor portion: It passes through jugular foramen and is originated in medulla, so is distributed to stylopharyngeous, parasympathetic distribution to parotid gland.

Function: Secretion of saliva.

Sensory portion: It arises from taste buds on posterior one third of tongue and from carotid sinus, passes through jugular foramen and it terminates in thalamus. It consists of afferent fibres from proprioceptors in swallowing muscles supplied.

Function: Taste and regulation of blood pressure.

(10) Vagus Nerve

This is the tenth cranial nerve which is mixed.

Motor function: It originates in medulla, passes through jugular foramen and terminates in muscles of respiratory pathways (lungs) oesophagus, heart, stomach, small intestine, large intestine and gall bladder, parasympathetic fibres innervates involuntary muscles and glands of gastro intestinal tract.

Function : Visceral muscle movement.

Sensory portion: It arises from essentially same structures supplied by motor fibres, passes through jugular foramen and terminates in pons and medulla. Also consists of afferent fibres supplied in muscles.

Function : Sensation from organs supplied.

(11) Accessory Nerve

This is eleventh cranial nerve, which is mixed but primarily motor.

Motor portion : It consist of both cranial and spinal portion. Cranial portion originates from medulla passes through jugular foramen and supplies voluntary muscles of pharynx, larynx and soft palate.

Spinal portion originates from grey horn anterior of first five cervical segment of spinal cord, passes through jugular foramen and supplies sternocleidomastoid and trapezius muscles.

Function - Cranial portion mediates for swallowing movements.

- Spinal portion mediates movement of head.

Sensory portion: It consist of afferent fibres from proprioceptors in muscles supplied and passes through jugular foramen.

12) Hypo Glossal Nerve

This is the twelfth cranial nerve which is mixed, primarily motor.

Motor function : It originates in medulla, passes through hypoglossal canal and supplies muscle of tongue.

Function: Movements of tongue during speech and swallowing.

Sensory portion : It consists of fibres from proprioceptors in tongue muscles that passes through hypoglossal canal terminate in medulla.



The concept of *shatchakra* has been derived from the Yogashastra. Yoga is a deeper science which leads to ultimate knowledge of the self. The principles of the Yogashastra also aim at achieving ultimate knowledge. The rajayoga deals with ashthanga (i.e.) *anga* namely *yama*, *niyam*, *asana*, *pranayama*, *pratyahara*, *dharana*, *dhyana* and *samadhi*. These constitute the steps for complete realization. The *kundalini yoga* involves the activation of the dormant *kundalini shakti* that is present in the form of a coiled serpent. This power of *kundalini* is present at the bottom of the *shushumna kanda*. This power is awakened by the movement of *prana* up the *shushumna kanda*. When finally the *prana* ascends past the *randhras*, one becomes enlightened with true knowledge.

The *chakra* are also nothing but forms of energy in a *chakra* like form (circular), present along the *sushumna kanda*. They exist on the metaphysical plane and denote different levels of consciousness. The activation of each *chakra* takes place by the ascent of the *kundalini shakti* along the *sushumna kanda*. The *sushumna* forms the base for all the *nadi*. As *prana* moves along the the *sushumna* corresponding change takes place in the *jiva*. when the *prana* moves up resulting in the ascent of *kundalini shakti* to the *aagya* and then to the *sahasrara chakra*, the *jiva* in the physical body becomes awakened and proceeds towards *moksha* or salvation.

सुषुप्तया ब्रह्मरन्ध्रमारोहत्यवरोहति ॥

जीवः प्राण समारूढो रुज्वां कोलहाटिको यथा ॥ (Sharngadhar Dipika)

Jiva along with the *prana* moves up and down the *sushumna*.

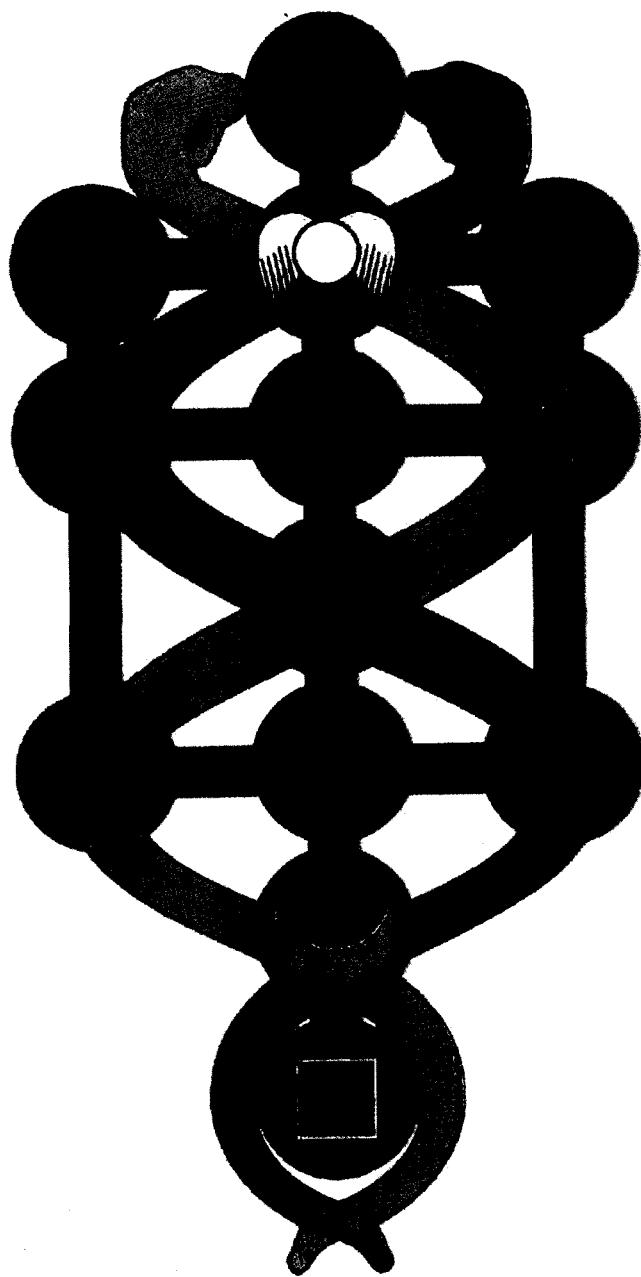
Hence, *pranayama* (i.e.) control of the movement of *prana* is given much importance in yoga.

कुण्डलीबोधकं क्षिप्रं पवनं सुखदं हितम् ।

ब्रह्नाडीमुखेसंस्थकफाद्यगलनाशनम् ॥ (Hathayoga Pradipika 2/66)

Through *pranamaya* the *kapha* and other impurities that are blocking the opening of the *brahmanadi* get cleared there by facilitating the free movement of *prana* and *jiva*. This in turn activates the *Kundalini shakti*.

Colour of Chakras



As the six *chakra* are connected with the *nadi*, the activation of each *chakra* gives rise to a corresponding impact on the *nadi*. This is experienced in the form of attainment of supernatural powers on the activation of the *chakra* and the *kundalini shakti*. Though the *nadi*. These *chakra* control the whole body.

The classical texts of *yoga* mention fourteen such *nadi* namely *sushumna*, *ida*, *pingala*, *gandhari*, *hastajihva*, *kuhu*, *sarasvati*, *puja shankhini*, *payasvini*, *varuna*, *alankuja*, *vishvodariyashasvini*.

These *nadi* enable the *chakra* to have an impact on the physical body.

The Shatchakra are:

- | | |
|----------------------------|-------------------------------|
| 1. <i>Muladhara chakra</i> | 2. <i>Svadhishtana chakra</i> |
| 3. <i>Manipura chakra</i> | 4. <i>Anahata chakra</i> |
| 5. <i>Vishudha chakra</i> | 6. <i>Aagya chakra</i> |

All these *chakra* are present along the *sushumna nadi* in an ascending order. The *muladhara chakra* is the lower most *chakra*, while the *agya chakra* is present at the top.

Muladhara Chakra

According to Yogashastra

कुलामिधं सुवर्णाभं स्वयम्भूलिङ्गसङ्कृतम् ।
 द्विरण्डो यत्र सिद्धोऽस्ति डाकिनी यत्र देवता ॥
 तत् पद्ममध्यगा योनिस्तत्र कुण्डलिनी स्थिता ।
 तस्या ऊर्ध्वे स्फुरतेजः कामबीजं भ्रमन्मतम् ॥
 तस्य स्याद् दार्दुरी सिद्धिर्भूमित्यागक्रमेण वे ।
 परिस्फुरत्वादि सान्तं चतुर्वर्णं चतुर्दलम् ॥

This *chakra* is present in the region of the anus and the inactive *Kundalini shakti* lies here. It shines like gold and resembles a *padma* (lotus). To activate this *chakra*, one must attain full control over the *bhumi* or *prithivi* principle.

Other name: *Aadhara chakra*

Site	- Yoni
dala	- four
Colour	- red (rakta)

BIJAKSHARA -	<i>van, shan, shan, san</i>	yantram -	<i>chatushkona</i>
NAMATATVA -	<i>prithivi</i>	gyanendriya -	<i>nasa</i>

TATTVABIJA	-	<i>lan</i>	karmendriya	-	<i>gudam</i>
GUNA	-	<i>gandha</i>			
DEVATA	-	<i>brahma</i>			
SHAKTI	-	<i>dakini</i>			

DHYANAPHALAM – when the *muladhara chakra* is properly activated by the person attains perfect *sharirakranti*, *arogyam*, *mantrasidhi*, and a powerful *jatharagni*. He also becomes the best among men and becomes capable of learning a number of arts (*vidya*), i.e *sarvavidya vinodi*. He is also blessed with complete, *ananda* of *chitta*.

The *muladhara chakra* is these days correlated to the pelvic plexus.

Svadhishthana chakra

द्वितीय तु सरोजं च लिङ्गमूले व्यवस्थितम् ।
बादिलान्तं च षड्वर्णं परिबास्वरषड्दलम् ॥
स्वाधिष्ठानामिर्थं ततु पंकजंशोणरू पकम् ।
बाणाख्यो यत्र सिद्धो अस्ति देवी यत्रास्ति शाकिणी ॥

This is the second *chakra* from below upwards. It is situated in the *lingamulam*. It resembles a red lotus *rakta padma* (lotus) when one has control over this, the *jalatattva* is reached by him, through *dhyana*.

Site	-	<i>lingamulam</i>
Dala	-	six
Colour	-	<i>sindura, varna</i>
Bijakshara	-	<i>ban, bhan, man, yam, ran, lan</i>
Namatatva	-	<i>jalam</i>
Tattvabija	-	b
Guna	-	<i>rasa</i>
Devta	-	<i>vishnu</i>
Shakti	-	<i>shakini</i>
Yantram	-	<i>chandrakara</i>
Gyanendriya	-	<i>rasana</i>
Karmendriya	-	<i>gudam</i>
Dhyanaphalam	-	when the svadhishthana chakra is activated by dhyana, the person becomes the best among the yogis. he becomes free of moha and ahankara. he is blessed with a capacity to compose gadya and padya instantaneously.

This is correlated with the inferior mesenteric plexus or hypo gastric plexus.

Manipura chakra

तृतीय पंकजं नाभो मणिपूरकसंशकम् ।
 दशारं अदि फान्तार्ण शोभितं हेमवर्णकम् ॥
 रुद्राख्यो यत्र सिद्धो अस्ति सर्वमङ्गलदायकः ।
 तत्रस्था लाकिनी नाम्नी देवि परमधर्मिका ॥

Manipura chakra is the third one, present in the *nabhi*.

नामिमूले स्वाधिष्ठानोर्ध्वे ।

It radiates like gold (*hemavarna*). A *siddha* named *rudra* resides in this *chakra*.

Site	- <i>nabhi</i>
<i>Dala</i>	- ten
Colour	- blue (<i>nila</i>)
<i>Bijakshara</i>	- <i>dan, dhan, nan, tan, than, dan, dhan, nan, pan, phan</i>
<i>Namatattva</i>	- <i>agni</i>
<i>Tattvabija</i>	- <i>ran</i>
<i>Guna</i>	- <i>rupam</i>
<i>Devata</i>	- <i>rudra</i>
<i>Shakti</i>	- <i>lakini</i>
<i>Yantram</i>	- <i>trikona</i>
<i>Gyanendriya</i>	- <i>chekeshu</i>
<i>Karmendriya</i>	- <i>pada</i>
<i>Dhyanaphalam</i>	- on the activation of this <i>chakra</i> one is blessed with <i>nirantar sukham</i> . He also attains the <i>siddhi</i> of <i>paradehapraveshana</i> (entering into another body), Goddess Saraswati always resides in his <i>jivha</i> and so, he has <i>vakasidhi</i> .

The *Manipura chakra* is correlated with the solar plexus.

Anahata Chakra

शब्दब्रह्मयः शब्दो अनाहत स्त्र दश्यते ।
 अनाहताख्यं पश्यं तत् मुनिभिः परिकीर्तितम् ॥

हृदये अनाहतं नाम चतुर्थं पंकजं भवेत् ।
 कादि अन्तार्ण संस्थानं द्वादशारसमान्वितम् ॥
 अतिशोणं वायुबीजं प्रसादस्थानमीरितम् ।
 सिद्धःपिनाकी यत्रास्ति काकिनी यत्र देवता ॥
 एतस्मिन् सततं ध्यानं हृत्पाश्वांजे करोति यः ।
 क्षुभ्यते तस्य कान्ता वै कामार्ता दिव्यशोषितः ॥

The *anahata chakra* has an *uttana* and *gambhira* aspect. It is situated in the *hridayam*. It is of a luminous red colour and *pranavayu* resides in this *chakra*. A *siddha* named *pinakei* resides in this.

<i>Site</i>	-	<i>hridayam</i>
<i>Dala</i>	-	12
<i>Colour</i>	-	<i>aruna</i>
<i>Bijakshara</i>	-	<i>kan, khan, gan, ghan, nan, chan, chen, jan, jhan, han, tan, than</i>
<i>Namatatva</i>	-	<i>vayu</i>
<i>Guna</i>	-	<i>sparsha</i>
<i>Devata</i>	-	<i>Rudra</i>
<i>Shakti</i>	-	<i>kakini</i>
<i>Yantram</i>	-	<i>shatkona</i>
<i>Gyanendriya</i>	-	<i>tvak</i>
<i>Karmendriya</i>	-	<i>hasta</i>

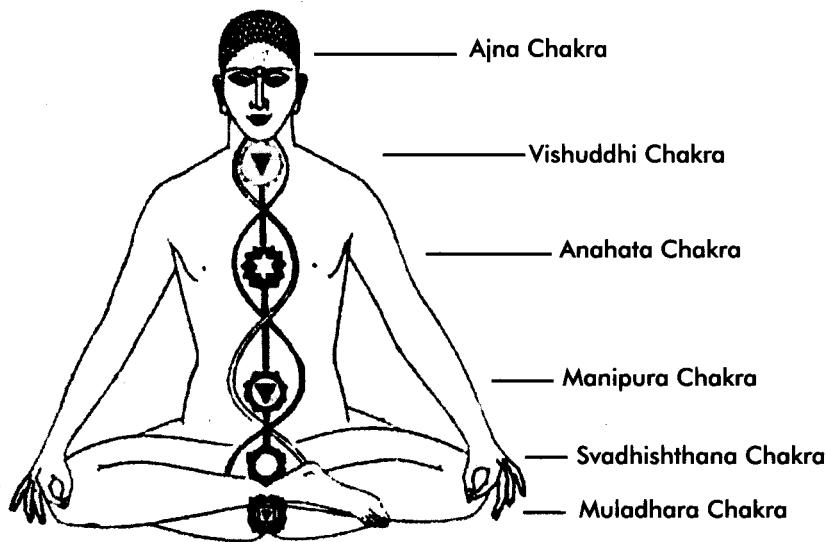
dhyanaphalam - gyanaprapti durashruti duradrishiti trikala gyanam etc. on activating the *anahata chakra*, one possesses power to fly on will. (*svechchhaya svagatam vrajet*).

The *anahata chakra* is correlated with the cardiac plexus.

Vishuddha Chakra

विशुद्धितनुते यस्माज्जीवस्य हंसलोकनात् ।
 विशुद्धं पद्माञ्ज्यातमाकाशाञ्चयं मदपरम् ॥
 कण्टस्तानस्थितं पद्म विशुद्धं नाम पञ्चमम् ।
 सुहेमाभं स्वरोपेतं षोडशस्वरसंयुतम् ॥
 छागलाण्डो अस्ति सिद्धो अत्र शाकिनी चाधिदेवता ।
 ध्यानं करोति यो नित्यं स योगीश्वरपण्डितः ॥

Shatchakra



किन्त्वस्य योगिनो अन्यत्र विशुद्धाञ्चे सरोरुहा ।
चतुर्वेदा विबासन्ते सरहस्या निधोरिष्य ॥

This is the fifth *chakra* present in the *kantha*. As the *jivatma* gets purified when one meditates on this *chakra*, this is named as *Vishuddha chakra*.

Site	-	<i>kantha</i>
<i>Dala</i>	-	16
Colour	-	<i>dhumra</i>
<i>Bijashara</i>	-	<i>a, aa, i, i, u, u, ri, e, ai, o, au, an, ah</i>
<i>Namatattva</i>	-	<i>akash</i>
<i>Tattvabija</i>	-	<i>ha</i>
<i>Guna</i>	-	<i>shabda</i>
<i>Devata</i>	-	<i>panchavaktra</i>
<i>Shakti</i>	-	<i>shakini</i>
<i>Yantram</i>	-	<i>shunyachakra</i>
<i>Gyanendriya</i>	-	<i>karna</i>
<i>Karmendriya</i>	-	<i>vak</i>
<i>Dhyanaphala</i>	-	<i>vakshakti gyana chitta shanti arogyam trikaladarshi tejasvi chiranjivi.</i> This is correlated with the pharyngeal plexus.

Agyachakra

आशानामाम्बुजं तद्दि मकरसदृशं ध्यानधामप्रकाशम् ।
आशा संक्रमणं तत्र भृवोरराजेति कीर्तितम् ॥
आशापद्मं भृवोर्मध्य हक्षोपेतं द्विपत्रकम् ।
शुक्राभं तन्माहाकालसिद्धो देव्यत्र डाकिनी ॥
शरञ्जननिभं तत्राक्षरफीजं विजृम्पितम् ।
पुमान् परमहंसो अयं यशात्वां नावस दति ॥
तत्र देवः परं तेजः सर्वतन्त्रेषु मन्त्रिणः ।
चिन्तायित्वापरां सिद्धिं लभते न अत्र संशयः ॥
आशापद्मामिदं प्रोक्तं यत्र देवा महेश्वरः ।
पीडत्रं ततषोध्वं निरुक्तं योगाचिन्तकैः ॥
तत्त्विन्दु नाद शक्तयाख्यं भाल पद्म व्यवस्थितम् ।

The *agyachakra* is present between the two eyebrows *bhrumadhy*a. A *siddha* named *mahakala* is present here. It looks like *sharatkalina chandra* (*i.e.*) the moon in the *sharad ritu*. One who reaches this level becomes free from all *bandhan*, and becomes equal to the gods.

Site	-	<i>bhrumadhy</i> a
<i>Dala</i>	-	2
Colour	-	white (<i>shweta varna</i>)
<i>bijaakshara</i>	-	<i>ha, ksha</i>
<i>Namatattva</i>	-	<i>mahat</i>
<i>Tattvabija</i>	-	<i>am</i>
<i>Guna</i>	-	<i>shabda</i>
<i>Devata</i>	-	<i>pomchavaktra</i>
<i>Shakti</i>	-	<i>hakini</i>
<i>Yantram</i>	-	<i>tapah</i>
<i>Gyanendriya</i>	-	<i>karna</i>
<i>Karmendriya</i>	-	<i>vak</i>
<i>dhyanaphalam</i>	-	<i>vakshakti</i> . This <i>chakra</i> is correlated with the naso-ciliary extension of the cavernous plexus of the sympathetic.

Some of the textbooks of yoga mention the *sahsrarachakra* present above the *agyachakra*. This is considered to be the *adbara* or site for the *purusha*. Reaching this *chakra*, one attains complete *moksha* (emancipation).



Introduction

The entire universe, including the human body is *panchabhautika* in nature. The general sustenance is maintained by the *shita* and *snigdha* nature of the body balanced by *agneya guna*. The basic nature of the human body is that of kapha. The process of transformation is enhanced by *pittam* and *vata* plays a major role in deterioration. The combination of *vata* and *pittam* (*i.e.*) *vayu* and *agni* creates an atmosphere that has a degenerative tendency. When *agni* combines with *vayu*, the degree of damage to the structure becomes more. *Vayu mahabhuta* is held in *agni*, which in turn is supported by the *shitatva* of *jalam*.

The bodies, even though *panchabhautika* in nature, has in it certain vital or vulnerable points where *agni* and *vayu* are predominant.

Such *vata* points on the body that are *agneya* in nature are called as *marmas*. This predominance of *agni* and *vayu* over these areas marks them vital and more prone to injuries that lead to instantaneous death. These points structurally correspond to areas where *mansa*, *sira*, *vayu* etc. comes together. Hence, these are given more importance, especially with reference to surgical operations done over that area, for any injury to the *marma* causes deleterious effects.

Marmachikitsa is basically *vata pittahara* in nature. Thus, it implies that even treatment of any other disease like *jvara*, *vatarakta* etc. is nothing but *marmachikitsa*, as the main aim of any *chikitsa* is to bring back the condition of normalcy in the body. (*prakritisthanam*).

Though *marmas* are coming under *madhya rogamarga*, so sufficient care has to be taken during the treatment of *marmachikitsa*. In our classics it is mentioned that every diseases treatment ends with *ghritapana* or *kshira pana*.

The term ‘*Marma*’ is derived from the Sanskrit root “*mri*” meaning *marana* or death. It is also defined as –“मारयन्ति इति मर्मणि उच्यन्ते”

Marmas are sensitive or vulnerable points in the body that may cause death or severe pain when traumatized. *Marmas* were initially used as a war medicine.

The first mention of *marmas* has been made in the Atharva Veda. During the Vedic period, kings and warriors had a sound knowledge of marmas and this mostly used in the battlefields to achieve a maximum fatal response against enemies.

Now a days marmas are much concentrated upon, for curative purposes besides using it has a means to attack and defend enemies. These *marmas stanas* are given importance while performing surgeries, as marmas are not operated during surgery. Operating a marma point may cause the death of an individual.

Another branch of science called Acupuncture deals with treatment methods concerned with such points on the body. *Marma* points in the body correspond to some of the acupuncture points. These points are also said to be "Energy Points". Any how acupuncture points are differ from the *marma* points described in Ayurveda as they are not that lethal. *Marma* points described in the Ayurveda texts are mostly those that cause death or dysfunction. These *marmas* when hit, produce deleterious effect and hence the exact location of these *marmas* is not disclose generally unless taught by an expert to his disciples traditionally.

When a *marma stana* traumatized, it cause not only local pain over the area, but also pain in distant parts of the body that are connected to that particular marma

Importance of Marmas

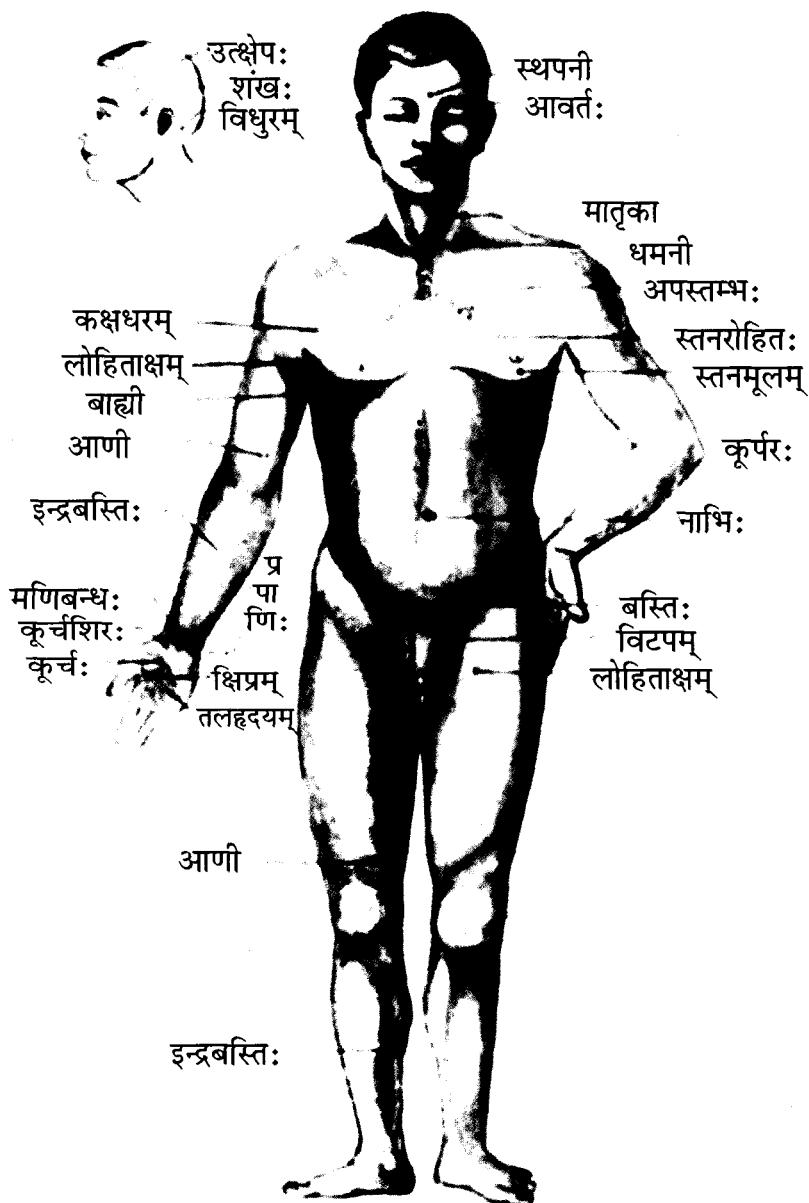
Marmas have been given importance in treatment and in classical texts. Acharya Susruta mentions in his "*pratyeka marmanirdeshadhyaya*" that *marmas* constitute half of "*shalyatantram*". This indicates the important role played by *marmas* in surgery. As mentioned before *marma stanas* are not operated during surgery, as it may cause injury to *marma*, which is considered more fatal compare to amputation of the whole part. Hence in certain condition where *marmas* cannot be traumatized, in order to save the life of the individual.

Marmas are dangerous sites for surgery also because some of the important anatomical structures like "*sira* and *snayus*" etc. that constitute a *marma* are present there.

Diseases that have their "*adhishthana*" as *marmas* are difficult to treat and even if they are curable, at most care should be taken during treatment.

The effects caused by the injury or traumas to *marmas* are also not easily rectified. Hence, a perfect knowledge of *marmas* helps in preventing conditions that may risks the life of the person.

Marma (Anterior View)



Definition of Marmas

Acharya Sushruta has defined marma as –

मर्मणि मांस सिरास्त्राव्यस्थि सन्धि सत्रिपाताः, तेषु स्वभावत एव विशेषेण प्राणस्तिष्ठन्ति ।

(Su.Sh.6/16)

Marma is defined as a point on the body where the following anatomical structures are present:

1. *Mansa*
2. *Sira*
3. *Snayu*
4. *Asthi*
5. *Sandhi*

Marma is the point where *prana* is most concentrated. Among the above-mentioned anatomical structures, a *marma* may not consist of all the five always, even when they are in junction or *sandhi* between any two of them the point can be called as *marma*.

Prana, which is a form of energy is present all over the body and gets conveyed through out by means of channels called as *nadis*. Generally, these *nadis* (*nadi*) lie deep inside. Some consider that when these *nadis* at some part of the body became superficial, they constitute a *marma*. This is why a *marma* is said to be concentrated with *prana*. Hence, these points became susceptible to injury and *trauma* and lead to death. When a *marma* is traumatized, the continuity in the flow of *prana* is disturbed and this leads to the death of the person.

Marmas are also connected, thus, in the same way with the internal organs. This is why there is referred pain in different parts of the body when a *marma* is hurt.

- (1) As *prana*, the most vital thing in a being is affected when *marmas* are hurt; the effects caused by its injury are always serious. Even though death is not always caused when a *marma* is injured, there is always a serious damage or dysfunction to the body.

This does not happen when any other point other than *marma* is hurt. This is the reason why *marmas* are considered the most lethal among all.

- (2) When a *marma* is hurt the general balance in the body is disturbed very quickly. There is a disturbance caused in the normal environment that is maintained internally by the *doshas*, *dhatus* and *malas*. The effects are also seen immediately compared to those caused by ordinary diseases.

Classification of Marmas

The total number of *marmas* are said to be 107.

These can be classified into specific groups based on different factors in order to make this study easier.

Marmas are classified as follows:-

(1) Based on the anatomical structures that lie on the marma, they are of five types namely –

- | | |
|------------------------|-----------------------|
| 1. <i>Mansa marma</i> | 2. <i>Sira marma</i> |
| 3. <i>Snayu marma</i> | 4. <i>Asthi marma</i> |
| 5. <i>Sandhi marma</i> | |

Each of this consists of

1. Mansa marma

तत्र तलहृदयेन्द्रबस्तिगुदस्तनरोहितानि मांसमर्माणि। *(Su.Sh.6/7)*

These are eleven in numbers. They are –

- | | |
|-----------------------|-------------------|
| 1. <i>Talabridaya</i> | – Four in number. |
| 2. <i>Indrabasti</i> | – Four in number. |
| 3. <i>Guda</i> | – One in number. |
| 4. <i>Stanarohita</i> | – Two in number. |

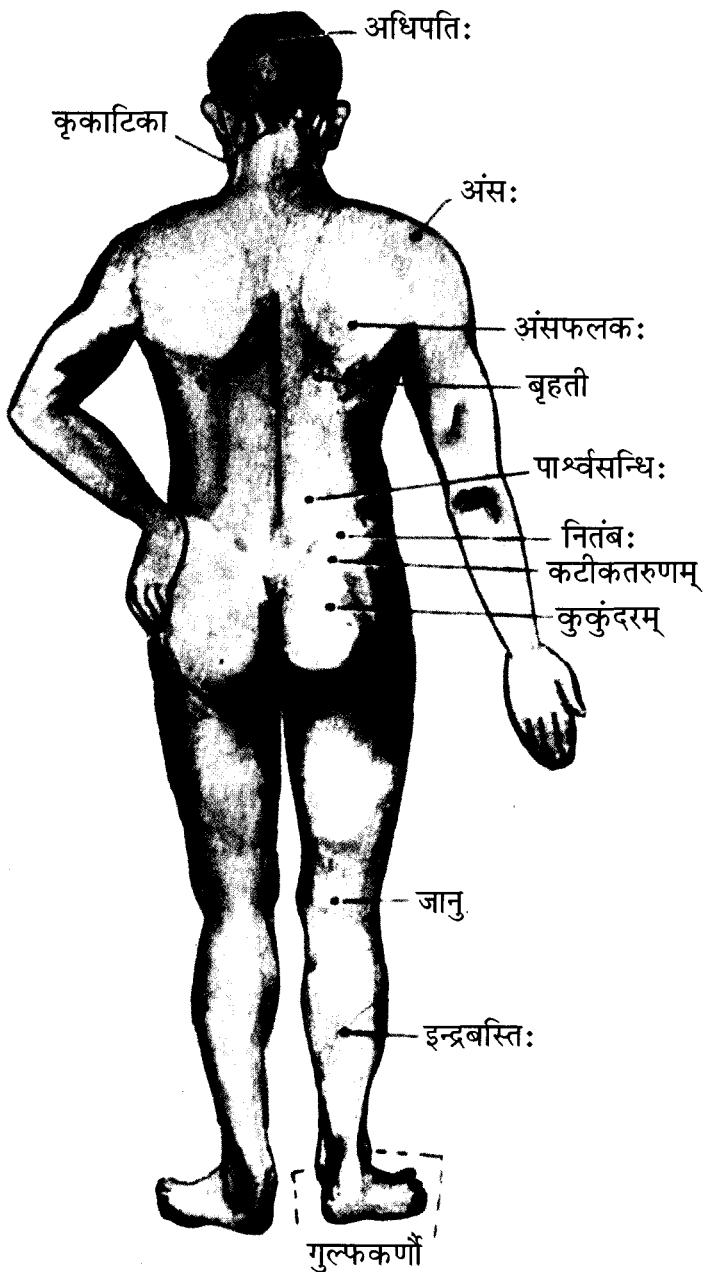
2. Sira Marma

नीलधमनीमातृकाशृङ्खाटकापाङ्ग स्थपनीफणस्तनमूलापलापापस्तहृदय नामिपार्श्वसन्धिबृहतीलोहिताक्षोव्यः
सिरामर्माणि। *(Su.Sh.6/7)*

They are fortyone in numbers –

1.	<i>Dhamani</i>	–	4	<i>Matrika</i>	–	8
3.	<i>Shningataka</i>	–	4	<i>Apanga</i>	–	2
5.	<i>Sthapani</i>	–	1	<i>Phana</i>	–	2
7.	<i>Stanamula</i>	–	2	<i>Apastamba</i>	–	2
9.	<i>Apalapa</i>	–	2	<i>Hridaya</i>	–	1
11.	<i>Nabhi</i>	–	1	<i>Parshwasandhi</i>	–	2
13.	<i>Brihati</i>	–	2	<i>Lohitaksha</i>	–	4
15.	<i>Urvi</i>	–	4			

Marma (Posterior View)



3. *Snayu Marma*

आणि विटपक्षधरकूच्कुर्चशिरो बस्तिक्षिप्रांसविधुरोत्क्षेपाः स्नायुमर्माणि । (Su.Sh.6/7)

They are twenty seven in numbers –

1. <i>Aani</i>	–	4	2. <i>Vitapa</i>	–	2
3. <i>Kakshadhara</i>	–	2	4. <i>Kurcha</i>	–	4
5. <i>Basti</i>	–	1	6. <i>Kurchashira</i>	–	4
7. <i>Kshipra</i>	–	4	8. <i>Ansa</i>	–	2
9. <i>Vidura</i>	–	2	10. <i>Utkshapaddha</i>	–	2

4. *Asthi Marma*

कटिकतरुण नितम्बांसफलक शङ्खाःतु अस्थिमर्माणि । (Su.Sh.6/7)

They are eight in numbers –

1. <i>Katikataruna</i>	–	2	2. <i>Nitamba</i>	–	2
3. <i>Ansaphalaka</i>	–	2	4. <i>Shankha</i>	–	2

5. *Sandhi Marma*

जानुकूर्पर सीमन्ताधिपतिगुल्फमणिबन्धकुकुन्द्रावरते कृकाटिकाशचोति सन्धिमर्माणि ॥

(Su.Sh.6/7)

They are twenty in numbers –

1. <i>Janu</i>	–	2	2. <i>Kurpara</i>	–	2
3. <i>Simanta</i>	–	5	4. <i>Adhipati</i>	–	1
5. <i>Gulpha</i>	–	2	6. <i>Manibandha</i>	–	2
7. <i>Kukundara</i>	–	2	8. <i>Aavarta</i>	–	2
9. <i>Krikatika</i>	–	2			

According to Vaghbhata, the *marmas* are divided into six types according to the structural composition.

Dhamani marma is the contributoion of Vaghbhata. It is total nine in number.

गुदापस्तम्भो विधूर शृङ्खाटानि नवादिशेत् मर्माणि धमनिस्थानि ॥

(As. H. Sh. 4/41)

They are nine in numbers –

<i>Guda</i>	–	1	<i>Apastambha</i>	–	2
<i>Vidhura</i>	–	2	<i>Shringataka</i>	–	4

(2) Based on the site of the marmas on the body they can be classified as follows:

- | | |
|--|-------------------------|
| 1. <i>Saktimarma</i> | 2. <i>Bahumarma</i> |
| 3. <i>Udara and Uro marma</i> | 4. <i>Prishthamarma</i> |
| 5. <i>Grivamarma Undhvajatrugata marma</i> | |

तत्र सविथमर्माणि क्षिप्रतलहृदयकूर्चकूर्चशिरोगुल्फेन्द्रबस्तिजान्वाण्युविलोहि ताक्षाणि विटपं चेति,
तेनतरत्सविथ व्याख्यातम्। (Su.Sh.6/6)

These *marmas* are present on the lower extremities. They are totally twenty two in numbers, as eleven *marmas* in each lower limb.

They are –

- | | |
|-------------------|-----------------------|
| 1. <i>Kshipra</i> | 2. <i>Talahridaya</i> |
| 3. <i>Kurcha</i> | 4. <i>Kurchashira</i> |
| 5. <i>Gulpha</i> | 6. <i>Indrabasti</i> |
| 7. <i>Janu</i> | 8. <i>Aani</i> |
| 9. <i>Urvi</i> | 10. <i>Lohitaksha</i> |
| 11. <i>Vitapa</i> | |

All the above-mentioned *marmas* are present, one on each of the lower limbs.

अत ऊर्ध्वं सविथमर्माणि व्याख्यास्यामः । तत्र पादस्याङ्गुष्ठाङ्गुल्योर्मध्ये क्षिप्रं नाम मर्म,
तत्रविद्धस्याक्षेपकेण मरणं। (Su.Sh.6/24)

Kshipra is situated between the great and the second toe of the foot. If it is injured death ensured by convulsion.

मध्यमाङ्गुलीमनुपूर्वेण मध्ये पादतलस्य तलहृदयं नाम, तत्र रुजाभिर्मरणं।

(Su.Sh.6/24)

Talahridaya is in the centre of the sole in straight line with the middle toe. Injury to this leads to severe pain and finally to death.

क्षिप्रस्योपरिष्टादुभयतः कुर्चो नाम तत्र पादस्य भ्रमणवेपने भवतः।

(Su.Sh.6/24)

Kurcha is situated between the two sides of kshipra. If it is injured it causes giddiness and trembling.

गुल्फेसन्धेरथ उभयतः कुर्चशिरः, तत्र रुजाशोफौ।

(Su.Sh.6/24)

Kurchashira is present on both the sides below the ankle joint. It causes pain and inflammation.

पादजङ्घयोः सन्धाने गुल्फः, तत्र रुजः स्तब्धपादता खड्डता वा।

(Su.Sh.6/24)

Gulpha is present at the junction of foot and the leg. It causes severe pain, stiffness in foot.

पार्षिं प्रति जङ्घामधे इन्द्रबस्तिः, तत्र शोणितक्षयेण मरणं।

(Su.Sh.6/24)

Indrabasti is situated in the middle of the leg in the calf muscle. It causes death by the loss of blood.

जङ्घोर्वोः सन्धाने जानु, तत्र खड्डताः।

(Su.Sh.6/24)

Janu is present at the junction of leg and thigh. It causes the person lame.

जानुन् ऊर्ध्वमुभयतस्ययज्ञुलमाणी, तत्र शोफाभिवृद्धिः स्तब्धसविथता च। (Su.Sh.6/24)

Aani is present three fingers above the knee joint. It causes severe swelling and stiffness in the leg.

ऊरुमधे उर्वा तत्र शोणितक्षयात् सविथशोष।

(Su.Sh.6/24)

Urvi is present in the middle of the thigh. It causes muscular dystrophy by loss of blood.

उर्वा ऊर्ध्वमधो वड्क्षणसंबेस्त्वमूले लोहिताक्षं, तत्र लोहितक्षयेण मरणं पक्षाधातो वा। (Su.Sh.6/24)

Lohitaksha is present above *urvi* and below the hip joint at the root of the thigh. It causes haemorrhage and leads to death or paralysis.

वड्क्षणवृषणयोरन्तरे विटपं, तत्र षाण्ठयमल्प शुक्रता वा भवति।

(Su.Sh.6/24)

Vitapa is present in between the inguinal region and the scrotum. It causes impotence or oligo-spermia or azoospermia.

एवमेतान्येकादशा सविथमर्माणि व्याख्यातानि। एतेनेतरसविथ काहु च व्याख्यातौ। विशेषतस्तु यानि सविथ गुल्फजानुविटपानि, तानि काहो मणिकान्धकूर्पर कक्षधराणि, यथा वड्क्षणवृषणयोरन्तरे विटपमेव वक्षःकक्षयोर्मध्ये कक्षाधरं, तस्मिन् विद्वे त एवोपद्रवाः। विशेषतस्तु मणिकन्धे कुण्डलाकूर्मराख्ये कुणिः, कक्षाधरे पक्षाधातः। एवमेतानि चतुष्टात्वारिंशत् शाखासु मर्माणि व्याख्यातानि॥ (Su.Sh.6/24)

Thus eleven *marma* situated in the leg has been described.

The same thing should be understood in the other leg and the arms. The only difference is *Gulpha*, *Janu* and *Vitapa* of leg are replaced *manibandha*, *kurpara* and *kakshadhara* in the arms. As there is *vitapa* between the inguinal region and the scrotum (In arms) *kakshadhara* is between the chest and axilla. Any injury to this causes the same complications particularly loss of activity in wrist, deformity in elbow and paralysis in *kakshadhara*.

बाहुमर्माणि तु शप्रतलहृदयकृचंशिरोमणिबन्धेन्द्रस्तिकूर्पराण्युर्विलोहिताक्षाणि कक्षधरं चेति, एतेनेतरो बाहुव्याख्यातः। (Su.Sh.6/6)

(2) These are the *marmas* present in the upper extremities. These are also totally twenty two in number present as eleven *marmas* on each hand. These are the same above mentioned *sakthimarma* present also similarly in the upper extremities.

(3) Udara and Uro *marma*

उदारोरसोस्तु गुदबस्तिनाभिहृदयस्तनमूलस्तनरोहि तापलापान्यपस्तम्भौ चेति। (Su.Sh.6/6)

These are *marmas* present on the abdomen and chest regions. They are totally twelve in numbers.

They are:

1. <i>Guda</i>	-	1	2. <i>Basti</i>	-	1
3. <i>Nabhi</i>	-	1	4. <i>Hridaya</i>	-	1
5. <i>Stanamula</i>	-	2	6. <i>Stanarohita</i>	-	2
7. <i>Apalapa</i>	-	2	8. <i>Apastambha</i>	-	2

तत्र वातवर्चोनिरसनं स्थूलान्तप्रतिबद्धं गुदं नाम मर्म, तत्र सद्यो मरणं।

(Su.Sh.6/25)

Guda is attached to the large intestine which expels the flatus, faeces. On injury it causes sudden death.

अल्प मांस शोणितेभ्यो आभ्यन्तरतः कट्ठां मूत्राशयो बस्तिः, तत्रापि सद्योमरणमश्मरीव्रणाहते, तत्राप्युभयतो भिन्ने न जीवति, एकतो भिन्ने मूत्रसावी व्रणो भवति, स तु यत्नोपक्रान्तो रोहति।

(Su.Sh.6/25)

Basti is made up of scanty musculature and blood situated inside the pelvis and the receptacle of the urine. Injury to this leads to immediate death except in case of chronic wound which is originated due to urinary calculi.

पक्वामाशयोर्मध्ये सिराप्रभवा नाभिः, तत्रापि सद्यो मरणं।

(Su.Sh.6/25)

Nabhi is present between the *pakvashaya* and the *amashaya*. It is the seat of the origin of the blood vessels. Injury to this leads to immediate death.

स्तनयोर्मध्यमधिष्ठायोरस्यामाशयोद्वारं सत्त्वरजस्तमसामधिष्ठानं हृदयं तत्रापि सद्यो एव मरणं।

(Su.Sh.6/25)

Hridaya is present between the two breasts near to the opening of the cardiac end of the stomach which is the seat of *Sattva*, *rajas* and *tamas*. It also leads to immediate death if it is injured.

स्तनयोरथस्ताद् द्व्यञ्जुलमुभयतः स्तनमूले, तत्र कफपूर्णकोष्ठतया कासश्वासाभ्यां ग्रियते।

(Su.Sh.6/25)

Stanamula is present two fingers below the breasts on the both sides. Injury to this leads to death by arresting the respiration.

स्तनचूचुकयोरुर्क्ष्वं द्व्यञ्जुलमुभयतौः स्तनरोहिते, तत्र लोहितपूर्णकोष्ठतया कासश्वासाभ्यां च ग्रियते।

(Su.Sh.6/25)

Stanarohita is present two fingers above the nipple of the breasts. Injury to this leads to death by producing Dyspnoea, cough and haemothorax.

अंसकूटयोरथस्तात् पाञ्चोपरिभागयोरपलापौ नाम, तत्र रक्तेन पूयभावं गतेन मरणम्।

(Su.Sh.6/25)

Apalapa is present just below the *Ansakuta* in the upper portion of bothe the flanks. Injury to this leads to putrifaction of blood and death.

उभयत्रोरसो नाड्यो वातवहे अपस्तम्भो नाम, वातपूर्णकोष्ठतया कासश्वासाभ्यां च मरणम्।

(Su.Sh.6/25)

Apastambha is present in both sides of the chest carrying the channels for *vata*. It causes death by continuous cough and expectoration.

अत ऊर्ध्वमुदरोरसोर्मर्माणि व्याख्यास्याम एवमेतानि उदरोरसोद्वार्दश मर्माणि व्याख्यातानि ॥

(Su.Sh.6/25)

The twelve marma of the abdomen and thorax are described.

(4) पृष्ठमर्माणि तु कटिकतरुणकुन्द्र नितम्बपार्श्वसन्धि बृहत्यंसफलकान्यंसौ चेति ।

(Su.Sh.6/6)

These are *marmas* that are present on the back.

They are fourteen in number

1. <i>Katikataruna</i>	-	2
2. <i>Kukundara</i>	-	2
3. <i>Nitamba</i>	-	2
4. <i>Parshva sandhi</i>	-	2
5. <i>Brihati</i>	-	2
6. <i>Ansaphalaka</i>	-	2
7. <i>Ansa</i>	-	2

Ata Urdhvam Prishthamarmani Vyakhya

तत्र पृष्ठवंशमुभयतः प्रति शोणिकाण्डमस्थिनी कटिकतरुणे, तत्र शोणितक्षयात् पाण्डुविवर्णो हीनरूपश्च प्रियते ।

(Su.Sh.6/26)

Katikataruna is present on both the sides of the vertebral column towards the pelvic bone. On injury the patient dies due to excessive bleeding, anaemia.

पार्श्वयोर्जघनबहिर्भागे पृष्ठवंशमुभयतो कुकुन्द्रे, तत्र स्पर्शशानमधःकाये चेष्टोपघातश्च ।

(Su. Sh. 6/26)

Kukundara is present in the outside of the perieneum on both the sides of the vertebral column. Injury to this leads to loss of sensation and paraplegia.

शोणिकाण्डयोरुपयार्शयाच्छादनौ पार्श्वन्तरप्रतिबद्धौ नितम्बौ, तत्राधःकायशोषो दौर्बल्यात्र मरणम् ।

(Su.Sh.6/26)

Nitamba is present on the pelvic bone and attached to the vertebral column. Injury to this leads to wasting of lower extremity and finally death.

अथः पार्श्वन्तरप्रतिबद्धौ जघनपार्श्वमध्ययोस्तिर्यगृष्वं च जघनात् पार्श्वसन्धि, तत्र लोहितपूर्णकोष्ठतया प्रियते ।

(Su.Sh.6/26)

Parshvasandhi is present between the sides of the hip obliquely above the buttocks. Injury to this leads to death by causing haemoperitoneum.

स्तनमूलाद्वजूभयतः पृष्ठवंशस्य बृहती, तत्र शोणितातिप्रवृत्तिनिमित्तरूपद्रवैर्प्रियते ।

(Su.Sh.6/26)

Bribati is present parallel to the root of the breasts on both sides of the vertebral column. Injury to this leads to excessive haemorrhage.

पृष्ठोपरि पृष्ठवंशमुभयतिकिसंबद्धे अंसफलके, तत्र बाहोः स्वापशोषो । (Su.Sh.6/26)

Ansaphalaka is present on back of both the sides of the vertebral column and attached to trikka.

Injury to this leads to loss of sensation and wasting of the arm muscle.

बाहुमूर्ध्यं ग्रीवामध्ये अंसपीदकन्थबन्धनावंसौ, तत्र स्तब्धबाहुता । (Su.Sh.6/26)

Ansa is present between the tip of the arm and neck binding *Ansapitha* and *Kandha*. Injury to this leads to stiffness and contracture of the fore arm.

एवमेतानि चतुर्दशं पृष्ठमर्माणि व्याख्यातानि ॥ (Su.Sh.6/26)

Thus, these fourteen marma of back are described.

(5) जङ्गुणं ऊर्ध्वं चतस्रो धमन्यो अष्टौ मातृका द्वे कृकाटिके द्वे विषुरे द्वे फगे द्वावपान्नौ द्वावावर्तौ द्वावुत्क्षेपौ द्वौ शङ्कावेका स्थपनी पञ्च सीमन्ताश्चत्वारि शङ्काटकान्येको अधिपतिरिति ॥ (Su.Sh.6/6)

These *marmas* are present above the clavicle, they are thirty seven in numbers –

1. <i>Dhamani</i>	—	4	2. <i>Matnika</i>	—	8
3. <i>Knikatika</i>	—	2	4. <i>Vidura</i>	—	2
5. <i>Phana</i>	—	2	6. <i>Apanga</i>	—	2
7. <i>Aavarta</i>	—	2	8. <i>Utkshepa</i>	—	2
9. <i>Shankha</i>	—	2	10. <i>Sihapani</i>	—	1
11. <i>Simanta</i>	—	5	12. <i>Shringataka</i>	—	4
13. <i>Adhipati</i>	—	1			

अत ऊर्ध्वमूर्ध्यजङ्गुणतानि व्याख्यास्थाम :— तत्र कण्ठनाडीमुभयतश्चतस्रो धमन्यो द्वे नीले द्वे च मन्ये व्यत्यासेन, तत्र मूकता स्वरवैकृतमरसंग्रहिता च। (Su.Sh.6/27)

On both the sides of the trachea, there are four blood vessels (*Dhamani*) in inverted order. On injury it causes motor aphasia, abnormality of voice and loss of taste.

ग्रीवायामुभयतश्चतस्रः सिरा मातृकाः, तत्र सहोमरणं। (Su.Sh.6/27)

In neck on both the sides there are four blood vessels named as Martrika. Injury to this lead to immediate death.

शिरोग्रीवायोः सन्थाने कृकाटिके, तत्र चलमर्धता। (Su.Sh.6/27)

Krikatika is present at the junction of head and neck. It produces shaking of the head.

कर्णपृष्ठतो अधः संश्रिते विधुरे तत्र वाधिर्यः। (Su.Sh.6/27)

Vidhura is present in the back side and below of the ear. It causes deafness.

ग्राणमार्गमुभयतः स्रोतमार्गप्रतिबद्धे आभ्यन्तरतः फणे, तत्र गन्धाज्ञानं। (Su.Sh.6/27)

Phana is present on both the sides of the nasal passage and attached to the olfactory nerve. It causes anosmia.

भूपुच्छान्तयोरधो अक्षणोर्बाह्यतो अपाङ्गौ, तत्रान्धं दृष्ट्युपघातो वा। (Su.Sh.6/27)

Apanga is present at the outside and below the eyebrows. It produces blindness or defect in the vision.

भ्रुवोरुपरि निम्रयोरावर्ती नाम, तत्राप्यान्धं दृष्ट्युपघातो वा। (Su.Sh.6/27)

Aavarta is present in the superior part of the eyebrow. Injury to this cause blindness or defect in the vision.

भ्रुवोरुपरि कर्णललाटयोर्मध्ये शङ्खौ तत्र सद्योमरणं। (Su.Sh.6/27)

Aavarta is present on the both the lateral end of the eyebrows between the ear and forehead. It causes immediate death.

शङ्खयोरुपरि केशान्त उत्क्षेपौ, तत्र सशल्यो जीवेत् पाकात् पतितशल्यो वा नोदृत्यशल्यः। (Su.sh.6/27)

Utkshepa is present above the temporal bone and at the end of hairline. Injury to this causes the patient lives till splinter is there or if it falls out after suppuration but never after extraction of the foreign body.

भ्रुवोर्मध्ये स्थपनी, तत्रोत्क्षेपवत्। (Su.Sh.6/27)

Sthapani is present between the eyebrows. Injury to this produces as like *utkshapa*.

पञ्च सन्धयः शिरसि विभक्ताः सीमन्ता नाम, तत्रोन्मादभयचित्तनाशोर्मरणं। (Su.Sh.6/27)

Simanta is present as five demarcated lines of joints. By injury it causes death after producing insanity, fear and loss of mental function.

प्राण श्रोत्रोक्षिजिह्वासंतर्पणीनां सिराणां मध्ये सिरासन्निपातः शृङ्खाटकानि ।

(Su.Sh.6/27)

Shringataka is present in the center of the blood vessels supplying nose, ear, eye and tongue. It causes immediate death.

तानि चत्वारि मर्माणि, तत्रापि सद्योमरणं, मस्तकाभ्यन्तरोपरिष्ठात् सिरासन्धि सन्निपातो रोमावर्तो अधिष्ठितः तत्रापि सद्यो एव ।

(Su.Sh.6/27)

Adhipati is present in the internal blood vessels of the brain and it is characterized by curly hairs on the superior portion. Injury to this causes immediate death.

एवमेतानि सप्तत्रिंशदूर्ध्वजनुगतानि मर्माणि व्याख्यातानि ॥ (Su.Sh.6/27)

Thus, the thirty seven situated in the Urdhvamurdhvjatvgata (supra-clavicular region) are described.

तान्येतानि पञ्चविकल्पानि भवन्ति, तदथा –सद्यःप्राणहराणि, कालान्तरप्राणहराणि, विशल्यज्ञानि, वैकल्यकराणि, रुजाकराणि चेति ।

(Su.Sh.6/8)

(3) Based on the fatality of the *marmas*, they can be classified as follows:

तत्र सद्यःप्राणहराणि एकोनविंशतिः, कालान्तरप्राणहराणि त्रयस्त्रिंशत्, त्रीणि विशल्यज्ञानि, चतुर्शत्वारिंशत् वैकल्यकराणि, अष्टौ रुजाकराणीति ॥

(Su.Sh.6/8)

- | | |
|------------------------------------|---|
| 1. <i>Sadyapranaharamarma</i> – 19 | 2. <i>Kalantarapranahara marma</i> – 33 |
| 3. <i>Vishalyaghna marma</i> – 03 | 4. <i>Vaikalyakara marma</i> – 44 |
| 5. <i>Rujakara marma</i> – 08 | |

(1) *Sadyapranaharamarma*

शृङ्खाटकान्यथिपतिः शङ्कौ कण्डसिरा गुदम् ।

हृदयं बस्तिनाम्बो च घन्ति सद्योहतानि तु ॥

(Su.Sh.6/9)

The *marmas* belonging to this group prove to be fatal immediately and cause effects very soon after the *marma* has been traumatized. This group consists of nineteen *marmas*

- | | |
|---------------------------|--------------------------|
| 1. <i>Shningataka</i> – 4 | 2. <i>Adhipaita</i> – 1 |
| 3. <i>Shankha</i> – 2 | 4. <i>Kanthasira</i> – 8 |
| 5. <i>Gudam</i> – 1 | 6. <i>Hridayam</i> – 1 |
| 7. <i>Basti</i> – 1 | 8. <i>Nabhi</i> – 1 |

(2) Kalantarapranahara Marma

These *marmas* produce effects only after sometime and not so immediately as *sadyapranahara marmas*. There are thirty three *marmas* in this group.

वक्षोमर्माणि सीमन्त तल क्षीप्रेन्द्रबस्तयः ।
 कीटकतरुणे सन्धि पार्श्वजौ बृहती च या ॥
 नितम्बाविति चैतानिकालान्तरहराणि तु । (Su.Sh.6/10,11)

1. <i>Stanamula</i>	- 2	2. <i>Stanarohita</i>	- 2
3. <i>Apalapa</i>	- 2	4. <i>Apastambha</i>	- 2
5. <i>Simanta</i>	- 5	6. <i>Tala</i>	- 4
7. <i>Kshipra</i>	- 4	8. <i>Indrabasti</i>	- 4
9. <i>Katikataruna</i>	- 2	10. <i>Parshvasandhi</i>	- 2
11. <i>Brihati</i>	- 2	12. <i>Nitamba</i>	- 2

(3) Vishalyaghnamarma

उत्क्षेपौ स्थपनि च एव विशल्यधानि निर्दिशेत् ॥ (Su.Sh.6/11)

These *marmas* are fatal one the *shalya* or foreign body (like arrows, darts etc.,) are removed from the site. There are three such *marmas*: -

1. <i>Utkshapa</i>	- 2	2. <i>Sthapani</i>	- 1
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(4) Vaikalyakaramarma

लोहिताक्षाणि जानूर्वी कूर्च विटपकूर्पराः ।
 कुकुन्दरे कक्षधरे विधुरे सकृकाटिके ॥
 अंसांसफलकापाङ्गा निलेमन्ये फणी तथा ।
 वैकल्याकरणान्याहुरावर्ता द्वौ तथैव च ॥ (Su.Sh.6/12,13)

These *marmas* cause deformity and dysfunction when traumatized. They include forty four *marmas* namely

1. <i>Lohitaksha</i>	- 4	2. <i>Aani</i>	- 4
3. <i>Janu</i>	- 2	4. <i>Urvi</i>	- 4
5. <i>Kurcha</i>	- 4	6. <i>Vitapa</i>	- 2
7. <i>Kurpura</i>	- 2	8. <i>Kukundara</i>	- 2
9. <i>Kakshadhabra</i>	- 2	10. <i>Vidura</i>	- 2

11. <i>Krikatika</i>	-	2	12. <i>Ansa</i>	-	2
13. <i>Ansaphalaka</i>	-	2	14. <i>Nila</i>	-	2
15. <i>Manya</i>	-	2	16. <i>Phana</i>	-	2
17. <i>Apanga</i>	-	2	18. <i>Aavarta</i>	-	2

(5) Rujakaramarma

गुल्फो द्वौ मणिबन्धो द्वौ द्वे द्वे कूर्चशिरांसि च ।

रुजाकराणि जानीयादष्टवेतानि बुद्धिमान् ॥

(Su.Sh.6/14)

These are the *marmas* that cause severe pain on trauma. There are eight such *marmas*:-

1. *Gulpha* - 2
2. *Manibandha* - 2
3. *Kurchashira* - 4 (two in the upper and two in lower extremities)

(4) Based on the length (in *angulas*) to be left from the left site of the *marma* for an incision during surgery, they can be classified as follows:-

(1) Marmas for which a space of one *angulas* is to be left from the spot of incision

- | | |
|--------------------------|-----------------------|
| 1. <i>Urvi</i> | 2. <i>Kurchashira</i> |
| 3. <i>Vitapa</i> | 4. <i>Kaksha</i> |
| 5. <i>Parshva sandhi</i> | 6. <i>Stanamula</i> |

(2) Marmas for which a space of two *angulas* is left

1. *Manibandha*
2. *Gulpha*

(3) Marmas for which a space of three *angulas* is left

- | | | |
|-----------------|-------------------|-------------------|
| 1. <i>Janu</i> | 2. <i>Kurpura</i> | 3. <i>Hridaya</i> |
| 4. <i>Basti</i> | 5. <i>Kurcha</i> | 6. <i>Guda</i> |
| 7. <i>Nabhi</i> | | |

(4) Marmas requiring space of four *angulas* to be left

1. *Shringataka*
2. *Simanta*
3. *Matrika*
4. *Nila*
5. *Manya*

(5) Marmas requiring a space of an half *angulas* to be left, the rest of them except the above mentioned marmas.

Fatality of Marmabhighata

मर्माणि मांस सिरास्त्राव्यस्थि सन्धि सञ्चिपाताः, तेषु स्वभावत एव विशेषेण प्राणास्तिष्ठन्ति;
तस्मात् मर्मस्वभिहतास्तांस्तान् भावानापद्धन्ते ॥ (Su.Sh.6/15)

तत्र सद्यःप्राणहरणि सप्तरात्राभ्यन्तरात् मारयन्ति, कालान्तर प्राणहरणि पक्षान्मासाद्वा, तेष्वपि तु क्षिप्राणि
कदाचिदाशु मारयन्ति, विशल्य प्राणहरणि वैकल्यकरणि च कदाचिदत्यभिहतानि मारयन्ति ॥ (Su.Sh.6/23)

As a *marma* point is constituted by *mamsa*, *sira*, *snayu*, *asthi* and *sandhi*, this point is more sensitive compared to other parts on the body.

Acharya Sushruta opines that he four main *siras* of the body namely

- 1. *Vativaha Sira*
- 2. *Pittavaha Sira*
- 3. *Kaphavaha Sira*
- 4. *Raktavaha Sira*

Enter the *marmas* and nourish the structure like *sira*, *snayu* etc., present there.

When a *marma* is hurt, *vayu* gets aggravated in the body. This aggravated *vayu* causes obstruction in the four types of *siras* present in the *marma*. Due to this, there is not only local pain on the site of the *marma*, but also a generalized pain an other symptoms seen all over the body, where ever these *siras* are present through out the body.

The fatality of each *marma* depends on its nature. Generally *marmas* are the seats of *soma*, *maruta*, *teja*, *rajas*, *sattva*, *tamas* and also *Bhutatma*. The fatality of the *marmas* depends on the presence of these factors in predominance. Even though all *marmas* have nearly a similar effect of causing and the time required to cause the effect differs in each case due to the predominance of each of these factors in each *marma*.

5) Based on *Panchabhautika* Composition

तत्र सद्यःप्राणहरणि आग्नेयानि, अग्निगुणेष्वाशु क्षीणेषु क्षपयन्ति, कालान्तरप्राणहरणि सौम्याग्रेयानि,
अग्निगुणेष्वाशु क्षीणेषु क्रमेण च सोमगुणेषु कालान्तरे रेण क्षपयन्ति, विशल्यप्राणहरणि वायव्यानि, शल्यमुखावरस्त्वा यावदन्त-
र्वायुस्तिष्ठति तावज्ज्ञिवति, उद्भूतमात्रे तु शत्ये मर्मस्थानाश्रितो वायुनिक्रमति, तस्मात् सशल्यो जीवत्युद्भूतशल्यो प्रियते,
वैकल्य कराणि सौम्यानि, सोमोहि स्थिरत्वाच्छेत्याङ्गं प्राणावलम्बनं करोति, रुजाकरण्यग्रिवायुगुणभूयिष्ठानि,
विशेषतश्च तौ रुजाकरौ, पाञ्चभौतिकीं च रुजामाहुरेके ॥ (Su.Sh.6/16)

Sadyaprana *marmas* are ‘*agreya*’ in nature (*i.e.*,) *tejas* is present in predominance in these *marmas*. As *agni* is very fast in action (*ashukari*), death occurs very fast (*i.e.*) within seven days after injury.

Kalantarapranahara marmas are *saumyagneya* in nature. Because of the ‘*saumya*’ nature the effect of injury to this *marma* is a bit delayed compared to *saddapranahara marmas*. But ‘*agreya*’ nature of the *marma* cause *kshinata* or weakness and pain. The effects are produced only after a fortnight (fifteen days) or a month after the injury is caused. As an exception, when *kshpara marma* is hurt, the effect is observed earlier than fifteen days or one month (*i.e.*) within about seven days.

Vishalyaghna marmas are *vayavya* in nature. Once the *shalya* is removed from the *marma*, the *vayu* present there escapes out causing immediate death of the individual. As long as the *shalya* is not removed from the *marma*, the person lives.

Vaikalyakara marmas are ‘*saumya*’ in nature. As ‘*saumya*’ nature is characterized by *sthira* and *shita* properties, they do not cause death. They only cause deformity and dysfunction of body parts and not death as the *prana* is not disturbed. When *vishalyaghna* and *vaikalyakara marmas* are excessively injured, they may also result in death.

Rujakara marmas are *agni vayu* predominant. *Agni* and *vayu* are specifically known to cause pain. Hence, when these *marmas* are hurt it causes only pain.

Generally, when *marmas* are hurt, som, marut etc., are disturbed and the effect of it is noticed only on the body. But when the *bhutatma* is also disturbed when the *marma* is hurt, the effect of it is observed also in the mind of the person-giving rise to symptoms like—

इन्द्रियार्थेष्वसम्प्राप्तिः मनोबुद्धि विपर्ययः ।

(Su. Sh. 6/36)

Improper functioning of the *indriyas*, loss of consciousness and bewilderment of *manas* and *buddhi*.

Because of these factors, *marmas* are given much importance.

Among these one hundred seven *marmas*, three of them are considered most important and vital.

They are

1. *Hridaya*
2. *Basti*
3. *Shiras*

These three *marmas* produce determinate effects as a result of injury and may lead to death immediately. Due to this fact, these are mentioned as “*pranayatana*” of the body.

TRIMARMA

(1) Hridayam

स्तनयोर्मध्यमधिष्ठाय उरस्यामाशयद्वारं सत्त्वरजस्तमसाम् । अधिष्ठानं हृदयं नाम, तत्रापि सद्य एव मरणम् ॥
 (Su. Sh. 6/25)

Hridaya is a *marma* present in between both the *Stana*s in the region of *Uras* (chest). It is located above the opening of *amashaya*. *Hridaya* is the seat of *sattva*, *rajas* and *tamas*. It is a *siramarma* that measures four *angulas* I length. Injury to this *marma* causes serious and immediate death. It is also fatal because it is enlisted under the group of *sadyaprannahara marma*. Acharya Dalhana describes the form of *hridaya* as “*kamalamukulakaram adhomukham*” as it resembles upside down lotus flower in shape.

The *dhamanies* that carry blood to all parts of the body originates from the *hridaya*. Hence, it is considered a very delicate part of the body.

(2) Basti

अल्पमांसशोणितेभ्यो आभ्यन्तरतः कट्टां मूत्राशयो बस्तिनाम तत्रापि सद्योमरणम् अश्मरीब्रणाद्वते ॥
 (Su. Sh. 6/25)

Basti is a mean situated in the pelvic cavity, composed of *mansa* and *shonita*. It serves as a reservoir of urine. It is a *snayu marma* measuring four *angulas* in length. This belongs to the group of *sadyaprannahara marmas* and hence causes immediate death when it is traumatized. *Basti*, *mansa*, *shonita* and *marma*.

(3) Shiras

मस्तकाभ्यन्तरोपरिष्टाच्छिरा सन्धि सन्निपातो रोमावतो अधिपतिः तत्रापि सद्योमरणम् ॥
 (Su. Sh. 6/80)

Adhipati is the *marma* present on the upper portion of the cranial cavity. It is formed by *sira sannipata* (*i.e.*) a network of *sira* and is covered by hair, externally. This is a *Sandhi marma* that measures an half *anguli* in length. This is also fatal as it falls under the category of *sadyaprannahara marma*. Any injury to this *marma* causes fatal death.

त्रिमर्म –

सप्तोत्तरं मर्मशतं यदुक्तं शरीरसंख्यामधिकृत्य तेष्यः ।
 मर्माणि बस्ति इदयं शिरश्च प्रधानभूतानि वदन्ति तज्ज्ञाः ॥
 प्राणाश्रयात्, तानि हि पीडयन्ते वातादयोऽसूनपि पीडयन्ति ।
 तत्सर्वश्रितानामनुपालनार्थं महागदानां शृणु सौम्य ! रक्षाम् ॥

(Ch. ch. 26)



I. On the Anterior Aspect of the Neck

1. Mandible

The mandible forms the lower part of the jaw. It is horse-shoe shaped which is present in the lower part of the mandible known as base of mandible. The base of mandible forms the chin, anteriorly.

2. Hyoid Bone

It is present just below and behind the chin at the junction of neck with the floor of the mouth. It is U shaped and continuous posteriorly with the greater cornu which is overlapped in its posterior part by the sternocleomastoid muscle.

3. Thyroid Cartilage

It forms a sharp protuberance and lies just below the hyoid bone. The protuberance of the laryngeal prominence called as adams apple. It is clearly seen in males in comparison with females.

4. Cricoid Cartilage

It lies below the cricoid cartilage at the upper end of the trachea.

The trachea is commonly palpated in the suprasternal notch which lies between the tendinous heads of origin of the right and left sternocleomastoid muscle.

5. Frontozygomatic Suture

It can be felt as a slight depression in the upper part of the lateral orbital margin.

6. Mandibular Notch

It is represented by a curved line concave forwards, extending from the head of the mandible to the anterior end of the zygomatic arch.

II. Landmarks on the Side of the Neck

1. Sternocleomastoid

It is prominently seen when the face is turned to the opposite side. The ridge raised by the muscle extends from the sternum to the mastoid process.

2. External Jugular Vein

It crosses the sternocleomastoid obliquely running downwards and backwards from near the auricle to clavicle. It is better seen in old age.

3. Greater Supraclavicular Fossa

It lies above and behind the middle one third of the clavicle. It covers the cervical part of the brachial plexus and the third part of the subclavian artery.

4. Mastoid Process

It is a large bony projection behind the auricle (concha).

5. Transverse Process of the Atlas

It can be felt on deep pressure mid way between the angle of the mandible.

6. Transverse Process of Fourth Cervical Vertebra

It can be palpated at the level of the upper border of the thyroid cartilage.

7. Transverse Process of Sixth Cervical Vertebra

It is present at the level of cricoid cartilage and its transverse process is larger than others cervical vertebral transverse process and is called as carotid tubercle because common carotid artery is best felt against this tubercle.

Forehead

It is the upper part of the face between the hair line of the scalp and eyebrows. The superolateral prominence of the forehead is known as the frontal eminence.

Parts of Nose

The prominent ridge separating the right and left halves of the nose is called the dorsum. The upper narrow end of the nose is the root of the nose. The lower end of the dorsum is in the form of a somewhat rounded tip. At the lower end of the nose we see the right and left nostrils of anterior nares. The two nostrils are separated by a soft median partition called the columella.

Supra Orbital Margin

1. It is present just below the upper margin of the eye brow. The supra orbital notch is palpable at junction of the medial one third with the lateral two thirds of the supra orbital margin.

2. The superciliary arch is a curved bony ridge situated immediately above the medial part of each supraorbital margin. The glabella is the medial part of each supra orbital margin. The glabella is the median elevation connecting the two super Ciliary arches and corresponds to the elevation between the two eyebrows.
3. The nasion is the point where the internasal and frontonasal sutures meet. It lies a little above the floor of the depression at the root of the nose, below the glabella.

Viscera

1. Stomach

It has two orifices and two curvatures and fundus –

A. *Cardiac Orifice*

It is marked by two parallel lines 2 cm apart, directed in downward direction and to the left side on seventh costal cartilage, and 2.5 cm towards the left side of the median plane.

B. *Pyloric Orifice*

It is also marked by two short parallel lines 2 cm apart, directed in upward direction and to the right side on the transpyloric plane. It is 1.25 cm to the right of the median plane.

C. *Lesser Curvature*

It is the place where right margin of the cardiac orifice joins with the upper margin of pyloric orifice by a J-shaped curved line.

D. *Greater Curvature*

This is marked by a curved line convex to the left and in downward direction, drawn from the fundus to the lower margin of pyloric orifice. It cuts the left costal margin between the tips of the 9th and 10th costal cartilages and extends down to the subcostal plane.

2. Duodenum

It is 25 cm in length, 2.5 cm wide and lies at the level of L1-L3, particularly above the umbilicus. It has four parts and they are marked in the following way.

A. *Superior or First Part*

It can be marked by two parallel lines 2.5 cm apart extending from the pyloric orifice upwards and to the right for 2.5 cm.

B. Descending Or Second Part

It can be marked by two parallel lines on the right lateral vertical plane extending from the end of the first part downwards for 7.5 cm.

C. Horizontal or Third Part

It is marked by two transverse parallel lines 2.5 cm apart on the subcostal plane, extending from the lower end of the second part towards the left for 10 cm. it crosses the median plane above the umbilicus.

D. Ascending or Fourth Part

It is marked by two lines extending from the left end of the third part to the duodenojejunal flexure which lies 1 cm below the transpyloric plane, and 3 cm to the left of the median plane.

Liver

The surface projection of the liver is triangular in shape when it is visualized from the front side.

A. The Upper Border – It is marked by the following points:

- First point in the left 5th intercostals space, 3.5 inches from the median plane.
- Second point at the xiphisternal joint.
- Third point at the right border of 5th costal cartilage.
- Fourth point at the level of 6th rib in midaxillary line.
- Fifth point at the inferior angle of right scapula.
- Sixth point at the T8 vertebra.

B. The Lower Border – It is marked by a curved line by joining the following points.

- First point at the left 5th intercostals space 3.5 inches from the median plane.
- Second point at the tip of 8th costal cartilage on the left costal margin.
- Third point at the transpyloric plane in the mid line.
- Fourth point at the tip of 9th costal cartilage on the right costal margin.

- Fifth point 1 cm below the right costal margin at the tip of 10th costal cartilage.
- Sixth point at the T8 vertebra.

C. The Right Border – It is marked on the anterior aspect by a curved line convex laterally drawn from a point a little below the right costal margin at the tip of 10th costal cartilage.

Gall Bladder

It is the reservoir of bile.

The fundus part of the gall bladder is marked at the angle between the right costal margin and the outer border of rectus abdominis muscle.

Bile Duct

It is marked by a 7.5 cm long line. The line is vertical in its upper half and inclines towards the right side in lower half. The line is extended from a point 5 cm above the transpyloric plane and 2 cm to the right of the median plane, to the middle of the medial border of the second part of duodenum.

Pancreas

It is a heterocrine gland presented with head, neck uncinate process, body and tail.

(a) Head

It is marked with in the concavity of the duodenum.

(b) Body

It is marked by two parallel lines 3 cm apart, drawn upwards and to the left for 10 cm from the neck, occupying the upper two-third of the space between the transpyloric and sub costal planes.

Caecum

It is marked in the right iliac fossa. It is about 6 cm long and 7.5 cm broad its axis is directed in downward direction and slightly medially.

Ileocaecal Valve

It is marked on the point of intersection of the right lateral and trans tubercular planes.

Vermiform Appendix

- The appendicular orifice is marked at a point 2 cm below the ileocaecal orifice.
- The appendix is marked by two parallel line 1 cm apart and 7 to 10 cm long, extending from the appendicular orifice usually upwards behind the caecum.

Ascending Colon

It is marked by two parallel line 5 cm apart, immediately to the right of the right vertical plane, from the level of transtubercular plane to the upper part of the ninth costal cartilage and right colic flexure.

Transverse Colon

It is marked by two parallel lines 5 cm apart. It begins at the upper part of the ninth costal cartilage and it runs downwards and medially to the umbilicus and then upwards and laterally, crossing the transpyloric plane and also the left lateral vertical plane, to end at the eighth costal cartilage (left colic flexure).

Descending Colon

It is marked by two parallel lines 2.5 cm apart. It begins at the eighth costal cartilage (left colic flexure) runs downwards immediately lateral to the left lateral vertical plane, and ends at the fold of the groin (inguinal ligament).

Rectum And Anal Canal

They are marked on the back by drawing two lines joining the posterior superior iliac spines to the anus. The lower parts of these lines (from 1 cm below the second sacral vertebra represent the rectum and anal canal.

Landmarks On The Lateral Side Of The Head

The external ear or pinna is a prominent feature on the lateral aspect of head. The named features on the pinna.

1. The zygomatic bone forms the prominence of the cheek at the infero lateral corner of the orbit.

The zygomatic arch bridges the gap between the eye and the ear. It is formed anteriorly by the temporal process of the zygomatic bone, and posteriorly by the zygomatic process of the temporal bone.

2. The head of the mandible lies in front of the tragus. It is felt best during movements of the lower jaw. The coronoid process of the mandible can be felt below the lowest part of the zygomatic bone when the mouth is opened. The process can be traced downwards in to the anterior border of the ramus of the mandible.
3. The parietal eminence is the most prominent part of the parietal bone, situated far above and a little behind the auricle.
4. The mastoid process is a large bony prominence situated behind the lower part of the auricle. The supramastoid crest, above 2.5 cm long.
5. The temporal line forms the upper boundary of the temporal fossa which is filled up by the temporalis muscle.
6. The pterion is the area in the temporal fossa where four bones (frontal, parietal, temporal and sphenoid) adjoin each other across an H- shaped suture. The center of the pterion is marked by a point 4 cm above the midpoint of the zygomatic arch.

Arteries

1. Facial Artery

It is marked on the face by joining these three points:-

- (a) A point on the base of the mandible at the anterior border of the masseter muscle.
- (b) A second point 1.2 cm lateral to the angle of the mouth.
- (c) A point at the medial angle of the eye.

2. Common Carotid Artery

It is marked by a broad line along the anterior border of the sternocleidomastoid muscle by joining the following two points:

- (a) A point on the sternoclavicular joint.
- (b) A second point on the anterior border of the sternocleidomastoid muscle at the level of the upper border of the thyroid cartilage.

3. External Carotid Artery

A artery is marked by joining these two points:

- (a) A point on the anterior border of the sternocleidomastoid muscle at the level of the upper border of the thyroid cartilage.

- (b) A second point on the posterior border of the neck of the mandible.

Veins

1. Facial Vein

It is represented by a line drawn just behind the facial artery.

2. Internal Jugular Vein

Internal jugular vein is marked by a broad line by joining these two points:

- (a) The first point on the neck medial to the lobule of the ear.
- (b) The second point at the medial end of the clavicle.

3. Subclavian Vein

It is represented by a broad line along the clavicle extending from a little medial to its mid point to the medial end of the bone.

NERVES

1. Facial Nerve

It is marked by a short horizontal line joining these two points:

- (a) A point at the middle of the anterior border of the mastoid process. The stylomastoid foramen lies 2 cm deep to this point.
- (b) A second point behind the neck of the mandible. Here the nerve divides into its five branches to the facial muscles.

2. Glossopharyngeal Nerve

It is marked by joining the following points:

- (a) The first point on the anteroinferior part of the tragus.
- (b) The second point anterosuperior to the angle of the mandible.

3. Vagus Nerve

The nerve runs along the medial side of the internal jugular vagus vein. It is marked by joining these two points:

- (a) The first point at the anteroinferior part of the tragus.
- (b) The second point at the medial end of the clavicle.

4. Hypoglossal Nerve

Hypoglossal nerve is marked by joining these points:

- (a) The first point at the anteroinferior part of the tragus.
- (b) The second point posterosuperior to the tip of the greater cornua of the hyoid bone.
- (c) The third point mid way between the angle of the mandible and the symphysis menti.

Thyroid Gland

The isthmus of thyroid gland is marked by two transverse parallel lines on the trachea, the upper 1.2 cm and lower 2.5 cm below the arch of the cricoid cartilage.

Trachea

It is marked by two parallel lines 2 cm apart, drawn from the lower border of the cricoid cartilage to the sternal angle, inclining slightly to the right.

Right Bronchus

Right bronchus is marked by a broad line running downwards and to the right for 2.5 cm from the lower end of the trachea to the sternal end of the right third costal cartilage.

Left Bronchus

It is marked by a broad line running downwards and to the left for 5 cm from the lower end of the trachea to the left third costal cartilage 4 cm from the median plane.

Oesophagus

It is marked by two parallel line 2.5 cm apart by joining the following points:

- (a) Two points 2.5 cm apart at the lower border of the cricoid across the median plane.
- (b) Two points 2.5 cm apart at the root of the neck a little to the left of the median plane.
- (c) Two points 2.5 cm apart at the sternal angle across the median plane.

- (d) Two points 2.5 cm apart at the left seven costal cartilage 2.5 cm from the median plane.

Thoracic Duct

It is marked by joining the following points:

- (a) A point 2 cm above the transpyloric plane slightly to the right of the median plane.
- (b) A second point 2.5 cm above the left clavicle 2 cm from the median point.
- (c) A third point just above the sternal angle 1.3 cm to the left of the median plane.

Pancreas

The head is marked within the concavity of the duodenum.

The neck passes upwards and to the left behind the pylorus in the transpyloric plane.

The body is marked by two parallel lines 3 cm apart drawn upwards and to the left for 10 cm from the neck.

Kidney

On the back it is marked within Morris Parallelogram which is drawn in the following way:

Two horizontal lines are drawn one at the level of the eleventh thoracic spine and other at the level of the third lumbar spine.

On front the bean shaped kidney marked with following specifications:

On the right side the center of the hilum lies 5 cm from the median plane a little below the transpyloric plane and on the left side it lies 5 cm from the median plane a little above the transpyloric plane.

Ureter

On the front

It is marked by a line running downwards and slightly medial from the tip of the ninth costal cartilage to the pubic tubercle.

On the back

It is marked by a line running vertically upwards from the posterior superior iliac spine to the level of the second lumbar spine.

Abdominal Aorta

It is marked by two parallel lines 2 cm apart extending from a point 2.5 cm above the transpyloric plane in the median plane to a point 1.2 cm below and to the left of the umbilicus at the level L4 vertebra.

Celiac Trunk

It is marked as a point 1 cm below the beginning of the abdominal aorta.

The left gastric artery is marked by a line passing from the celiac artery upwards and to the left towards the cardiac end of the stomach.

Inferior Vena Cava

It is marked by two vertical parallel lines 2.5 cm apart a little to the right of the median plane. It extends from a point below the transtubercular plane to the sternal end of the right sixth costal cartilage.

Portal Vein

It is marked by a broad line extending from a point on the transpyloric plane 1.2 cm to the right of the median plane upwards and to the right for about 8 cm.

Inguinal Canal

It is marked by two parallel lines 1 cm apart and about 3.7 cm long, above the medial half of the inguinal ligament, extending from the deep to the superficial inguinal ring.



Pancha Gyanendriya (Five Sense Organs)

The *gyanendriya* or sense organs that are five in number are the main means for an individual to attain knowledge. Hence, they are termed as *gyanendriya*. It is through these five *gyanendriya* that an individual perceives or attains full knowledge of the external world that exists outside him. This process of perception is brought about with the help of mind. *Vayu* acts as a connecting medium between the mind and the sense organs and their objects of perception. Thus, *Vata* is the functional aspect of the sense organs, while basically, the structure is that of *jalam*. The process of perception is effected by *pranavayu*, which connects the sense organs and the mind. Once perception takes place, it results in the formation of thoughts in the mind. This in turn sets an impression in the *atma*, which witnesses everything.

शरीरेन्द्रिय सत्त्वात्म संयोग धरी जीवितम् ॥

(Ch. Sha. 1)

The body is constituted by *indriya* (*pancha gyanendriya*, *panch karmendriya*), *ubhayatmaka mana* and *atma*.

एकैकाधिक युक्तानि खादीनामिन्द्रियाणि तु ।

पञ्चकर्मानुमेयानि येभ्यो बुद्धिः प्रवर्तते ॥

(Ch. Sha. 1/24)

The *pancha gyanendriya* are originated from the respective maha *bbutas* it is also called as *budhi indriya*.

- | | | |
|-----------------|------------------|-----------------|
| 1. <i>Karna</i> | 2. <i>Tvacha</i> | 3. <i>Netra</i> |
| 4. <i>Jihva</i> | 5. <i>Nasa</i> | |

महाभूतानि खं वायुरग्निरापः क्षितिस्तथा ।

शब्द स्पर्शश्च रूपं च रसौगंधाश्च तद्गुणाः ॥

तेषां एक गुणोपूर्वो गुणवृद्धिः परे परे ।

पूर्वः पूर्वगुणश्चैव क्रमशो गुणिषु स्मृतः ॥

(Ch. Sha. 1/27, 28)

The *pancha gyanendriya* are originated from the respective *mahabhutas* it is also called as *budhi indriya*.

आकाशाद्वायुः वायोरधिः अग्नेरापोदभ्यः पृथिवी।

खरद्रवचलोष्णात्वं भूजलानिलतेजसाम् ।

आकाशस्याप्रतीघातो हृष्टं लिङ्गं यथाक्रमम् ॥

(Ch. Sha. 1/29)

From *Akasha*, *vayu* is originated, from *vayu agni* is originated, from *agni*, *jalam* is originated, from *jalam Pritivi* is originated.

Kharthua is related to *Pritivi*. *Dravya* is related with *jala*. *Chala* is related with *Vayu*. *Ushnathvam* is related to *Agni*. *Akasha* is related to *Aprathigatha*.

तस्मादव्यक्तान्महानुत्पद्यते तलिङ्गं एव। तलिङ्गाज्ञा महतलक्षण एवाहंकार उत्पद्यते, स त्रिविधो वैकारिकस्तैजसो भूतादिरिति। तत्र वैकारिकादहंकारात्तैजससहायाततलक्षणान्ये वैकादशेन्द्रियाण्युत्पद्यन्ते, तद्यथा श्रोत्रत्वक्यक्षुजिह्वाद्वाणवाघस्तोपस्थपायुपादमनांसीति, तत्रपूर्वाणि पञ्च बुद्धीन्द्रियाणी, इतराणि पञ्च कर्मन्द्रियाणी, उभयात्मकं मनः, भूतादेरपि तैजससहायाततलक्षणान्येव पञ्चतन्मात्राण्युत्पद्यन्ते शब्दतन्मात्रं, स्पर्शतन्मात्रं, रूपतन्मात्रं, रसतन्मात्रं, गंधतन्मात्रं इति, तेषां विशेषाः शब्दस्पर्शरूपरसगन्धाः, तेष्यो भूतानि व्योमानिलानलजलोर्ध्वः, एवमेषा तत्त्वचतुर्विशतिर्व्याख्याताः ॥

(Su Sha. 1/4)

Mahan is originated from *avyaktha* it is get mixed with *ahankara*. *Ahankara* is again divided into three types:

1. *Sattvika*

2. *Rajasika*

3. *Tamasika*

Due to the permutation and combination of above mentioned *bhavas* it produces eleven *indriyas* (*pancha gnanendriya*, *pancha karmendriya* and *ubhyaatmaka mana*).

NETRA

Synonyms

अक्षि, दृष्टि, चक्षुः, दर्शनेन्द्रिय।

Shape

सुवृत्तं गोस्तनाकारं सर्वभूतगुणोद् भवम् ॥

पलं भुवोऽग्नितो रक्तं वातात्कृष्णं सितं जलात् ।

आकाशादश्रुमार्गश्च जायन्ते नेत्रं बुद्बुदे ॥

(Su. Ut. 1/10,11)

The eye is just looks like the mammary gland of cow. It is made up of *pancha mahabhuta* the *mansa tattva* is related with *Pritivi*. *Rakta* related with *agni*. Black colour related with *vayu*. White colour related with *jala*. The space and the lacrymal gland is related with *akash maha bhuta*. (As. H. Su. 12)

It is the site for *Aalochaka pitta*, *Vyanavayu*, *pranavayu* and *tarpaka Kapha*.

मंडालानि च सन्धिश्च पटलानिधि लोचने ।
यताक्रमम् विजानीयात् पञ्च षट् च षण्व च ॥ (Su. Ut. 1/14)

Mandala are *pakshma mandala*, *vartma mandala*, *shveta mandala*, *krishna mandala*, *drishti mandala*.

Sandhi are six in number.

Pakshmavartmagata sandhi, *kama drishtigata sandhi*, *kaninaka sandhi*, *shveta Krishnagata sandhi*, *varthma sukla gata sandhi*, *apanga sandhi*.

Patala are six in number out of the six *patala* two *patala* are present in the *vartma* and four *patala* are remaining inside the eye.

नेत्रे श्लेष्मणः प्रसादात् शुक्रमण्डलं तत् पितृजम् ।
असृजः कृष्णमण्डलं तन्मातृजम् मध्ये दृष्टिमण्डलम् तदुभयात्मकम् ॥ (Ast. San. Sha. 5)

Shuklamandala, *krishna mandala*, *dristhimandala* are derived from *matrijam*, *pitrijam* and *ubhayatmakam* respectively.

आलोचकं पित्तं दृक्स्थं रूपालोचनतः स्मृतम् । (Ast. Hru. Su. 12/13)

Due to the presence of *alochakam pittam* we are able to get the knowledge of sight or vision.

Human beings are the most evolved organisms in the animal kingdom and amongst the five senses, viz., vision, smell, taste, touch and hearing.

Vision is the most important one and we have been endowed or gifted with two eyes each of which can function independently but coordinates with each other to provide us a wide field of vision. It has the capability of depth perception, colour and contrast discrimination.

Eyes are window to the world and a delicate organ covered by eyebrow, eyelashes and orbits. Sight is a sophisticated function.

Basic Anatomy of Eye

The eyeball is a globular structure slightly longer anteroposteriorly (24mm) than its horizontal (23.5mm) or vertical (23mm) spread.

Its total circumference is about 72-75mm.

Its volume is 6 cubic centimeters (or 6 ml). The weight of eye ball is about 7gm. Total orbital volume is about 30 ml. Out of its total surface area, only the anterior one-sixth is exposed. The remainder is recessed and protected by the orbit in to which it fits.

Eye ball is made up of three coats/layers.

1. Outer or fibrous coat

It comprises of sclera and cornea.

2. Middle or vascular coat

It is also called as uvea comprises of

- (a) Choroid
- (b) Ciliary body
- (c) Iris

3. Inner or Nervous Coat Retina –

When light enters the eyeball it passes through several refracting media. From before backwards the structures are the cornea, the aqueous humour, the lens and vitreous body.

Sclera

It is the outer fibrous coat which protects the intra ocular contents. It is opaque and shines as the “White of the eye” except for its anterior one-sixth which is transparent and called as cornea.

The sclera contributes the posterior five sixths of eyeball. It is composed of dense fibrous tissue which is firm and maintains the shape of eyeball.

The junction between the sclera and cornea is called as limbus. A thin layer of conjunctiva which covers the sclera is firmly attached at the limbus. It is thickest near the entrance of the optic nerve, and thinnest about 6 mm behind the sclero-corneal junction (canal of schlemm).

The sclera covers all the eyeball except the cornea, gives shape to the eyeball, makes it more rigid and protects its inner parts.

The outer surface of sclera is white and smooth. It is covered by Tenson's capsule. Its anterior part is covered by conjunctiva through which it can be seen as white of the eye. The inner surface is brown and grooved for the Ciliary nerves and vessels. It is separated from the choroid by perichoroidal space which contains a delicate cellular tissue termed the suprachoroidal lamina.

Cornea

It is coming under the superficial fibrous coat of the eyeball. It is avascular, transparent which covers the colored iris. It replaces the sclera over the anterior one sixth of the eyeball.

Cornea is more convex than the sclera and is nourished by lymph which circulates in the numerous corneal spaces.

Structurally, the cornea consists of the following layers

- (a) *Corneal epithelium* – It is continuous with that of conjunctiva.
- (b) *Bowman's membrane* is a structureless homogenous layer. It contains no elastic fibres.
- (c) *The substantia propria* – It consists of bundles of dense collagen fibres separated by corneal spaces.
- (d) *Descemet's membrane* – It is also structureless and homogenous but contains elastic fibres.

Vascular Tunic

The vascular tunic or uvea is the middle layer of the eyeball it has three parts

1. Choroid,
2. Ciliary body and
3. Iris.

The middle vascular coat which supplies nutrition to the various parts of the eyeball. It has three parts:

(a) Iris

It is the anterior most part of the uveal tract. It forms pupil. It acts like a diaphragm to control the rays of light. It acts like a diaphragm to control the rays of light. By adjusting the size of the pupil it controls the amount of light entering the eye.

It is vertically placed in between the cornea and lens, and divides the eye into anterior and posterior chambers. Both the chambers contain aqueous humour.

It has two margins

1. Peripheral margin

It is attached to the middle of Ciliary body and separated from the cornea by the iridocorneal angle.

2. The central free margin is forming the boundary of the pupil and it rests against the lens.

It has two surfaces

1. *Anterior surface* – It is covered by a single layer of mesothelium.

2. *Posterior surface* – It is covered by a double layer of deeply pigmented cells which are continuous with those of the Ciliary body.

The main back of iris is made up of blood vessels and loose connective tissue in which there are pigment cells.

The colour of the iris is determined by the number of pigment cells in its connective tissue.

In some cases the iris is blue in colour due to absence of pigment cells due to diffusion of light in front of black posterior surface.

It is supplied by a well-developed ring of muscle called as sphincter pupillae which lies near the margin of pupil dilator pupilla is placed near the posterior surface of iris.

It is supplied by parasympathetic nerves.

Choroid

It is the posterior part of the uvea which has three vascular layers and maintains nourishment of retina.

It helps to separate the posterior part of sclera from the retina.

Anteriorly it ends at the ora serrata by merging with the Ciliary body.

Posteriorly it is perforated by the optic nerve to which it is firmly attached.

It has *two surfaces*

1. *Outer surface*

It is separated from the sclera by the supra choroidal lamina which is traversed by the Ciliary vessels and nerves.

2. *Inner surface*

It is firmly united to the retina.

Structurally it consists of

- (a) outer vascular lamina
- (b) middle capillary lamina
- (c) inner basal lamina.

Ciliary Body

It is an intermediate structure present in between the iris (anteriorly) and choroid (posteriorly). It is a thickened part of uveal tract lying just posterior to the corneal limbus. Lens is suspended by the Ciliary body which helps in accommodation for near vision. It has two parts

- a. Pars plicata (anteriorly)
- b. Pars plana (posteriorly)

Pars Plicata

It has the secretory pars plicata which maintains the necessary tone of the eyeball in addition to supplying nutrients and lodges the Ciliary muscle which helps in accommodation.

Pars Planata

It is the posterior part of vitreous surfaces which is smooth and black. It merges with choroid and retina at ora serrata.

Retina

It is the innermost layer. It has an outer pigmentary layer, retinal pigment epithelium and inner layers collectively called the sensory retina. A potential space separates these two layers. This sensory layer performs the visual functions like the photographic film of a camera.

It is continuous posteriorly with the optic nerve. The outer surface of retina is attached to choroid, while the inner surface is in contact with the hyaloid membrane.

Optic disc is a circular area present just opposite to the entrance of optic nerve. It is 1.5 mm in diameter.

The retina is divided according to thickness

1. *Optic part* – it contains nervous tissue and sensitive to light.
2. *Ciliary part and Iridial part* – non-nervous insensitive layer that covers the Ciliary body and iris.

The thickness gradually decreases from optic part to iridial part.

Physiological Blind Spot

It is a depressed area of the optic disc does not contain rods or cones and it is insensitive to light.

Macula Lutea

It is the central part of the retina present in the posterior pole of the eye.

It is avascular and yellow in colour. The center most point is the fovea centralis, the area with maximum concentration of cones (the sensory end organs) and the area of vision par excellence. The image formed on the retina is inverted, this is transmitted through the optic nerve, which exits about 12 to 15 nasal to the fovea and continues as visual pathways after crossing of half of its fibres to the other side at optic chiasma.

The rods and cones are the light receptors of the eye. The rods contains a pigment called as visual purple. Usually rods respond to dim light. The peripheral part of the retina contains only rods but the fovea has none at all. The cones respond only to bright light and are sensitive to colour.

The fovea centralis has only cones.

The retina is composed of ten layers are:

- | | |
|-------------------------------|-------------------------------------|
| 1. outer pigmented layer | 2. layer of rods and cones |
| 3. external limiting membrane | 4. outer nuclear layer |
| 5. inner nuclear layer | 6. inner molecular layer |
| 7. outer molecular layer | 8. ganglion cell layer |
| 9. nerve fibre layer. | 10. the internal limiting membrane. |

Blood Supply

It is supplied by the central artery which is an end artery.

The retinal vein run with the arteries.

Lens

It is a transparent bi-convex structure which is placed between the anterior and posterior segments of the eye. The diameter of lens is about 1 cm.

Proteins called crystallins arranged like the layers of an onion, make up the lens. Normally, the lens is perfectly transparent. It is enclosed by a clear connective tissue capsule and held in position by encircling suspensory ligaments.

Lens has two surfaces : 1. Anterior 2. Posterior

The posterior surface of the lens is more convex than the anterior.

Anterior surface is kept flattened by the tension of the suspensory ligament. When the ligament is relaxed (by contraction of the Ciliary muscle) the anterior surface becomes more convex due to elasticity of the lens substance.

A lens having a focal length of an half meter has a power of 2 dioptres.

Interior of The Eye Ball

The interior of the eye ball is a large space divided by the lens in to two cavities:

1. Anterior cavity
2. Vitreous chamber.

Anterior Cavity

It is the space anterior to the lens and again sub divided in to the anterior chamber and posterior chamber.

Anterior chamber – It lies behind the cornea and in front of the iris.

Posterior chamber – It lies behind the iris and in front of the suspensory ligaments and lens.

The anterior cavity is filled with a watery fluid called aqueous humor.

Aqueous Humour

It is a clear fluid which fills space between the cornea in front and lens behind.

The aqueous humour is secreted in to the posterior chamber from the capillaries in the Ciliary processes. It passes in to the anterior chamber through the pupil. From the anterior chamber, aqueous humor drains in to the scleral venos sinus (canal of scyphleum) and then in to the blood. Normally aqueous humor is completely replaced about every 90 minutes.

Functionally, aqueous humor helps nourish the lens and cornea. Also the pressure in the eye, called intraocular. The intraocular pressure, along with the vitreous body maintains the shape of the eyeball and keeps the retina smoothly pressed against the choroid so the retina will be an even surface for reception of clear images.

The intraocular pressure is about 16 mm Hg and the pressure is maintained due to a balance between production and outflow of the aqueous humour.

Excessive intraocular pressure is called glaucoma. It leads to degeneration of the retina, causing blindness.

The second and larger cavity of eye ball is the vitreous chamber (posterior cavity). It lies between the lens and the retina and contains a jelly like substance called as vitreous body.

Vitreous body helps to prevent the eyeball from collapsing and hold the retina flush against the internal portions of the eyeball.

The vitreous body, unlike the aqueous humor, does not undergo constant replacement. It is formed during embryonic life and is not replaced thereafter.

Accessory Structure of The Eye

The Accessory structure of the eye are eye lids, eye lashes, eye brows, lacrimal apparatus and extrinsic eye muscles.

Eyelids (Palpebrae)

There are two eyelids upper and lower. It shade the eyes during sleep, protect the eyes from excessive light, prevents the entry of foreign bodies and spread lubricating secretions over the eyeballs.

Each eyelid consists of

- | | |
|-------------------------|--|
| (a) epidermis | (b) dermis |
| (c) subcutaneous tissue | (d) fibers of orbicularis oculi muscle |
| (e) a tarsal plate | (f) tarsal glands |
| (g) conjunctiva | (h) Tarsal Plate |

It is a thick fold of connective tissue that gives form and support to the eyelids.

Each tarsal plate contains a row of elongated modified sebaceous glands known as tarsal or meibomian glands. Their oily secretion helps keep the eyelids from adhering to each other.

Conjunctiva

It is a thin, moist, transparent and protective mucous membrane composed mostly of stratified columnar epithelium with numerous globulet cells and areolar connective tissue.

The palpebral conjunctiva

It lines the posterior surface of the eyelid.

The bulbar conjunctiva

It covers the anterior surface of the eyeball.

When the blood vessels of the bulbar conjunctiva are dilated and congested due to local irritation or infection, the person has blood shot eyes.

Eye Lashes

It project from the border of each eye lid and together with the eyebrows, which arch transversly above the upper eyelids, help protect the eyeballs from foreign objects, perspiration and direct sunlight.

It contains a sebaceous Ciliary gland or glands of zeis, it pours a lubricating fluid in to the follicles. Infections of these glands is called stye.

Lacrimal Apparatus

The lacrimal apparatus is a group of structures that produces and drains lacrimal fluid or tears.

The lacrimal apparatus is made up of following parts:

1. lacrimal gland and its ducts
2. conjuctival sac
3. lacrimal puncta and lacrimal canaliculi
4. lacrimal sac
5. nasolacrimal duct.

Lacrimal Gland

The size is just like an almond, it secretes lacrimal fluid which drains in to the excretory lacrimal ducts that empty tears on to the surface of the conjuctiva of the upper lid. It is a type of serous gland situated in the lacrimal fossa (on the anterolateral part of the bony orbit) and partly on the upper eye lid.

Small accessory lacrimal glands are found in the conjuctival fornices. It is a J shaped gland supplied by levator palpebrae superioris muscle.

It has two parts:

- (a) an orbital part (b) a palpebral part.

About a dozen of its ducts pierce the conjuctiva of the upper lid and open in to the conjuctival sac near the superior fornix.

The lacrimal gland is supplied by the lacrimal branch of the ophthalmic artery and by the lacrimal nerve.

The lacrimal fluid secreted by the lacrimal gland flows in to the conjuctival sac where it lubricates the front of the eye and the deep surface of lids.

Periodic blinking helps to spread the fluid over the eye. Most of the fluid evaporates. The rest is drained by the lacrimal canaliculi. When secretion is excessive it overflows as tears.

Conjunctival Sac

The conjunctiva is a thin, protective mucous membrane composed mostly of stratified columnar epithelium with numerous goblet cells and areolar connective tissue. The palpebral conjunctiva lines the inner aspect of the eyelids on to the anterior surface of the eyeball.

Conjunctival sac is the potential space present between the palpebral and bulbar part of conjunctiva.

The palpebral conjunctiva is thick, opaque, highly vascular, and adherent to the tarsal plate. The bulbar conjunctiva covers the sclera. It is thick, transparent and loosely attached to the eyeball.

Over the cornea it is represented by the anterior epithelium of the cornea.

Lacrimal Puncta

Excretory lacrimal ducts empty tears on to the surface of the conjunctiva of the upper lid. From here the tears pass medially over the anterior surface of the eyeball to enter two small openings called as lacrimal puncta. Tears then pass in to two ducts, the lacrimal canal, which lead in to the nasolacrimal sac and then in to the nasolacrimal duct. This duct carries the lacrimal fluid in to the nasal cavity just inferior to the inferior nasal concha.

Lacrimal punctum is about 10mm in long. It has a vertical part which is 2mm long and a horizontal part which is 8mm long.

Lacrimal Sac

It is a membranous sac 12mm long and 5mm wide situated in the lacrimal groove behind the medial palpebral ligament. Its upper end is blind, the lower end is continuous with the nasolacrimal duct.

The sac is related anteriorly to the medial palpebral ligament and to the orbicularis oculi.

Inflammation of the lacrimal sac is called dacryocystitis.

Nasolacrimal Duct

It is a membranous passage 18 mm long. It starts at the lower end of the lacrimal sac and opens in to the inferior meatus of the nose.

Muscles That Move The Eyeballs

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. Movements of the eyeballs are controlled by three pairs of extrinsic muscles. Two pairs of rectus muscles 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 rotate the eyeballs on their axes.

The extrinsic muscles of the eyeballs are among the fastest contracting and most precisely controlled skeletal muscles of the body.

Mnemonics

SLIM-R, SI-O

- | | |
|--------------------|---------------------|
| 1. Superior rectus | 4. Medial rectus |
| 2. Lateral rectus | 5. Superior oblique |
| 3. Inferior rectus | 6. Inferior oblique |

Superior rectus – rolls eye ball superiorly – supplied by oculomotor nerve

Inferior rectus – rolls eye ball inferiorly – supplied by oculomotor nerve

Lateral rectus – rolls eye ball laterally – supplied by abducens nerve

Medial rectus – rolls eye ball medially – supplied by oculomotor nerve

Superior oblique – rotates eye ball on its axis, directs cornea inferiorly – supplied by trochlear nerve and laterally.

Inferior oblique – rotates eyeball on its axis, Directs cornea superiorly – supplied by oculomotor nerve laterally.

KARNA – EAR

कर्णयोद्देः ।

(Su.Sha.5/37)

There are two ears present in the body.

सन्धि-गण्डकर्णशङ्कुष्वेकैकः ।.

(Su.Sha.5/26)

There is only one *Sandhi* present in between *karna* and *sankha*.

घ्राणकर्णग्रीवाक्षिकोषेसु तरुणानि ॥

(Su.Sha.5/20)

Tarunasthis are present in the *nasa*, *karna*, *griva* and *akshi*.

श्रोत्रशृंगाटकेषु शङ्कावर्ताः ॥

(Su.Sha.5/27)

The type of *Sandhi* present in between the ear ossicles – *Shankhavartah*.

द्वे कर्ण शङ्कुलिके, द्वौ कर्णपुत्रकौ ॥

(Ch.sha. 7/11)

There are two *karna shashkuli* and two *karnapatraka*.

It is one of the sense organ which is called as organ of hearing. It is a vital organ which is constitute of

- External ear *Bahih Karna*
- Middle ear *Madhya Karna*
- Internal ear *Antah Karna*

It helps for the equilibrium of the body due to the presence of membranous labyrinth.

External Ear – Bahih Karna

It consists of - (a) The pinna or auricle (b) External acoustic meatus.

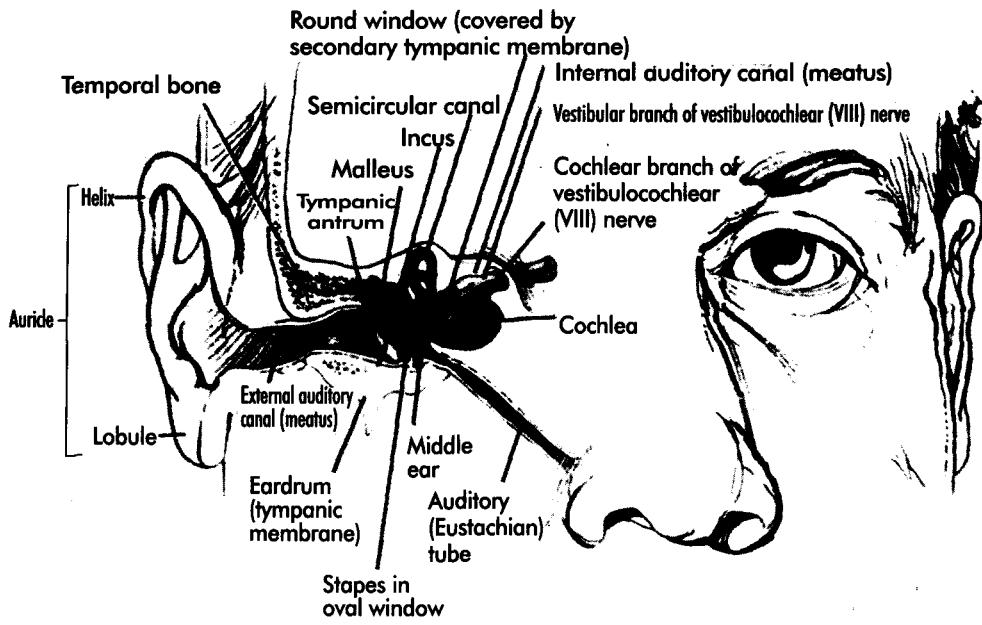
Pinna (Auricle) Karnashashkuli

This is the external part of the ear which is visible from outside. It is mainly made up by the cartilage and the cartilage is covered by skin. The lower pat of the pinna which is soft called as ear lobule.

The large depression is called as concha which goes in to the external acoustic meatus.

Helix is the superior part and circular in structure one depression which is visible externally and triangular in shape called as triangular fossa.

Divisions of Right Ear into External Middle & Internal Portions



The auricle is supplied by posterior auricular and superficial temporal arteries.

The lymphatics are drained in to pre and post auricular lymph nodes.

Nerve Supply

The auricular muscles are supplied by the branches of facial nerve.

The upper two-third of lateral surface supplied by auriculotemporal nerve while the lower one-third by greater auricular nerve.

External Acoustic Meatus

It is a S – shaped structure. It is directed medially, forwards and upwards. It conducts the sound waves from the concha to the tympanic membrane. It is about 20-26 mm long averagely 24 mm. out of the total length two thirds (16 mm) are bony in structure and the lateral one third (8 mm) is cartilaginous. It is oval in section. The isthmus which is the narrowest point and lies about 5 mm from the tympanic membrane.

The bony part formed by the tympanic plate of temporal bone.

The skin of the cartilaginous part contains hairs, sebaceous glands and ceruminous (wax) glands.

Blood Supply

Outer part by superficial temporal and posterior auricular artery.

Inner part by the deep auricular branch of maxillary artery.

Lymphatic Drainage

It passes to pre auricular, post auricular and superficial cervical lymph nodes.

Nerve Supply

Half of the meatus is supplied by the auriculo-temporal nerve and posterior half by the auricular branch of the vagus.

APPLIED ANATOMY

1. Boils and other infections of the external meatus cause little swelling and severe pain because it is closely adherent with the bone and cartilage.
2. The examination of the meatus and tympanic membrane the auricle should be drawn upwards, backwards and slightly laterally.

3. Persistent cough is produced due to the reflex action by ear wax or syringing and it is produced due to irritation of the auricular branch of the vagus.

Tympanic Membrane

This act as a partition between external acoustic meatus and middle ear.

It is thin, oval in shape, obliquely placed measures about 9 x 10 mm

It has two surfaces – Outer – lined by skin and concave shape.

- Inner – attached with the handle of the malleus and convex in shape.

The greater part of tympanic membrane is known as pars tensa which is tightly stretched,

The part which is present between two mallleolar fold is loose and called as pars flaccida,

This is more prone to rupture than the pars tensa because internally it is crossed by chorda tympani.

The tympanic membrane is supplied by tensor tympani which is inserted to the upper end of the handle lof malleus.

It is composed of three layers are:

1. *Outer cuticular layer* – supplied by deep auricular branch of maxillary artery.
2. *Middle fibrous layer* – maxillary and posterior auricular artery.
3. *Inner mucus layer*

They drain into external jugular vein.

Nerve Supply

Outer surface – auriculo-temporal nerve and auricular branch of vagus nerve.

Inner surface – tympanic branch of glossopharyngeal nerve.

Applied Anatomy

For the drainage of pus in the middle ear, the tympanic membrane is incised.

Middle Ear – Madhya Karna

It is otherwise known as tympanic cavity or tympanum.

It is a narrow area filled with air situated in the petrous part of the temporal bone between the external and internal ear.

It is shaped like a biconcave disc. The vertical and antero posterior diameters are 15mm, while the transverse diameter is 6 mm at the upper part, 2 mm at the center and 4mm at the lower part.

Walls

The tympanic cavity resembles match box having six walls:

1. *Lateral wall* – it is formed mainly by the ear drum and the bone above, below and behind the drum.

The tympanic cavity is thus divided into

- (i) *Epitympanum* – which is above the ear drum and contains the upper half of the malleus and a large part of the incus.
- (ii) *Mesotympanum* – it is situated medial to the tympanic membrane.
- (iii) *Hypotympanum* – lying below the ear drum.

2. *Medial wall* – It separates the middle ear from the inner ear.

Promontory is the most obvious feature seen as a smooth round projection formed by the basal turn of cochlea.

3. *Anterior wall* – It contains the following openings:

- (i) Canal for chorda tympani nerve.
- (ii) Canal for tensor tympani muscle
- (iii) Eustachian tube orifice.

4. *Posterior wall* – Superiorly there is an opening or aditus through which the epitympanic recess communicates with the mastoid (tympanic) antrum.

The fossa incudis is a depression which lodges the short process of the incus.

A conical projection called the pyramid lies near the junction of the posterior and medial walls. It has an opening at its apex for passage of the tendon of the stapedius muscle.

Facial nerve runs downwards in the fallopian canal behind the posterior wall.

5. *Floor* – It is separated from the jugular bulb by a thin plate of bone.

6. *Roof* – Tegmen tympani separates the tympanum from the middle cranial fossa. There may be a dehiscence in the floor as well as in the roof.

Communication

The middle ear communicates in the front with the nasopharynx through the pharyngotympanic tube, while posteriorly, it is connected to the mastoid antrum through the aditus.

Contents

The tympanic cavity contains the following structures:

(a) Ossicles

There are three tiny bones which conduct the sound from the ear drum to the oval window.

1. Malleus – Mudgaraka (Hammer)

It is the largest, land the most laterally placed ossicle. It measures about 228 mm in length.

It has a head, neck, handle and also anterior and lateral processes.

The head is situated in the epitympanum. The lateral process projects from the upper end of the handle and provides attachment to the malleolar folds.

The head articulates posteriorly with the body of incus. It provides attachment to the superior and lateral ligaments.

The neck lies against the pars flaccida and is related medially to the chorda tympani nerve.

The handle extends downwards, backwards and medially, and is attached to the upper half of the tympanic membrane.

2. Incus – Ankushaka

It resembles like an anvil (used by blacksmiths) it resembles a molar tooth and has the following parts:

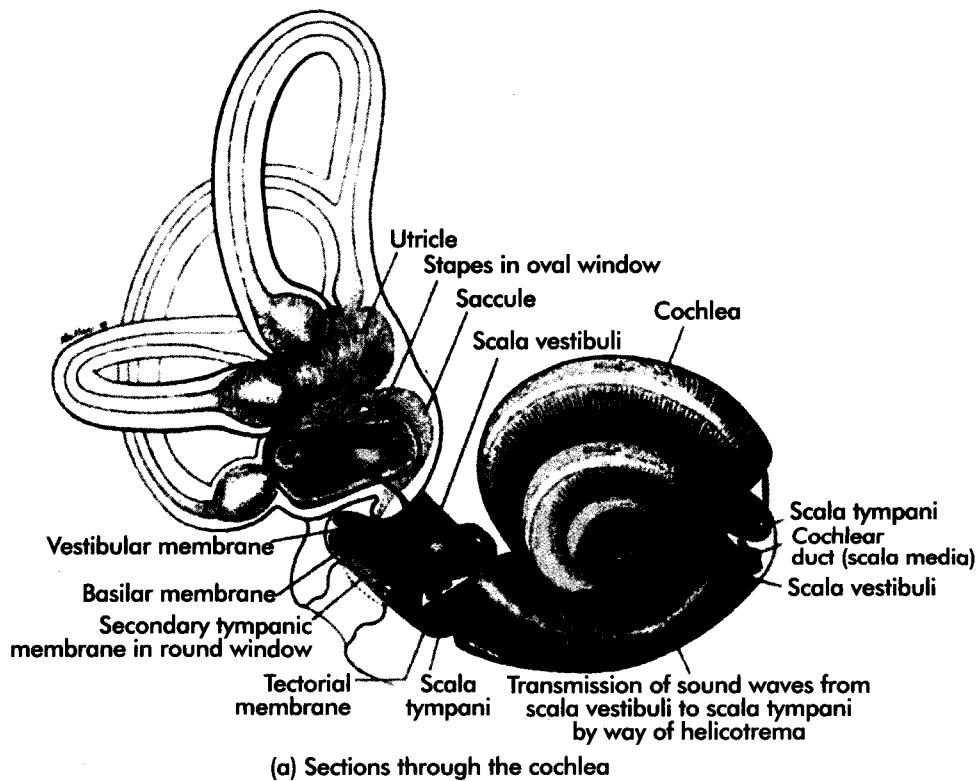
- (a) The body, a short process and long process. The body articulates with the head of the malleus in the attic and the short process projects backwards in the attic.

The long process projects downwards behind the handle of the malleus running parallel to it, and articulates with the head of the stapes.

3. Stapes – Dharanaka

It resembles like a stirrup. It is the smallest, and the most medially placed ossicle to

Internal Ear



the ear. It measures about 3.5 mm and consists of a head, neck, foot plate and also anterior and posterior crura (limbs).

The head has a concave facet which articulates with the lentiform nodule of the incus.

The neck provides insertion to the thin tendon of the stapedius.
The foot plate is oval in shape and fits in to the fenestra vestibuli.

Joints of The Ossicles

There are two joints present with the ear ossicles:

1. The incudo malleolar joint – The joint between the malleus and incus is a type of saddle joint.
2. The incudo stapedial joint – It is a ball and socket joint.

Both joints are synovial joint. They are surrounded by capsular ligaments. All the ligaments are extremely elastic.

Muscles of Ossicles

There are two muscles named as tensor tympanic and stapedius. The both muscles decrease the movement of the ossicles. The tensor tympani is inserted in to the neck of the malleus, while the stapedius is inserted in to the neck of the stapes.

Nerves

Chorda tympani is the branch of the facial nerve which carries the sense of tastes. It enters the middle ear cavity from the posterior wall, runs forwards and lateral to the incus and medial to the malleus, escaping out through the anterior wall.

Tympanic plexus lies on the promontory.

Air – it fills the tympanic cavity and the mastoid.

Tympanic (Mastoid) Antrum

This is a small, circular, air filled space situated in the posterior part of the petrous part of temporal bone.

Its size is just like a small pea, 1 cm in diameter. It has a capacity of about 1 ml.

It consists of three parts.

(i) Aditus of Antrum

It is a short canal connecting the epitympanum with the mastoid antrum. The short

process of the incus lies in its floor. The facial nerve runs in its canal in the floor, while the lateral semicircular canal is in the medial wall. The bone lateral to the aditus appears like a bridge during ear operations.

(ii) Mastoid Antrum

It is the largest air cell in the mastoid bone. The antrum is an important land mark in the surgery of the mastoid bone, and is always present.

Anteriorly

The antrum receives the aditus. The facial nerve also lies anterior to the antrum.

Medially

It is related to the horizontal semicircular canal. Roof is formed by the tegmen plate.

Lateral wall

It is formed by the cortex of the mastoid bone which lies medial to the suprameatal triangle. Its thickness can be upto 1.5 cm.

Postero-inferiorly

The antrum communicates with numerous mastoid air cells.

(iii) Mastoid Air cells

These are variable in number, size and distribution. These communicate with the mastoid antrum.

There are three types of mastoid processes are:

- (a) *Cellular* – with large and numerous air cells.
- (b) *Diploic* – with small and less numerous air cells.
- (c) *Sclerotic* – with air cells practically absent.

The cellular mastoid accounts for 80% of subjects and is considered to be normal. The diploic and sclerotic types may be due to blockage of the eustachian tube.

The mastoid air cells are named according to the anatomical distribution as

- | | |
|----------------------------|----------------------|
| 1. Tip cells | 2. Perisinus cells |
| 3. Sub dural cells | 4. Sinodural cells |
| 5. Zygomatic cells | 6. Retrofacial cells |
| 7. Perilabyrinthine cells. | |

Applied Anatomy

Mastoid infection is secondary to otitis media. It is very difficult to treat because drainage of pus from the mastoid antrum requires an operation through the suprameatal angle. During this period there is a chance for the injury of the facial nerve.

Antah Karna – Internal Ear

The internal ear otherwise known as labyrinth.

It is present in the petrous part of the temporal bone.

It is divided into bony labyrinth and membranous labyrinth.

Membranous Labyrinth

The Membranous labyrinth is present within the bony labyrinth. The Membranous labyrinth is filled with a fluid called endolymph. It is separated from the bony labyrinth by another fluid called the perilymph.

BONY LABYRINTH

It consists of three parts:

- (a) Cochlea is present anteriorly
- (b) Vestibule in the middle
- (c) Semicircular canal posteriorly.

Cochlea

The shape of the bony cochlea resembles like the shell of a common snail. It is helpful for the formation of anterior part of bony labyrinth. It has a conical central axis (known as modiolus) around which the cochlear canal makes two and three quarter turns. The modiolus is directed forwards and laterally.

The spiral lamina which is a spiral ridge of bone projected from the modiolus and partially divides the cochlear canal in to the scala vestibuli above, and the scala tympani below.

The scala vestibuli communicates with the scala tympani at the apex of the cochlea by a small opening, called as helicotrema.

Vestibule

It is the central part of bony labyrinth which lies medial to the middle ear cavity. Its lateral wall opens in to the middle ear at fenestra vestibuli which is closed by the footplate of one ear ossicle named as stapes.

Three semicircular canals open in to is posterior wall.

The medial wall is presented by two recess

- (a) Spherical recess in front
- (b) The elliptical recess in behind

The two recesses are related to the internal acoustic meatus and the both recesses are separated by a vestibular crest which splits inferiorly to enclose the cochlear recess.

Semicircular Canals

The semicircular canals are three in number, which lies posterosuperior to the vestibule and are set at right angles to each other. Each canal describes two-thirds of a circle, and is dilated at one end to form the ampulla. Three canals open in to the vestibule by five openings.

The *three bony semicircular canals* are:

1. Anterior or Superior
2. Posterior
3. Lateral

The anterior semicircular canal lies in a vertical plane at right angles to the long axis of the petrous part of temporal bone.

Membranous Labyrinth

It is a closed cavity filled with endolymph.

The Membranous labyrinth consists of three main parts.

1. The spiral duct of the cochlea (organ of hearing) anteriorly.
2. The utricle and saccule (organs of static balance)
3. The semicircular canals (organs of kinetic balance).

The Duct of The Cochlea

The spiral duct occupies the middle part of the cochlear canal between the scala vestibuli and the scala tympani. Basilar membrane contributes for the formation of floor vestibular membrane contributes for the formation of roof and the outer wall by the bony wall of the cochlea.

The basilar membrane supports the spiral organ of corti which is the end organ for hearing

The duct of cochlea is connected to the saccule posteriorly by the help of a narrow ductus reuniens.

Saccule and Utricle

It lies in the vestibule of the bony labyrinth. The utricle is larger than the saccule and it lies in the posterosuperior part of the vestibule. The semicircular canals open in to the utricle, which is connected from to the saccule by the endolymphatic duct. The endolymphatic duct is connected to saccule endolympaticus which probably helps in the absorption of the endolymph.

The utricle as well as the saccule have a patch of neuroepithelium called the macula, which is the end-organ responding to the gravitational pull and linear acceleration. Maculae are end organs that give information about the position of the head. They are static balance receptors.

Semicircular Ducts

The three semicircular ducts lie within the corresponding bony canals. It is a bony cochlea and is coiled for 25 turns around the central bony modiolus. It is connected to the saccule by the ductus reuniens. Each duct has an ampulla corresponding to that of the bony canal. In each ampulla there is an end organ called the ampullary crest (crista). Cristae respond to pressure changes in the endolymph caused by the movements of head.

Blood Supply

The inner ear is supplied by labyrinthine branch of basilar artery.

JIHVA – TONGUE

जिहा कफशोणितमांसानां सारो जिहा प्रज्ञायते ।

(Su.Sha.4/28)

It is made up of the essence part of

दश प्राणायतनानि च मूर्धा, जिहाबंधनं, कंठो हृदयं नाभिः, बस्तिः गुदम्, शुक्रमोजो रक्तं च । तेषां आद्यानि सप्त पुनः महामर्म संशानि ॥

(Ast.San.Sha.5)

There are ten seats of life, out of which *Jihva* is one among them.

सप्त सेवन्यः शिरसि विभक्तं पञ्च जिहा शोफसोरेकैकाः ॥

(Su.Sha.5/15)

It contains one suture.

It is the sense organ for taste. Some other functions like speech, deglutition and mastication are also associated with tongue.

The tongue, together with its associated muscles, forms the floor of the oral cavity. It is composed of skeletal muscles and covered with the mucous membrane.

The tongue is divided into symmetrical lateral halves by an inverted V-shaped sulcus terminalis. The two parts are – an oral part which lies in the mouth Pharyngeal part that lies in the pharynx.

Inferiorly the tongue is attached with the hyoid bone, mandible and styloid process of the temporal bone.

External Features of The Tongue

The tongue has

1. A Root
2. A Tip and
3. A Body.

Root

It is attached to the mandible above, and to the hyoid bone below. In between the two bones it is related to the tip of the Geniohyoid and Mylohyoid muscles.

Tip

It is present just behind the upper incisor teeth anterior end of the tongue is free body. It has a curved upper surface known as dorsum and an inferior surface. The dorsum is divided into oral and pharyngeal parts.

It is convex in all directions it is divided into

An oral part (anterior two-third) and a pharyngeal part (posterior one-third) by a V-Shaped sulcus called as the oral (papillary) part of the tongue is placed on the floor of the mouth. Its margins are free.

It has two parts:

1. Superior surface
2. Inferior surface

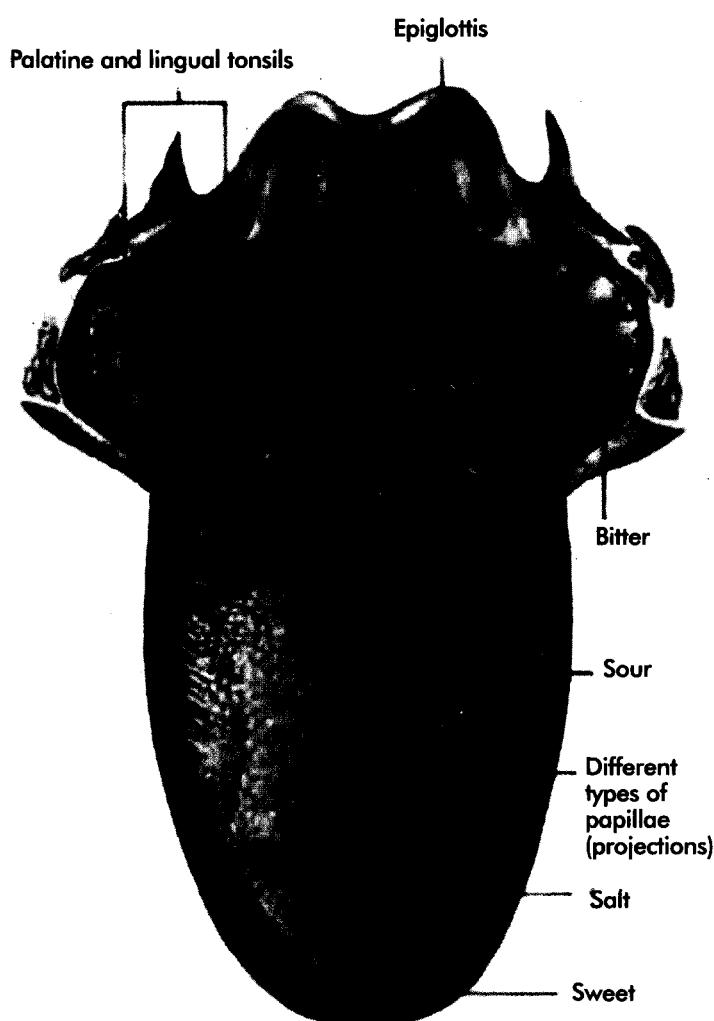
The superior surface is rough due to the presence of papillae.

1. Filiform papillae
2. Fungiform papillae
3. Circumvallate papillae

Inferior surface is covered with a small mucous membrane which shows a median fold called Frenulum linguae or the lingual frenulum. It is attached to the floor of the mouth and aids in limiting the movement of the tongue posteriorly.

In front of the palatoglossal arch each margin shows four to five vertical folds named as Foliate papillae.

Tongue with Location of Papillae



Pharyngeal Part

It lies behind the palatoglossal arches and sulcus. The posterior surface of the pharyngeal part forming the anterior wall of the oropharynx.

It is devoid of papillae and smooth. There are collections of lymphoid tissue under the mucous membrane called as lingual tonsil, which makes the surface empty. The lingual tonsil with the faucial tonsils and the pharyngeal tonsil, make up the lymphoid ring of Waldeyer.

The mucous membrane of this part of the tongue is connected to the epiglottis by the median, right and left glosso epiglottic fold.

Papillae of The Tongue

The mucous of the dorsum of the basal part of the tongue has small projections of the lamina propria creating papillae, which increase the surface area of mucosa available for taste receptors.

The *types of papillae* are:

1. *Vallate papillae* – These are about ten to twelve in number forming a single row in front of the largest papillae being 2-4mm in diameter. Each papilla is a cylindrical projection surrounded by a circular sulcus.
2. *Fungiform papillae* – These are numerous, bright red in colour, flat dots of about 1mm in diameter along the edges, dorsum and tip of the tongue. The taste buds are situated in the walls of the groove.
3. *Filiform papillae* – These are transverse mucosal folds on the lateral aspect of the tongue anterior to the palato glossal arch. They are rudimentary in main.

Muscles of The Tongue

The tongue is divided into two symmetrical halves by a median fibrous septum. Each half contains muscles arranged in two groups, extrinsic and intrinsic. Extrinsic muscles alter the position of the tongue, whereas as the intrinsic muscles alter the shape of the tongue.

Extrinsic Muscles

1. *Hyoglossus* – It arises from the greater horn and partly from the body of hyoid bone and inserted into the posterior half of the tongue.
2. *Styloglossus* – It arises from the apex of the styloid process and stylohyoid ligament and inserted into the side of the tongue.

3. *Genioglossus* – It arises from the upper mental spine of the mandible inserted into the whole length of the tongue.
4. *Palatoglossus* – It takes origin from the under surface of palatine and inserted into the side of the tongue in front of sulcus terminalis.

Intrinsic Muscles

They form a large part of the muscle mass of the tongue and are attached to the septum and the mucous membrane. They are named according to the direction of their fibres.

- | | |
|------------------------------------|------------------------------------|
| 1. Longitudinalis linguae superior | 2. Longitudinalis linguae inferior |
| 3. Transversalis linguae | 4. Verticalis linguae |

Nerve Supply

Motor supply

All the extrinsic and intrinsic muscles of the tongue are supplied by the hypoglossal nerve except palatoglossus.

The palatoglossus is supplied by the pharyngeal plexus through the pharyngeal branch of vagus which is its motor nerve.

Sensory supply

The sensory innervation is both general and special (taste) and the innervation of the anterior two thirds (pre-sulcal part) is different from that of the posterior two thirds (post-sulcal part).

Anterior Two-Thirds

- The lingual nerve, is the nerve of general sensation for the anterior two-thirds of the tongue.
- The chorda tympani branch of the facial nerve carries taste from the anterior two-thirds of the tongue.

Posterior One-Third

- The glossopharyngeal supplies fibers of both general sensation and of taste to the posterior third of the tongue.

Vascular Supply

Artery

The lingual artery, a branch of the external carotid is the principal artery supplying the tongue.

Vein

The vein of the tongue are arranged into superficial and deep sets.

- Superficial vein drains tip and undersurface of tongue passes superficial to the hypoglossus. It is formed by the deep lingual and sublingual vein. It ends in the internal jugular vein.
- Deep lingual vein is the largest and principal vein of the tongue. It joins with internal jugular vein either directly or after joining the superficial vein.

Lymphatic Drainage

1. The anterior two-thirds of the tongue drains unilaterally to the submandibular nodes.
2. The posterior one-third of the tongue drains bilaterally to the jugulo-omohyoid nodes.
3. The tip of the tongue drains bilaterally to the submental nodes.
4. The marginal portions of the anterior two-thirds of the tongue unilaterally through the mylohyoid muscles to the submandibular nodes.

Applied Anatomy

1. *Glossitis* – inflammation of tongue.
2. Injury to hypoglossal nerve produces paralysis of the muscles of the tongue on one side of lesion.
3. Some drugs are administered through the sublingual route E.g., iso-sorbide mono nitrate, nifedipine because drug is absorbed easily by the help of sublingual artery which is a branch of external carotid artery.
4. *In facial palsy* – the patient cannot identify the taste sensation because of papillae.

NASA – NOSE

Nasa is the opening to the *Shira*.

नासा ग्राण्ड्रिय स्थानम् ।

(Ast.Hru.Sha.5/28)

It is the seat for the organs of smell.

बहिर्मुखे द्वे स्रोतांसि ।

(Su.Sha.5/10)

It is composed of two *srotasa*.

It is the first organ of the upper respiratory tract. It is the organ for the sense of smell.

Olfactory (Olfat = Smell) cells are present in this organ.

Nose is lined by the olfactory mucosa.

It contains many sweat glands which make the air moist.

Olfactory receptors are located in the nasal epithelium in the superior portion of the nasal cavity on the either side of the nasal septum.

The nasal epithelium consists of three principle kinds of cells.

1. Supporting
2. Olfactory
3. Basal

Anatomically the nose is divided into two main parts:

1. *External nose* – external portion.
2. *Nasal Cavity* – Internal portion inside the skull.

The external portion consists of a supporting framework of cartilage and bone covered with skin and mucous membrane. It is partly bony and partly cartilaginous.

The bridge of the nose is formed by the nasal bones by which it is in a fixed position. The bones involved are – nasal bones and frontal processes of maxilla.

Due to the presence of the cartilage the rest part are somewhat flexible.

The cartilages involved are – Superior and inferior nasal cartilage and some small cartilages.

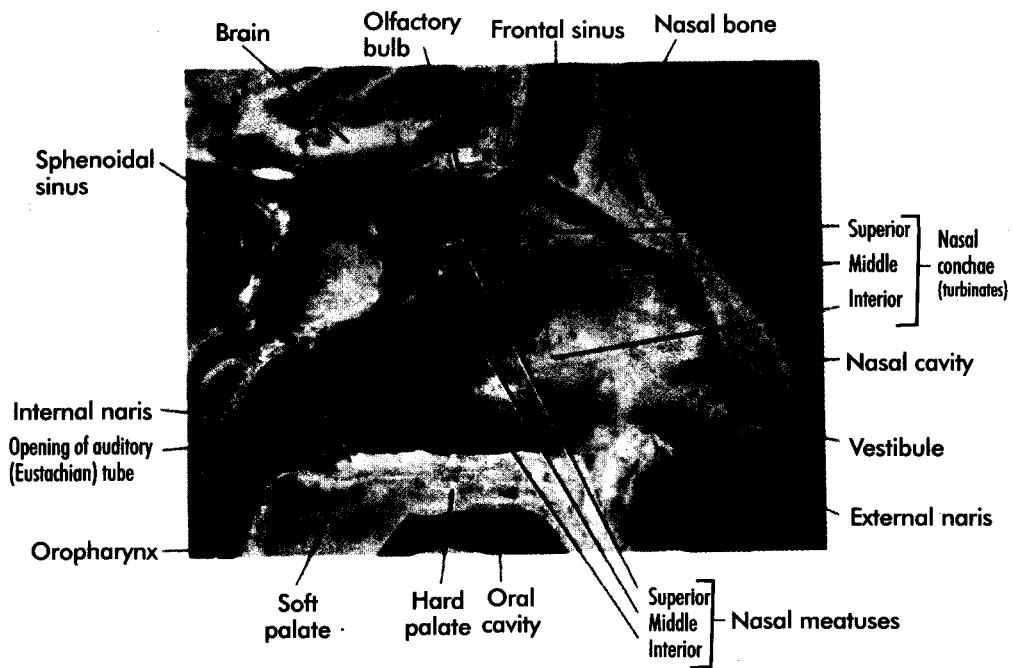
Dorsum

It is the prominent ridge, which separates the right and left halves of the nose.

Root

The upper narrow end of the nose, which is present just below the forehead.

Internal Structure of Nose



Tip

The lower end of the dorsum, which is present in a round shape.

Nostrils or External Nose

The two openings of the nose at the lower end e.g. right and left nostrils.

Columella

The right and left nostrils are separated from each other by a soft median partition called as columella. It is continuous with the nasal septum, which separates the two nasal cavities.

Ala – It is the lateral boundary of each nostril.

Nasal Cavity

It is extended from the nostrils to the posterior nasal apertures. Which is again divided into right and left halves by the nasal septum.

This internal portion of the nose lies inferior to the cranium and superior to the mouth. Anteriorly it merges with the external nose and posteriorly it is connected with the throat (pharynx) through two openings called as internal nares (choanae).

Each half of the nasal cavity has

- | | |
|---------------|----------------|
| – a roof | – a floor |
| – medial wall | – lateral wall |

Each half measures about 5 cm in height, 5 to 7 cm in length, 1.5 cm width near to the floor and 1 to 2m width near the roof.

Roof of the each nasal cavity measures about 7 cm long and 2 mm wide.

The middle horizontal part is made by cribiform plate of ethmoid bone.

The Roof has *two slopes*.

Anterior slope – Formed nasal part of frontal bone nasal bone and nasal cartilages.

Posterior Slope – It is formed by the inferior surface of the body of sphenoid bone.

Floor

It measures about 5 cm long and 1.5 cm wide. It is formed by the palatine bone and palatine process of the maxilla. It is concave in shape from sides.

Nasal Septum

It divides the nasal cavity into right and left sides by a vertical osteocartilaginous partition.

It forms the medial wall of both nasal cavities and it is covered by mucous membrane.

It has *three parts*.

- (a) *Bony part* – It is formed by vomer, perpendicular plate of ethmoid rostrum of sphenoid, nasal spine of frontae bone and maxillary bones.
- (b) *Cartilaginous part* – It is formed by septal and inferior nasal cartilages.
- (c) *Cuticular part* – It is formed by fibro-fatty tissue covered by skin. It is the lower end of the septum presented as columella.

It has *four borders* - Superior, inferior, anterior and posterior.

Two surfaces – Right and left.

Blood Supply

Anterosuperior part – It is supplied by anterior ethmoidal artery and superior labial branch of facial artery.

Postero inferior part – It is supplied by sphenopalatine artery.

The anterior portion of the nasal cavity just inside the nostrils is called as vestibule which contains between the septal ramus of the superior labial branch of facial artery and sphenopalatine artery and a large capillary network.

This is the commonest site of bleeding from the nose (epistaxis) which is known as *Little's area* and *kieselback's area*.

Venous drainage by the help of facial vein sphenopataline vein.

Nerve Supply

1. General sensory nerves are supplied to the whole of the septum which are the branches of trigeminal nerve.
2. Special sensory nerves are supplied to the upper part of the nasal septum which are the branches of olfactory nerve.

Lateral Wall of Nose

Structurally it is irregular and it is due to the presence of three shelf-like bony projection

called as conchae. The conchae increases the surface area and works as airconditioner of nose.

The lateral wall has three parts.

- | | |
|---------------------------------------|---|
| 1. <i>Vestibule</i> | — Depressed area present anteriorly |
| 3. <i>Atrium of the middle meatus</i> | — middle part |
| 4. <i>Conchae</i> | — It is present posteriorly which is separated by meatuses. |

Framework of Lateral Wall

Lateral wall of nose partly bony, partly cartilaginous and partly made up of soft tissues.

Bony Part

It is formed by nasal bones, lacrimal bone frontal process of maxilla, inferior nasal concha, perpendicular plate of the palatine bone, medial pterygoid plate.

Cartilaginous Part

It is formed by the upper nasal cartilage, the lower nasal cartilage and three or four small cartilages of the ala.

Soft Tissue Part

The cuticular lower part is formed by fibro fatty tissue covered with skin.

The lateral wall of the nose is divisible in to three areas.

1. The Vestibule

It is the lowest part. It is lined by the skin of the nose. In addition to normal hairs, longer thicker hairs, called vibrissae, are seen in the vestibule. The vibrissae act as filter for the air entering during respiration.

2. The Atrium of the Middle Meatus

It is present just above and slightly posterior to the vestibule and immediately anterior to the middle meatus. The atrium is limited above by a mucous ridge called an agger nasi which represents an additional concha which is present in some mammals. The function between the vestibule and the atrium forms a curved muco-cutaneous ridge known as limen nasi.

3. The Region of Conchae and Meatuses

It presents three shelf like projections called the superior, middle and inferior conchae. Below and lateral to each concha a space called as meatus. There are three meatuses, superior, middle and the inferior.

Conchae

Inferior concha is independent and longer. It covers the inferior meatus of nose.

Middle concha is a projection from the medial surface of the ethmoidal labyrinth. It connects with the middle meatus and it is much larger in size.

Inferior concha- it is shorter and straighter than others it connects with the superior meatus.

Meatuses

It represents the various openings of the paranasal sinuses of the mucosal lined nasal cavity.

Inferior meatus – The naso-lacrimal duct which drains the lacrimal sac opens in the anterior part of the inferior meatus.

Middle meatus – It lies below the middle concha. It represents the following features –

1. Infundibulum
2. Bulla ethmoidalis
3. Hiatus semilunaris

Superior meatus – It is the opening of the posterior ethmoidal cells into the superior meatus is by one or more orifices.

Arterial Supply of Lateral Wall

1. The antero-superior part is supplied by anterior and posterior ethmoidal artery.
2. The postero superior part is supplied by sphenopalatine artery.
3. The antero-inferior part is supplied by the greater palatine and facial artery
4. The postero-inferior part is supplied by the branches from the greater palatine artery.

Venous Drainage

Anteriorly the veins drains in to facial vein.

Posteriorly into the pharyngeal plexus of veins.

Middle part by pterygoid plexus of veins.

Nerve Supply

1. *Special sensory nerves* – fifteen to twenty bundles of olfactory nerves conveying sense of smell arise from the mucosa of the superior nasal concha and upper part of nasal septum.
2. *General sensory nerves* – these are derived from maxillary nerve except for an area, anteriorly and superiorly, which is supplied by the ophthalmic nerve.

Lymphatic Drainage

- From the anterior part of lymphatics emerge through the anterior nares and end in submandibular and deep cervical.
- From the posterior part of the lymphatics pass backwards to retro-pharyngeal and deep cervical nodes.

Applied Anatomy

1. Common cold (rhinitis is the commonest infection of the nose).
2. Hypertrophy of the mucosal over the inferior nasal concha is a common feature of allergic rhinitis.

Para Nasal Sinus

The term para nasal sinuses refers to the position and content of spaces present around the nasal cavity in pairs in the frontal, maxillary, ethmoid and sphenoid bones.

These para nasal sinuses are air-filled spaces in certain bones of the skull and they are in direct communication with the nasal cavity through their openings called ostia.
The sinuses are

- | | |
|---------------|--------------|
| 1. Frontal | 2. Maxillary |
| 3. Sphenoidal | 4. Ethmoidal |

Developmentally all the paranasal sinuses are out growths from the lateral wall of the nose.

Function

It is not clearly known but possibly they make the skull lighter and resonance to voice.

Development

All sinuses are present in rudimentary form at birth, except the frontal sinuses which

start development two or three years after birth. They enlarge rapidly during the ages of six to seven yrs and then after puberty.

Frontal Sinus

The frontal sinuses are situated in between two plates of frontal bone and are the upward outgrowths of the anterior ethmoidal sinuses.

It is present just above the nasal cavity on either side of the midline posterior to the superciliary arches.

Shape And Size

The frontal sinus is like a pyramid. About 2-3 cm in height, depth and width. The right frontal sinus is larger than the left one.

Capacity

It is approximately 7 cc in an adult.

Relations

They are related infero-laterally to the orbit, inferiorly to nasal cavity and laterally to the meninges and frontal lobe of the brain.

Opening

It opens in to the middle meatus of nose at the anterior end of the hiatus semiulnaris.

Artery Supply

Supra orbital artery.

Venous Drainage

It drains in to the anastomotic vein between the supra orbital and superior ophthalmic veins in the supraorbital notch.

Maxillary Sinus

It is the largest paranasal sinus and it occupies inside the body of maxilla.

Shape And Size

It is pyramidal in shape, with its base directed medially towards the lateral wall of nose, and the apex directed laterally in the zygomatic process of maxilla.

It is about 3 cm in height, 3 cm in length and 2.5 cm in width.

Capacity

Approximately 15 cc is the capacity of adult maxillary sinus.

RELATIONS

Anterior Wall

It is formed by the facial surface of the maxilla. It contains the infra-orbital foramen.

Roof

It is very thin and is formed by the floor of the orbit. It is grooved by the infra-orbital nerve.

Floor

It is formed by the alveolar process and the palate. It lies at or above the level of the floor of the nasal cavity in a child, while in an adult it is at a lower level.

Posterior wall

Separates the sinus from the pterygopalatine fossa.

The medial wall

Forms a large part of the lateral wall of nose. It has a large opening reduced in size by the articulating bones.

Opening

In the hiatus semiulnaris in the middle meatus of the nose is near the roof of the sinus.

Development

It appears at about fourth month of intra-uterine life as an outgrowth of the nasal cavity. Rudimentary at birth, it enlarges by about 6-7 years till puberty and rapidly grows thereafter.

Venous Drainage

Drains in to the facial vein and pterygoid plexus of veins.

Lymphatic Drainage

It drains in to the submandibular nodes.

Nerve Supply

Infraorbital and anterior, middle and posterior superior alveolar nerves.

Sphenoidal Sinuses

There are two sphenoidal sinuses in the sphenoid bone, and they are separated into two unequal sinuses by a septum.

Shape And Size

About 2 cm in height, width and depth shape is somewhat cuboidal but usually irregular.

Relations

Superiorly – pituitary gland, optic chiasma, frontal lobe of the cerebrum, olfactory bulb.

Inferiorly – nasopharynx

Anteriorly – nasal cavity

Posteriorly – brain stem, basilar artery

Laterally – cavernous sinus containing 3rd, 4th and 5th (except mandibular division) 6th cranial nerve, internal carotid artery.

Openings

Anterior sinuses in to the anterior part of hiatus semiulnaris in the middle meatus.

Applied Anatomy

Pituitary gland can be approached through the sphenoidal sinus, by the transantral or transnasal routes.

Ethmoidal Sinuses

There are three groups of ethmoidal sinuses having approximately 15 to 20 ethmoidal cells on either side. They occupy the ethmoidal bone.

The ethmoidal sinuses are divided into anterior, middle and posterior groups.

The anterior ethmoidal sinus is made up of up to 11 air cells. It opens in to the anterior part of the hiatus semiulnaris of the nose.

It is supplied by the anterior ethmoidal nerve and vessels. Its lymphatics drain in to the submandibular nodes.

The middle ethmoidal sinus (consisting of one to seven air cells) opens in to the superior meatus of the nose.

It is supplied by posterior ethmoidal nerve and vessels. Lymphatic drain in to submandibular nodes.

The posterior ethmoidal sinus (consisting of one to seven air cells) opens in to the superior meatus of nose. It is supplied by the posterior ethmoidal nerve.

Relations

Superiorly – cranial cavity

Inferiorly – maxillary sinus

Anteriorly – external nose

Posteriorly – sphenoidal nose

Laterally – orbit, optic nerve, nasolacrimal duct separated by a thin bone called as lamina papyraceae.

Medially – nasal cavity, superior and middle turbinates.

TVACHA – SKIN

Skin is the largest organ of the body. The skin is developed from the ectoderm.

Functions of The Skin

1. Protection from external environment (microorganism).
2. Removes the waste products of the body in the form of sweat.
3. It regulates the body temperature.
4. The skin acts as a medium in the formation of vitamin D.
5. It is responsible for tactile sensation.

The skin is divided into two parts:

1. Epidermis (outermost layer)
2. Dermis (inner layer).

1. Epidermis

It is the outermost layer and it is composed of stratified epithelium, which varies in thickness in different parts of the body. There is no blood supply and nerves to epidermis.

Epidermis is composed of four layers

- | | |
|-----------------------|----------------------|
| 1. Stratum corneum | 2. Stratum lucidum |
| 3. Stratum granulosum | 4. Germinative layer |

Factors responsible for the maintenance of the skin colour

1. *Melanin*

It is a dark pigment secreted by melanocytes in the deep germinative layer, which is observed by surrounding epithelial cells. The amount of the melanin varies in different parts of the body and sunlight promotes its secretion.

2. *The Presence of Oxygenated Haemoglobin*

The level of the oxygenated haemoglobin and its amount in circulating blood, present in the dermis gives a pink colour to the skin.

3. *Bile Pigments* in blood and keratin present in subcutaneous fat gives a yellowish colour to the skin.

Dermis

Dermis is composed of collagen fibres. The deepest layer of the dermis is surrounded by aerolar connective tissue.

The structures present in the dermis are:

- | | |
|--------------------------------------|---------------------------------|
| 1. Blood vessels | 2. Sensory nerve endings |
| 3. Hair roots, hair follicles, hairs | 4. Sweat glands and their ducts |
| 5. Sebaceous gland | 6. Arrector pilorum |
| 7. Lymph vessels | |

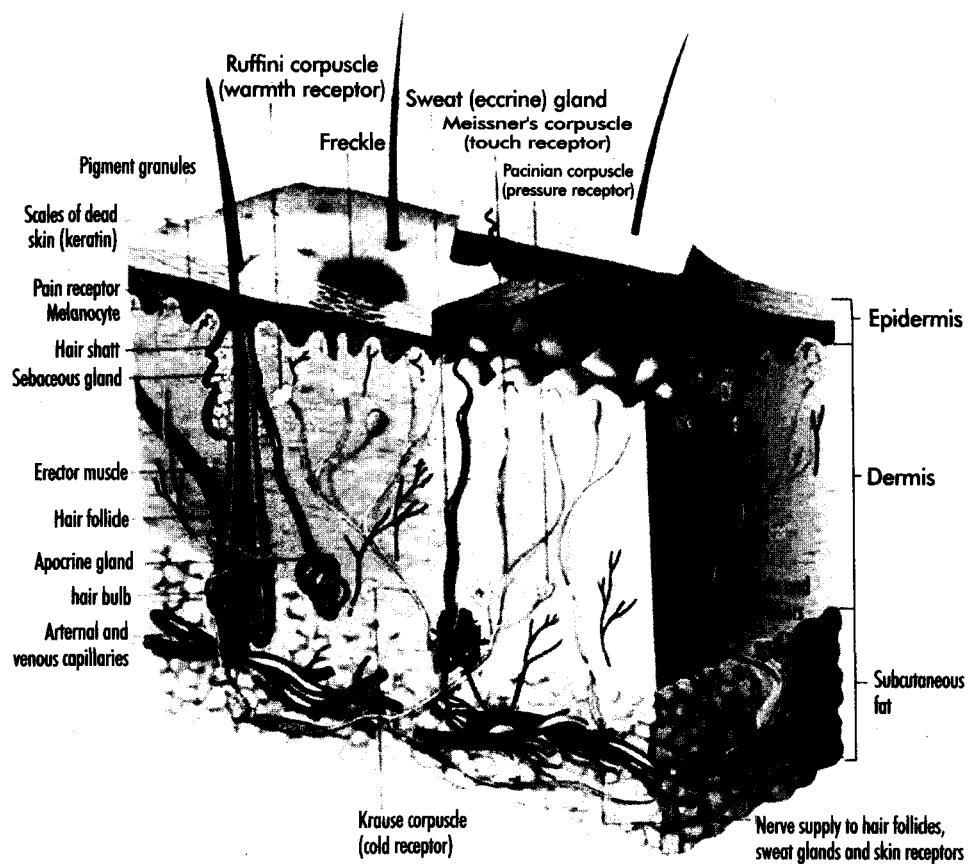
1. *Blood Vessels*

In Blood vessels arterioles form a fine network with capillary branches supplying sweat gland, sebaceous glands, hair follicles and the dermis. The epidermis has no blood supply and the dermis obtains nutrition and oxygen from the interstitial fluid derived from the blood vessels.

2. *Sensory Nerve Endings*

Somatic nerves are supplied to the dermis and the dermis is very sensitive to touch, change in temperature, pain (external injury), nerve impulses that originate in the nerve endings in the dermis are conveyed to the spinal chord by the sensory nerves and then from the sensory area to the cerebrum, where the sensations are produced.

Skin & Underlying Subcutaneous Layer



3. Sweat Glands

Sweat glands are present throughout the skin. The sweat glands are composed of epithelial cells. Some sweat ducts open to the skin surface at tiny depressions or tiny pores in the skin. Sweat is bad in odour particularly in axilla. The sweat glands are stimulated by sympathetic nerves in response to rise in body temperature and fear.

4. Hair Follicles

It consists of a down growth epidermal cells in to the dermis or subcutaneous tissues. At the base of the follicle there is a cluster of cells called as bulb. When the epidermal cells of the hair follicle die, they are converted in to keratin. The part of the hair above the skin is called as shaft and the remaining portions are called as roots. The hair follicle is attached with the arrector pilorum muscle.

5. Sebaceous Gland

It mainly consists of epithelial cells. Their secretion in to the hair follicles is called sebum. Sebaceous glands are absent in the palms and soles.

Sebum is an oily substance and it gives a shiny appearance on the skin and it makes the hair soft.

6. Arrector Pilorum

It is a little bundle of involuntary muscles attached to the hair follicles. The contraction of this muscle makes the hair stand erect. This muscle is stimulated by sympathetic nerves in response to fear and cold.

7. Lymph Vessels

It forms a network throughout the dermis and deeper layer of the epidermis.

Tvacha

तस्य खल्वेवंप्रवृत्तस्य शुक्रशोणितस्याभिपच्यमानस्य क्षिरस्येव सन्तानिकाः सप्त त्वचो भवन्ति।
यदेतत् प्रमाणं निर्दिष्टं तन्त्मांसलेघवकाशेषु, न ललाटे, सूक्ष्माङ्गुल्यादिषु च, यतो वक्ष्यत्युदरेषुश्च-
त्रीहिमुखेनाङ्गुष्ठोदरप्रमाणमवगाढं विध्येत् इति ॥ (Su. Sha. 4/4)

In such conglomerate of sperm and ovum (foetus) development takes place and consequently seven layers of *tvacha* come into existence like those of cream in milk.

The skin is called as *tvacha* in Ayurveda. The *Bhrajaka pitta* is presented in *tvacha*. The *tvacha* is divided into seven layers according to Sushruta and into six layers according to Charaka.

Layers of Tvacha according to Susrutha

- | | | |
|----------------------|------------------|------------------|
| 1. <i>Avabasini</i> | 2. <i>Lohita</i> | 3. <i>Shveta</i> |
| 4. <i>Tamra</i> | 5. <i>Vedini</i> | 6. <i>Rohini</i> |
| 7. <i>Mansadhara</i> | | |

Layers of Tvacha According to charaka

- | | | |
|----------------------|----------------------|-------------------|
| 1. <i>Udakadhara</i> | 2. <i>Asriddhara</i> | 3. <i>Tritiya</i> |
| 4. <i>Chaturthi</i> | 5. <i>Panchami</i> | 6. <i>Shasthi</i> |

1. *Avabhasini*

तासां प्रथमा अवभासिनी नाम या सर्वान् वर्णनवभासयति पञ्चविधां च छायां प्रकाशयति, सा ब्रह्मरषादशभागप्रमाणा, सिध्मपद्मकण्टकाधिष्ठाना ॥ (Su. Sha. 4/4)

According to Sushruta, the first layer of the skin is called as *Avabhasini*. It provides color to the skin. When the sunlight falls on this layer five types of colours gets reflected. This layer measures about one-eighteenth of *Vrihi*. The diseases caused from this layer are *Sidhma* (small ulcers) and *Padmakantaka* (*pemphigus mollaceous*).

2. *Lohita*

द्वितीया लोहिता नाम, षोडशभाग प्रमाणा, तिलकालकन्यच्छव्यङ्गाधिष्ठाना ॥ (Su. Sha. 4/4)

According to Sushruta the second layer of skin is called as *Lohita*.

It measures about one-sixth of a *Vrihi*. The diseases caused in this layer are *tilakaalaka* (moles), *nyachchha* (pimples) and *Vyanga* (acne vulgaris).

3. *Shveta*

तृतीया श्वेता नाम द्वादशभागप्रमाणा, चर्मदलाजगलिमषकाधिष्ठाना ॥ (Su. Sha. 4/4)

The third layer of skin according to Sushruta is *shveta*. it measures about one-twelfth of a *vrihi*. The diseases caused in this layer are *Charmadala*, *Ajagalli*, *Mashaka* (taenia infection of skin and candidiasis).

4. *Tamra*

चतुर्थी ताम्रानाम अष्टभागप्रमाणा, विविधकिलासकुष्टाधिष्ठाना ॥ (Su. Sha. 4/4)

The fourth layer of the skin is called as *tamra*. It measures about one-eighth of a *Vrihi*. He diseases seen in this layer are *Vividha Kilasa*, *Kustha* (lepromatous and tuberculous leprosy).

5. Vedini

पञ्चमी वेदिनी नाम, पञ्चभागप्रमाणा, कुष्ठविसर्पाधिष्ठाना ॥ (Su. Sha. 4/4)

The fifth layer is called as *Vidini* it measures about one-fifth of a *Vrishi*. The diseases are *Kushtha* (leprosy) and *Visarpa* (erysipelas).

6. Rohini

षष्ठी रोहिणी नाम, ब्रीहिप्रमाणा, ग्रन्थ्यपच्यर्बुदश्चिलपदगलगण्डाधिष्ठाना ॥

(Su. Sha. 4/4)

According to Sushruta the sixth layer of skin is called as *Rohini*. It measures about a *Vrishi*. The diseases caused from this layer are *granthya* (varicose veins), *apachi* (benign tumors), *arbuda* (tumors), *shlipada* (filariasis), *galaganda* (goiter).

7. Mansadhara

सप्तमीमांसधरा नाम ब्रीहिद्वयप्रमाणा, भगन्दर-विद्रध्यर्शो अधिष्ठाना ॥

(Su. Sha. 4/4)

The seventh layer of the skin is called as *mansadhara*. It measures about two *Vrishi*. The disease caused in this layer are, *bhagandara* (fistula-in-ano), *Vidradhi* (abscess), *arshas* (piles).

Layers according to Charaka

1. Uidakdhara

The outermost layer of the skin which is exposed to the sun light is called as *udakdhara*.

2. Asrikdhara

This is the second layer of the skin.

3. Tritiya

The third layer of the skin according to Charaka is called as *Tritiya*. The diseases caused from this layer are *siddha kilasa* (during curing the small ulcer some black patches come out on the skin that is called as *Kilasa*).

4. Chaturthi

The fourth layer is called as *chaturthi*. The diseases caused are *dadru kushta* means light elevation in the skin (macular rash).

5. Panchami

The diseases caused from this layer are *Alaji Vidradhi* (abscess).

6. Shashthi

When there is any injury to the sixth layer of *tvacha*, then the clinical feature is *tamah pravisyati* (black out).

Lusture of the Skin : Lusture of the skin is coming by the help of the *bhrajaka pitta*.

Applied Anatomy

1. Skin is the site for absorption of vitamin – D.
2. Dermatitis – Inflammation of the skin.
3. Vitiligo and albinism – Deficiency of melanin causes white pigmentation in the body.
4. Sun burn and hyperkeratosis – the skin becomes reddish black due to the hyper pigmentation.
5. Sebaceous cyst, acne vulgaris – usually occurs in the skin of the face.



1. Calcitonin is secreted by
 1. Pituitary
 2. Thyroid
 3. Supra renal
 4. Pancreas
2. Myxedema and cretinism are related to
 1. Parathyroid
 2. Pituitary
 3. Thyroid
 4. Testis
3. Thyroid gland has
 1. 1 Lobe
 2. 2 lobes
 3. 3 lobes
 4. 4 lobes
4. Graves disease is related to
 1. Pituitary
 2. Ovary
 3. Testes
 4. Thyroid
5. Smallest endocrine gland of body
 1. Pituitary
 2. Parathyroid
 3. Thyroid
 4. Adrenal
6. Aldosterone is secreted by
 1. Zona glomerulosa
 2. Zona Fasiculata
 3. Zona reticularis
 4. Thyroid
7. Gigantism and acromegaly are related to
 1. Growth hormone
 2. Leutinising hormone
 3. Follicle stimulating
 4. Prolactin hormone
8. Neurohypophysis is other wise known as
 1. Anterior pituitary
 2. Parathyroid
 3. Thyroid
 4. Posterior pituitary
9. Vasopressin and oxytocin is secreted by
 1. Anterior pituitary
 2. Posterior pituitary
 3. Thyroid
 4. Parathyroid
10. Relaxin is secreted by
 1. Posterior pituitary
 2. Anterior pituitary
 3. Pancreas
 4. Ovary

11. Prostaglandin, histamine are known as
 1. Enzymes
 2. Local hormones
 3. Placental hormones
 4. Biogenic hormones.

12. HCG (Human Chorionic Gonadotrophine) is secreted by
 1. Pituitary
 2. Testes
 3. Ovary
 4. Placenta

13. In the year 1922, Banting and Best had discovered
 1. HCG
 2. Oxytocin
 3. Relaxin
 4. Insulin

14. Deficiency of ADH leads to
 1. Diabetes insipidus
 2. Diabetes mellitus
 3. Cushing's Syndrome
 4. Turner's Syndrome.

15. Which one of the following is steroid in nature
 1. LH
 2. FSH
 3. ACTH
 4. GH

16. 44 autosomes and XXY sex chromosome gives rise to
 1. Turner's Syndrome
 2. Klinefelter Syndrome
 3. Down Syndrome
 4. Super female

17. 44 autosome with XO sex chromosome gives rise to
 1. Turner's Syndrome
 2. Klinefelter Syndrome
 3. Down Syndrome
 4. Super female

18. 44 autosomes with XXX sex chromosome gives rise to
 1. Turner's Syndrome
 2. Klinefelter Syndrome
 3. Down Syndrome
 4. Super female

19. Male genitalia are developed from
 1. Mullerian duct
 2. Wolffian Duct
 3. Major Duct
 4. Minor Duct

20. Female genitalia are developed from
 1. Mullerian duct
 2. Wolffian Duct
 3. Major Duct
 4. Ovary

21. Autosomal trisomy at 21 position is known as
 1. Turner's Syndrome
 2. Klinefelter Syndrome
 3. Down Syndrome
 4. Super female

22. Leydig's cells synthesize
 1. Testosterone
 2. Oestrogen
 3. Progesterone
 4. Oxytocin

23. Androgens are secreted by
1. Zona glomerulosa 2. Zona Fasiculata
3. Zona reticularis 4. Thyroid
24. Cortisol and corticosterone is secreted by
1. Zona glomerulosa 2. Zona Fasiculata
3. Zona reticularis 4. Thyroid
25. Which gland is present on the superior pole of kidney
1. Adrenal 2. Placenta 3. Thyroid 4. Pancreas
26. Which hormone control gamatogenesis in both male and female
1. LH 2. Placenta 3. MSH 4. FSH
27. Which organs are having greater width than length
1. Appendix and Gall bladder 2. Caecum and Prostrate
3. Testis and ovary 4. Stomach and Duodenum.
28. First heart sound is produced due to the closure of
1. Both semilunar valves 2. both atrio ventricular valves
3. bicuspid and pulmonary valves 4. tricuspid and aortic valves
29. second heart sound is produced due to closure of
1. Both semi lunar valves 2. Both atrio ventricular valves
3. bicuspid and pulmonary valves 4. tricuspid and aortic valves
30. Duration of the first heart sound is
1. 0.14 – 0.16 seconds 2. 0.24 – 0.26 seconds
3. 0.34 – 0.36 seconds 4. 0.08 -0.10 seconds
31. Duration of the second is
1. 0.14 – 0.16 seconds 2. 0.24 – 0.26 seconds
3. 0.34 – 0.36 seconds 4. 0.08 – 0.10 seconds
32. E.C.G is useful to diagnose the disorders present in
1. Lungs 2. Heart 3. Brain 4. Liver
33. E.E.G is useful to diagnose the disorders present in.
1. Lungs 2. Heart 3. Brain 4. Liver
34. Nephron is a _____ unit of the kidney
1. structural 2. functional
3. structural and functional 4. morphological

35. Which is the vestigial organ of the body
 1. gall bladder 2. liver
 3. vermiform appendix 4. rectum
36. Which hormone is secreted by the juxta - Glomerular cells
 1. secretin 2. renin 3. bradykinin 4. serotonin
37. Bowman's capsule is related to
 1. brain 2. lungs 3. liver 4. kidney
38. What is the normal G.F.R (Glomerular filterate rate) /minute
 1. 125 – 150 ml 2. 175 – 200 ml
 3. 225 – 250 ml 4. 250 – 275 ml
39. How many *marmas* are 4 *angula pramana*:
 1. 29 2. 4 3. 16 4. 54
40. How many *marmas* are 3 *angula pramana*:
 1. 29 2. 4 3. 16 4. 54
41. How many *marmas* are 2 *angula*:
 1. 29 2. 4 3. 16 4. 54
42. How many *marmas* are 1 *angula*:
 1. 29 2. 4 3. 16 4. 54
43. How many *marmas* are $\frac{1}{2}$ *angula pramana*:
 1. 29 2. 4 3. 16 4. 54
44. Total number of *mamsa marmas*
 1. 11 2. 41 3. 27 4. 08
45. Total number of *sira marma*
 1. 11 2. 41 3. 27 4. 08
46. Total number of *snayu marma*
 1. 11 2. 41 3. 27 4. 08
47. Total number of *Sandhi marma*
 1. 11 2. 41 3. 20 4. 08
48. Total number of *asthi marma*
 1. 11 2. 41 3. 20 4. 08
49. Total number of *visalyaghana marma*
 1. 19 2. 33 3. 03 4. 08

50. Total number of *ruja karma marma*
1. 19
 2. 33
 3. 03
 4. 08
51. Total number of *vaikalyakara marma*
1. 19
 2. 33
 3. 44
 4. 55
52. Total number of *marmas* present in one limb
1. 11
 2. 44
 3. 14
 4. 37
53. Total number of *marmas* present in *madhya sarira*
1. 11
 2. 14
 3. 26
 4. 37
54. Total number of *marmas* present in *jatrurdhva*
1. 11
 2. 14
 3. 36
 4. 37
55. Total number of *marmas* present in *vaksha*
1. 06
 2. 07
 3. 08
 4. 09
56. *Vitapa* is a type of
1. *sira marma*
 2. *sandhi marma*
 3. *asthi marma*
 4. *snayu marma*
57. *Simata* is a type of
1. *sira marma*
 2. *sandhi marma*
 3. *asthi marma*
 4. *snayu marma*
58. Indra basthi and guda are the example of
1. *sira marma*
 2. *sandhi marma*
 3. *snayu marma*
 4. *mamsa marma*
59. Injury to kaksha dhara marma leads to
1. *paksha ghata*
 2. *khangata*
 3. *marana*
 4. *ruja and sopha*
60. Fatality period *sadyaprannahara marma*
1. 1 week
 2. 1 paksha
 3. 3 months
 4. 1 year
61. Fatality period of the *kalantarapranahara marma*
1. 1 week
 2. 1 paksha
 3. 3 months
 4. 1 year
62. Where the *nabhi marma* is situated
1. in between *pakwasaya* and *amasaya*
 2. *pakwasaya*
 3. *amasaya*
 4. below the *pakwasaya*
63. Marma contributes
1. $\frac{1}{2}$ of *shalya*
 2. $\frac{1}{3}$ of *shalya*
 3. $\frac{1}{4}$ of *shalya*
 4. equal to *shalya*
64. *Sira vyadha* contributes
1. $\frac{1}{4}$ of *shalya chikitsa*
 2. $\frac{1}{3}$ of *shalya chikitsa*
 3. $\frac{1}{2}$ of *shalya chikitsa*
 4. equal to *shalya chikitsa*

65. How many *sringataka marmas* are present in the body

1. 2 2. 3 3. 4 4. 5

66. How many *seemanta marmas* are present in the body

1. 2 2. 4 3. 5 4. 6

67. Measurement of *mani bandha* and *Gulpha marma*

1. 1 *angula* 2. 2 *angula* 3. 3 *angula* 4. 4 *angula*

68. Measurement of *janu* and *karpara*

1. 1 *angula* 2. 2 *angula* 3. 3 *angula* 4. 4 *angula*

69. Measurement of *hrudya*, *basthi*, *guda* and *nabhi*

1. 1 *angula* 2. 2 *angula* 3. 3 *angula* 4. 4 *angula*

70. Measurement of *vitapa* and *kakshadhara marma*

1. 1 *angula* 2. 2 *angula* 3. 3 *angula* 4. 4 *angula*

71. Measurement of *indra vasthi* and *stanarohitha marma*

1. $\frac{1}{2}$ *angula* 2. 1 *angula* 3. 2 *angula* 4. 3 *angula*

72. Amsa and Amsa palaka comes under

- | | |
|---------------------------|------------------------------|
| 1. <i>sadya pranahara</i> | 2. <i>kalantarapranahara</i> |
| 3. <i>visalyagha</i> | 4. <i>vaikalyakara</i> |

73. *Sankha* and *Adhipathi* comes under

- | | |
|--------------------------|------------------------------|
| 1. <i>sadyapranahara</i> | 2. <i>kalantaropranahara</i> |
| 3. <i>visalyaghna</i> | 4. <i>vaikalyakara</i> |

74. *Trimarmas* are described by

- | | |
|-------------------|-------------------|
| 1. Charaka | 2. Sushruta |
| 3. Madhava Nidana | 4. Bhava Prakasha |

75. References of *trimarmas* are available in

- | | |
|-------------------------|-------------------------|
| 1. Charaka sutrasthana | 2. Charaka sarirasthana |
| 3. Charaka siddhisthana | 4. Charaka nidanasthana |

76. Dhamani marmas are described by

- | | |
|--------------------|-------------------|
| 1. Charaka | 2. Sushruta |
| 3. Astanga Hridaya | 4. Madhava Nidana |

77. Total number of *dhamani marmas* are

1. 9 2. 8 3. 6 4. 7

78. *Adhi pathi* is a type of
1. *mamsa marma* 2. *sira marma* 3. *snayu marma* 4. *sandhi marma*
79. Lesser and greater curvatures are present in
1. heart 2. stomach 3. liver 4. kidney
80. Which organ has five surfaces
1. heart 2. stomach 3. liver 4. kidney
81. Structural and functional unit of the kidney
1. alveoli 2. nephron 3. bowman's capsule 4. loop of henle
82. Bare area is present in
1. heart 2. stomach 3. liver 4. kidney
83. Lingula is present in
1. heart 2. stomach 3. liver 4. lungs
84. Which is the nervous layer of the eye
1. choroid 2. ciliary body 3. sclera 4. retina
85. Which is the vascular layer of the eye
1. retina 2. conjunctiva 3. pupil 4. sclera
86. Insufficient peristalsis leads to
1. diarrhoea 2. constipation
3. colitis 4. irritable bowel syndrome
87. Internal and External haemorrhoids are known as
1. piles 2. fistula 3. fissure 4. anal polyp
88. Hitton's line present in
1. Rectum 2. Lungs 3. Liver 4. Stomach
89. Broca's area is otherwise
1. Area 17, 18 2. Area 41, 44 3. Area 32, 36 4. Area 2, 3
90. Endolymph and perilymph present in
1. tongue 2. Ear 3. Nose 4. Skin
91. Waldeyer's ring is related with
1. Appendix 2. Caecum 3. Tonsil 4. Anus
92. Number of fissures present in right lung
1. 1 2. 2 3. 3 4. 4

93. Number of Chakras described in Yoga shastra

1. 2 2. 3 3. 5 4. 6

94. Visuddha chakra is situated in

- | | |
|----------|---------------------------|
| 1. kanta | 2. head |
| 3. nabhi | 4. root of genital organs |

95. Agyan chakra is situated in the

- | | |
|----------|---------------------------|
| 1. kanta | 2. head |
| 3. nabhi | 4. root of genital organs |

96. Rickets is related with

1. Adrenal 2. Pituitary 3. Parathyroid 4. Pineal

97. Matrika marma is an example of

- | | |
|-----------------|----------------|
| 1. Sira marma | 2. snayu marma |
| 3. sandhi marma | 4. asthi marma |

98. Adhipathi marma is an example of

- | | |
|-----------------|----------------|
| 1. Sira marma | 2. snayu marma |
| 3. sandhi marma | 4. asthi marma |

99. Sanka is an example of

- | | |
|-----------------|----------------|
| 1. sira marma | 2. snayu marma |
| 3. sandhi marma | 4. asthi marma |

100. Manipura chakra is situated in

- | | |
|----------|---------------------------|
| 1. kanta | 2. head |
| 3. nabhi | 4. root of genital organs |

101. Anahata chakra is situated in

1. kanta 2. head 3. nabhi 4. Hridaya

102. swadhista chakra is situated in

- | | |
|----------|------------------------------|
| 1. kanta | 2. head |
| 3. nabhi | 4. in between nabhi and head |

103. Mooladhara chakra is situated in

- | | |
|--------------------------------------|---------------------------|
| 1. kanta | 2. head |
| 3. in between genital organ and guda | 4. Root of genital organs |

104. Reference for Shat chakra is available only in

- | | |
|---------------------|-------------------|
| 1. Yoga shastra | 2. Charak samhita |
| 3. Susruta Samhitha | 4. Sarangadhara |

105. Little's area is situated in
 1. Tongue 2. Eye 3. skin 4. Nose
106. Lingual artery is an direct branch of
 1. Common carotid 2. external carotid
 3. Internal carotid 4. Arch of aorta
107. Total number of sense organ present in the body
 1. 3 2. 5 3. 6 4. 7
108. Arrector pilorum is present with
 1. Nose 2. tongue 3. skin 4. Eye
109. *Pratanabati, Vritta, Pruthu* and *Sushira* are the varieties of
 1. *Snayu* 2. *Peshi* 3. *Kandara* 4. *Sira*
110. *Vritta snayu* are referred as
 1. *Peshi* 2. *Sandhi* 3. *Kandara* 4. *Mamsarajjie*
111. *Pratanabati snayus* are present in
 1. *Sakha* and all *sandhis* 2. All over the body
 3. *Amapakvashaya* 4. *Parshva*
112. *Pruthula snayu* are present in
 1. *Parshva* 2. *Uras*
 3. *Prushta* and *shiras* 4. All the above
113. Which type of *snayu* are present in basti
 1. *Pratanabasti* 2. *Vritta* 3. *Pruthu* 4. *Sushira*
114. Type of *Sandhi* present in ear and nose
 1. *mandala* 2. *tunnasevani* 3. *Kora* 4. *Sankhabarta*
115. Type of *Sandhi* present in between maxilla and mandible
 1. *mandala* 2. *vayusatunda* 3. *kora* 4. *ullukhala*
116. Type of *sadhi* present in cervical vertebrae
 1. *pratara* 2. *kora* 3. *ullukhala* 4. *mandala*
117. Type of *Sandhi* present in the body
 1. 2. 2. 3 3. 4 4. 6
118. *Nitambasti* is an example of
 1. *kapala* 2. *ruchaka* 3. *taruna* 4. *valaya*

119. Accurate line present in the
1. illium
 2. Sacrum
 3. Scapula
 4. Humerus
120. Internal oblique muscle is related with
1. Eye
 2. Abdominal wall
 3. Scapula
 4. Humerus
121. Which muscle separates abdominal cavity from thoracic cavity
1. Diaphragm
 2. Iliacus
 3. psoas major
 4. Psoas minor.
122. Oesophagus pierces the diaphram at the level of
1. T 10 vertebra
 2. T 11 vertebra
 3. T 12 vertebra
 4. T 13 vertebra
123. Kidney is covered by
1. renal capsule
 2. perirenal fat
 3. renal fascia
 4. all the above
124. Pouch of morison is related to
1. peritoneum
 2. pleura
 3. pericardium
 4. synovial membrane
125. The average weight of the one supra renal gland
1. 5 gm
 2. 25 gm
 3. 35 gm
 4. 45 gm
126. Stomach gets its arterial supply directly from
1. supra renal artery
 2. abdominal aorta
 3. coeliacartery
 4. superior mesenteric artery
127. Duodenum is curved like letter _____ around the head of the pancreas
1. D
 2. X
 3. G
 4. C
128. Ligament of trietz is related with
1. liver
 2. kidney
 3. brain
 4. duodenum
129. Meckle's diverticulum is found on the
1. small intestine
 2. large intestine
 3. liver
 4. kidney
130. Cauded process is seen in
1. liver
 2. duodenum
 3. kidney
 4. brain
131. The average length of the common bile duct
1. 8 – 12 cm
 2. 15 – 20 cm
 3. 20 – 25 cm
 4. 25 – 30 cm
132. How many visceral impressions are seen in the spleen
1. 1
 2. 2
 3. 3
 4. 4
133. Which wall of the pelvis represents the piriformis muscle
1. anterior
 2. superior
 3. inferior
 4. posterior

134. The average weight of the prostate is about
1. 8 – 10 gm 2. 15 – 20 gm 3. 20 – 25 4. 25 – 30 gm
135. Adam's apple is present in
1. neck 2. head 3. back 4. leg
136. Stenson's duct is otherwise known as
1. parotid duct 2. mandibular duct
3. sub mandibular duct 4. duct of santorine
137. Massesters is the main muscle for
1. mastication 2. laughing 3. crying 4. whistiling
138. Formula for permanent teeth
1. ICPM 2123 2. IPCM – 2213
3. IMCP – 3122 4. CPIM – 2123
139. Formula for the temporary teeth
1. ICM – 122 2. ICM – 212
3. CIM – 212 4. CIM – 122
140. Laryngopharynx communicates with
1. oesophagus 2. trachea 3. lungs 4. bronchus
141. Length of the mid brain is about
1. 1. 2 cm 2. 12 cm 3. 10 cm 4. 14 cm
142. The usual spot chosen for the lumbar puncture
1. T12 – L1 2. L1 – L2 3. L2 – L3 4. L3 – L4
143. Filum termiale is related with
1. cerebrum 2. cerebellum 3. spinal cord 4. mid brain
144. The cerebrum is otherwise known as the
1. procencephalon 2. telencephalon
3. mesencephalon 4. rhombencephalon
145. The fore brain is otherwise known as
1. procencephalon 2. telencephalon
3. mesencephalon 4. rhombencephalon
146. The mid brain is other wise known as
1. procencephalon 2. telencephalon
3. mesencephalon 4. rhombencephalon

147. The hind brain is other wise known as

- | | |
|------------------|--------------------|
| 1. procephalon | 2. telencephalon |
| 3. mesencephalon | 4. rhombencephalon |

148. Pons, cerebellum, medulla oblongata are the parts of the

- | | | | |
|---------------|--------------|---------------|-------------|
| 1. fore brain | 2. mid brain | 3. hind brain | 4. cerebrum |
|---------------|--------------|---------------|-------------|

149. Cerebrum and diencephalon are the branches of the

- | | | | |
|---------------|--------------|---------------|-------------|
| 1. fore brain | 2. mid brain | 3. hind brain | 4. cerebrum |
|---------------|--------------|---------------|-------------|

150. The transverse section of the spinal cord resembles

- | | | | |
|-------------|-------------|-------------|-------------|
| 1. C shaped | 2. H shaped | 3. P shaped | 4. O shaped |
|-------------|-------------|-------------|-------------|

151. Muscular coordination of maintenance of muscle tone is done by

- | | | | |
|-------------|---------------|---------------|---------|
| 1. cerebrum | 2. cerebellum | 3. hind brain | 4. pons |
|-------------|---------------|---------------|---------|

152. Maintenance of equilibrium is done by the help of

- | | | | |
|-------------|---------------|---------------|---------|
| 1. cerebrum | 2. cerebellum | 3. Hind brain | 4. pons |
|-------------|---------------|---------------|---------|

153. Broca's area is other wise known as

- | | | | |
|-------------------|---------------|----------------------|---------------|
| 1. olfactory area | 2. taste area | 3. motor speech area | 4. smell area |
|-------------------|---------------|----------------------|---------------|

154. Angle of louï's is present in

- | | | | |
|-------------|---------|------------|------------|
| 1. clavicle | 2. neck | 3. sternum | 4. scapula |
|-------------|---------|------------|------------|

155. Montgomery's tubercles are related with

- | | | | |
|-----------|-----------|----------|-----------|
| 1. vagina | 2. pelvis | 3. chest | 4. breast |
|-----------|-----------|----------|-----------|

156. Flexor follicles brevis is related with

- | | | | |
|-----------|----------|--------------|----------|
| 1. pelvis | 2. thumb | 3. great toe | 4. tibia |
|-----------|----------|--------------|----------|

157. Flexor hallucis longus is related with movement of

- | | | | |
|-----------|----------|--------------|------------|
| 1. pelvis | 2. thumb | 3. great toe | 4. humerus |
|-----------|----------|--------------|------------|

158. How many kalas are described by Sushruta

- | | | | |
|------|------|------|------|
| 1. 3 | 2. 4 | 3. 5 | 4. 7 |
|------|------|------|------|

159. Which kala is spreaded between *amasaya* to *pakwasaya* and digest the food

- | | |
|-----------------------|------------------------|
| 1. <i>Maladhara</i> | 2. <i>Pitta dhara</i> |
| 3. <i>Sukhradhara</i> | 4. <i>Sleshmadhara</i> |

160. The name of the first *kala* according to Sushruta

- | | | | |
|----------------------|-----------------------|------------------------|-----------------------|
| 1. <i>Mala dhara</i> | 2. <i>pitta dhara</i> | 3. <i>Sukhra dhara</i> | 4. <i>Mamsa dhara</i> |
|----------------------|-----------------------|------------------------|-----------------------|

161. Which kala is present in small and large bone

- | | | | |
|----------------------|-----------------------|------------------------|----------------------|
| 1. <i>Mala dhara</i> | 2. <i>pitta dhara</i> | 3. <i>Raktha dhara</i> | 4. <i>medo dhara</i> |
|----------------------|-----------------------|------------------------|----------------------|

162. Which layer of twacha injury causes tamah pravesha
 1. 2nd layer 2. 4th layer 3. 5th layer 4. 6th layer
163. Which Kala represents all over the body
 1. *Mala dhara* 2. *purisa dhara* 3. *Raktha dhara* 4. *sukra dhara*
164. Vrihi *pramana* of *tamra* twacha
 1. 1/8 of *vrihi* 2. 1/12 of *vrihi* 3. 1/16 of *vrihi* 4. 1/18 of *vrihi*
165. Normal quantity of C S F is about
 1. 150 ml 2. 1500 ml 3. 2000 ml 4. 3000 ml
166. How many hemispheres are present in cerebrum
 1. 2 2. 3 3. 4 4. 5
167. Sylvian aqueduct is a continuous with the
 1. Mid brain 2. fore brain 3. spinal cord 4. hind brain
168. Normal pressure of C. S. F.
 1. 110 – 130 mm/hg 2. 210 – 230 mm/hg
 3. 310 – 330 mm/hg 4. 410 – 430 mm/hg
169. Inner most layer of the eye
 1. Sclera 2. Cornea 3. Ciliary body 4. Retina
170. Muscula lutea present in
 1. Sclera 2. Cornea 3. Ciliary body 4. retina
171. Malleus, Incus and Stapes are present in the
 1. External ear 2. Middle Ear 3. Inner ear 4. Eye
172. Labrynth is present in
 1. External Ear 2. Middle ear 3. Inner ear 4. Nose
173. Columella is present in
 1. Nose 2. Eye 3. Ear 4. Tongue
174. Swallowing, coughing and vomiting centers are situated in
 1. Medulla 2. Pons 3. Cerebellum 4. Cerebrum
175. Speech area, smell area are situated in
 1. Medulla 2. Pons 3. Cerebellum 4. Cerebrum
176. How many meninges are present
 1. 2 2. 3 3. 4 4. 5

177. Total number of cranial nerves
 1. 12 pairs 2. 31 pairs 3. 8 pairs 4. 11 pairs
178. Total number of spinal nerves
 1. 12 pairs 2. 31 pairs 3. 8 pairs 4. 11 pairs
179. Which cranial nerves are sensory in nature
 1. 1,2,8 2. 5,7,9,10 3. 3,4,6 4. 11,12
180. Which cranial nerves are motor in nature
 1. 1,2,8 2. 5,7,9,10 3. 3,4,6 4. 11,12
181. Facial nerve is
 1. Purely motor 2. Purely sensory 3. Both 4. none
182. Vagus nerve is
 1. Purely motor 2. Purely sensory 3. Both 4. none
183. Optic nerve is
 1. Purely motor 2. Purely sensory 3. Both 4. none
184. Hypoglossal nerve is
 1. Purely motor 2. Purely sensory 3. Both 4. none
185. How many divisions are present in trigeminal nerve
 1. 1 2. 2 3. 3 4. 4
186. Which cranial nerve supplies the trapezius and sternocleomastoid muscle
 1. Facial 2. Auditory 3. Accessory 4. Hypoglossal
187. External ocular muscles are supplied by
 1. Hypoglossal 2. Oculomotor 3. Trigeminal 4. Facial
188. Total number of *pratyangas* described by Charaka
 1. 56 2. 66 3. 46 4. 36
189. Number of *peshis* present in 4 *sakhas*
 1. 400 2. 66 3. 34 4. 20
190. Number of *peshis* present in *koshta*
 1. 400 2. 66 3. 34 4. 20
191. Number of *peshis* present in *jatrurdhwa*
 1. 400 2. 66 3. 34 4. 40

192. The largest lymphatic duct is
 1. Thoracic duct 2. Spleen 3. Appendix 4. Tonsil
193. The largest lymphatic gland is
 1. Thoracic duct 2. Spleen 3. Appendix 4. Tonsil
194. Example of Ellipsoid joint
 1. Radio-carpal 2. Shoulder 3. Radio-ulnar 4. Inter carpal
195. Example of symphysis
 1. Intervertebral 2. Shoulder 3. Radio-ulnar 4. Inter carpal
196. Squamous suture is present between
 1. Frontal-parietal 2. Parieto-temporal
 3. Parietal-occipital 4. Occipito-sphenoidal
197. Total number of *nabhi pravaba siras*
 1. 10 2. 40 3. 500 4. 175
198. Total number of *siras* present in 4 *sakhas*
 1. 10 2. 40 3. 400 4. 175
199. *Sakha, hanu* and *kati sadhis* are the example of
 1. *chesta* 2. *sthira* 3. fibrous 4. ball & socket
200. The bones present in the *prishta* are examples of
 1. *kapala* 2. *taruna* 3. *valaya* 4. *nalaka*
201. Total number of *dantas* described by Sushruta
 1. 20 2. 30 3. 32 4. 42
202. *Pramana* of *udaka* in *anjali pramana*
 1. 10 2. 9 3. 8 4. 7
203. *Pramana* of *sukra* in *anjali pramana*
 1. 1/2 2. 1 3. 8 4. 7
204. *Pramana* of *meda* in *anjali pramana*
 1. 1/2 2. 1 3. 2 4. 3
205. *Pramana* of *purisha* in *anjali pramana*
 1. 1/2 2. 1 3. 6 4. 7
206. *Pramana* of *vasa* in *anjali pramana*
 1. 1/2 2. 1 3. 3 4. 4

207. *Pramana of sleshma in anjali pramana*

- | | | | |
|--------|------|------|------|
| 1. 1/2 | 2. 1 | 3. 6 | 4. 7 |
|--------|------|------|------|

208. How many factors are responsible for *garbha utpatthi*

- | | | | |
|------|------|------|------|
| 1. 2 | 2. 4 | 3. 6 | 4. 8 |
|------|------|------|------|

209. Total number of *peshis* present in both sthanas

- | | | | |
|------|-------|------|------|
| 1. 5 | 2. 10 | 3. 4 | 4. 6 |
|------|-------|------|------|

210. The disease *kusta* is related with

- | | | | |
|-----------------|------------------|------------------------------|------------------|
| 1. <i>Tamra</i> | 2. <i>Vedini</i> | 3. <i>Tamra & vedini</i> | 4. <i>Rohini</i> |
|-----------------|------------------|------------------------------|------------------|

211. Which is not a type of joint

- | | | | |
|--------------------|------------------|-----------------------|-----------------------|
| 1. <i>Ulukhala</i> | 2. <i>Pruthu</i> | 3. <i>Tunnasevani</i> | 4. <i>Vayusatunda</i> |
|--------------------|------------------|-----------------------|-----------------------|

212. Which is differentiating *dhatu* and *Ashaya*

- | | | | |
|------------------|----------------|-----------------|-------------------|
| 1. <i>Twacha</i> | 2. <i>Kala</i> | 3. <i>Peshi</i> | 4. <i>Simanta</i> |
|------------------|----------------|-----------------|-------------------|

213. Which of the following is a *prathyanga*

- | | | | |
|-----------------|------------------|--------------------|----------------|
| 1. <i>siras</i> | 2. <i>sakthi</i> | 3. <i>hridayam</i> | 4. <i>bahu</i> |
|-----------------|------------------|--------------------|----------------|

214. Which is not included in *satwa shareera*

- | | |
|-------------------------|-------------------------|
| 1. <i>varuna sarira</i> | 2. <i>Brahma sarira</i> |
| 3. <i>Yama sarira</i> | 4. <i>Sakuna sarira</i> |

215. The following *dhatus* are included under *dasa pranayatanas* except

- | | | | |
|-----------------|------------------|-----------------|-----------------|
| 1. <i>Sukra</i> | 2. <i>Raktha</i> | 3. <i>Mamsa</i> | 4. <i>Medas</i> |
|-----------------|------------------|-----------------|-----------------|

216. Body can be divided into how many parts according to *Ayurveda*

- | | | | |
|------|------|------|-------|
| 1. 3 | 2. 9 | 3. 6 | 4. 15 |
|------|------|------|-------|

217. Best book for *Sarira*

- | | |
|-----------------------------|--------------------------|
| 1. <i>Charakam sarira</i> | 2. <i>Shuruta sarira</i> |
| 3. <i>Astanga samgraham</i> | 4. none of the above |

218. Number of *garbha utpathaga bhavas* are

- | | | | |
|------|------|------|------|
| 1. 4 | 2. 6 | 3. 5 | 4. 8 |
|------|------|------|------|

219. The first organ develops in *garba* according to *subhudi gowtama* is

- | | | | |
|-------------------|--------------------------|-----------------|----------------|
| 1. <i>Hridaya</i> | 2. <i>Madhya sareera</i> | 3. <i>Nabhi</i> | 4. <i>Sira</i> |
|-------------------|--------------------------|-----------------|----------------|

220. The length of *guda* as per *Sushruta* is _____ angulis

- | | | | |
|-------|-------|-------|-------|
| 1. 2½ | 2. 3½ | 3. 4½ | 4. 5½ |
|-------|-------|-------|-------|

221. Length of *grahani* is

- | | | | |
|----------|----------|----------|----------|
| 1. 15 cm | 2. 10 cm | 3. 25 cm | 4. 35 cm |
|----------|----------|----------|----------|

222. *Pramana* of *Sukra* in the body is
 1. 3 *anjali* 2. 1 *anjali* 3. 2 *anjali* 4. $\frac{1}{2}$ *anjali*
223. The number of carpal bone is
 1. 6 2. 7 3. 8 4. 5
224. The number of thoracic vertebrae
 1. 7 2. 4 3. 5 4. 12
225. Number of bones in pelvis according to *Charaka*
 1. 3 2. 4 3. 5 4. 6
226. Number of *asthi* in the nose
 1. 3 2. 1 3. 5 4. 9
227. The number of ribs joining the sternum on each side
 1.7 2. 9 3. 8 4. 12
228. Facial bones are ____ in number
 1. 28 2. 20 3. 18 4. 14
229. Lastely ossifying bone is
 1. ilium 2. ischium 3. pubis 4. sternum
230. Bone with long neck
 1. Femur 2. Ulna 3. Humerus 4. Radius
231. Sphenoid bone is found in
 1. Anterior cranial cavity 2. Middle cranial cavity
 3. Posterior cranial
232. Number of vertebrae
 1. 31 2. 32 3. 33 4. 34
233. Deltoid tuberosity is found in
 1. Head of femurus 2. Shaft of Humerus
 3. Ulna 4. Clavicle
234. Styloid process is present in
 1. base of skull 2. anterior pelvis
 3. brim of pelvis 4. none of above
235. Cuboid bone is present in
 1. Foot 2. Arm 3. Head 4. Neck

236. Acetabulum is a

1. Bony cavity 2. Bony elevation 3. Bony crease 4. Bony process

237. Wormian bones are found more frequently in the

- | | |
|----------------------|----------------------|
| 1. Lower extremities | 2. Upper extremities |
| 3. Vertebral column | 4. Cranial sutures |

238. The area of greatest growth activity in the bone is

- | | |
|--------------|--------------------------|
| 1. Epiphysis | 2. Metaphysis |
| 3. Diaphysis | 4. Ephiphysial cartilage |

239. The bone at vertebral column, formed by 4 bone is

- | | | | |
|-----------|-----------|---------------|----------|
| 1. Coccyx | 2. sacrum | 3. innominate | 4. pubis |
|-----------|-----------|---------------|----------|

240. The *kala* which is present in all *sandhis*

- | | | | |
|---------------|-----------------|----------------|---------------|
| 1. Medhodhara | 2. Sleshmadhara | 3. Rakthadhara | 4. Pithadhara |
|---------------|-----------------|----------------|---------------|

241. According to Ayurveda the temporary mandibular joint is

- | | | | |
|---------------|---------|-------------|--------------|
| 1. Vayastunda | 2. Kora | 3. Samudgam | 4. Ulukhalam |
|---------------|---------|-------------|--------------|

242. Thunnasevani is a variety of

- | | | | |
|----------|-----------------|----------|---------|
| 1. Asthi | 2. Asthi Sandhi | 3. Snayu | 4. None |
|----------|-----------------|----------|---------|

243. Total number of *Simntha Sandhi* is

- | | | | |
|------|-------|-------|------|
| 1. 7 | 2. 14 | 3. 21 | 4. 3 |
|------|-------|-------|------|

244. *Janu Sandhi* belongs to the following variety:

- | | | | |
|--------------|------------|---------|------------|
| 1. Ullukhala | 2. Pratara | 3. Kora | 4. Samudga |
|--------------|------------|---------|------------|

245. The number of siras present in sroni

- | | | | |
|-------|-------|-------|-------|
| 1. 30 | 2. 31 | 3. 32 | 4. 33 |
|-------|-------|-------|-------|

246. *Hridaya* is the *mula srotas* of

- | | |
|----------------------|----------------------|
| 1. Rakthavaha srotas | 2. Rasavaha srotas |
| 3. Mamsa vaha srotas | 4. None of the above |

247. Spleenic artery is the branch of

- | | |
|----------------------|----------------------|
| 1. Mesenteric artery | 2. Pudental artery |
| 3. Coeliac artery | 4. None of the above |

248. Great saphenous vein drains into

- | | |
|------------------------|----------------------|
| 1. Popliteal vein | 2. Femoral vein |
| 3. External iliac vein | 4. None of the above |

249. The vein carries pure blood is

- | | | | |
|----------------|-------------------|-----------------|------------------|
| 1. Portal vein | 2. Pulmonary vein | 3. Hepatic vein | 4. Coronary vein |
|----------------|-------------------|-----------------|------------------|

250. Blood flows from left ventricle to
1. Lungs 2. Left auricle 3. Right auricle 4. Aorta
251. The number of umbilical artery is/are
1. 1 2. 3 3. 2 4. 4
252. Portal vein is formed by
1. Superior mesenteric and splenic vein 2. Inferior mesenteric and splenic vein
3. Superior mesenteric and renal vein 4. Inferior mesenteric and renal vein
253. Boxer's muscle
1. Latissimus dorsi 2. Serratus anterior
3. Pectoralis 4. Sartorius
254. Largest muscle of neck
1. Sternocleido mastoid 2. Platysma
3. Pectoralis major 4. None of the above
255. Gastrocnemius is in
1. Abdomen 2. Heart 3. Calf muscle 4. Neck
256. Femoral triangle is bounded by
1. Adductor longus 2. Adductor magnus
3. Rectus femoris 4. Semi membranosis
257. Teres major originates from
1. Inferior angle of scapula 2. Head of humerus
3. Coracoid process 4. Head of ulna
258. Origin of coraco brachialis muscle is
1. Femur 2. Radius 3. Ulna 4. Humerus
259. Vayu after breaking the srothas and division of mamsa produces
1. Pesi 2. Sira 3. Snayu 4. Kandara
260. The *pesis* in *sthana* are
1. 3 2. 10 3. 4 4. 20
261. Gracilis and sartorius muscle are situated in the
1. Thigh 2. Foot region 3. Leg region 4. Gluteal region
262. *Kandara* is an *upadhatu* of _____ *dhatu*
1. Rakta 2. Mamsa 3. Asthi 4. None

263. *Mamsarajju* is situated in

1. *Siras* 2. *Griva* 3. *Hridaya* 4. *Prushta*

264. Gastro pancreatic ligament is otherwise known as

1. Greater omentum 2. Lesser omentum
3. Mesogastrum 4. Mesentery

265. The ligament connects the vertebra is

1. Ligamentum teres 2. Ligamentum venosum
3. Ligamentum flavum 4. Deltoid ligament

266. *Suddha mamsa sneha* is known as

1. *Kala* 2. *Kandara* 3. *Snayu* 4. *Vasa*

267. *Ligamentum teres* is situated in

1. Liver 2. Hip 3. Both a & b 4. Kidney

268. _____ is not mentioned in *kala*

1. *Mamsadhabra* 2. *Rakthadhabra*
3. *Pittadhabra* 4. *Asthidhabra*

269. Which kala is *udarasthana*

1. *Medodhabra* 2. *Sleshmadhabra* 3. *Rakthadhabra* 4. None

270. Which kala is known as *Grahani*

1. 6th 2. 4th 3. 5th 4. 7th

271. Garbhashaya is situated in

1. 1st avartha of *yoni* 2. 2nd avartha of *yoni*
3. 3rd avartha of *yoni* 4. 4th avartha of *yoni*

272. The shape of *yoni* is

1. Like *sankhanabhi* 2. Like fruit of *udumbara*
3. Like mouth of *rohitakshaya* 4. None of the above

273. *Raktashaya* is

1. *Hridaya* 2. *Yakrit-pliha*
3. *Amashaya* 4. *Rasavahi dhamanis*

274. The unidentified organ in ayurveda is

1. *Thalu* 2. *Unduka* 3. *Kloma* 4. *Vrikka*

275. According to Charaka Samhitha, *vapavanam* is mentioned under

1. *Karmendriyas* 2. *Pranayathanas* 3. *Koshtangas* 4. All the above

276. "Jagritastad vikasati svaptasch nimilati" is
 1. *Klomam* 2. *Hridayam* 3. *Vrikka* 4. *Annavaha srotas*
277. The *koshtanga* according to Susruta are
 1. 15 2. 12 3. 13 4. 8
278. The *phupphusa* as a *kostanga* is described
 1. *Charaka* 2. *Vaghbhata* 3. *Sushruta* 4. *Sharngadhara*
279. Marmas are found described in Susruta Samhitha
 1. Sutra sthana 6th chapter 2. Sarira sthana 6th chapter
 3. Sarira sthana 10th chapter 4. Sutra sthana 10th chapter
280. Gastric pacemaker is
 1. Fundus 2. Pyloric end 3. Body 4. Cardiac end
281. Morrison's pouch is
 1. Recto uterine pouch 2. Hepato renal pouch
 3. Pituitary diverticulum 4. None of the above
282. Kidney is placed in _____ part of *Udara*
 1. Anterior 2. Posterior 3. Lateral 4. None
283. Hardest substance in the body
 1. Cement 2. Enamel 3. Periosteum 4. None
284. Tricuspid valve is present in between
 1. Right atrium and right ventricle 2. Left atrium and left ventricle
 3. Left atrium and right ventricle 4. Right atrium and left ventricle
285. Police man of abdomen is
 1. Greater omentum 2. Rectus abdominis
 3. Liver 4. Vermiform appendix
286. "Islets of langerhans" present in
 1. Thymus 2. Liver 3. Kidney 4. Pancreas
287. In liver Caudate lobe is situated on the
 1. Posterior surface 2. Inferior surface 3. Anterior surface 4. Right surface
288. The right and left lobes of the liver is separated by
 1. Round ligament 2. Falciform ligament
 3. Cruciate ligament 4. Popliteal ligament

289. The loop of henle is present in the
 1. Liver 2. Heart 3. Kidney 4. Adrenal gland
290. Bundle of His is seen in
 1. Liver 2. Heart 3. Kidney 4. Adrenal gland
291. Suspensory ligament is present in
 1. Liver 2. Heart 3. Eye 4. Adrenal gland
292. Abdominal tonsil is
 1. Liver 2. Heart 3. Kidney 4. Vermiform appendix
293. Respiratory centers are located in
 1. Medulla and pons 2. Frontal lobe
 3. Occipital lobe 4. Hypothalamus
294. Gastric ulcer occurs typically along the
 1. Greater curvature 2. Lesser curvature 3. Fundus 4. Body
295. Male accessory sex glands include
 1. Seminal vesicle 2. Bulbus urethra 3. Vas deferens 4. Prostate gland
296. Bartholins glands are present in
 1. Seminal vesicle 2. Bulbus urethra 3. Labia majora 4. Labia minora
297. Spinal cord gets nourishment from
 1. Meningeal coverings 2. Spinal fluids
 3. Both 1 &2 4. CSF
298. Canal of schlemn is seen in
 1. eye 2. ear 3. brain 4. nose
299. The length of the oesophagus is
 1. 25 cm 2. 35cm 3. 30 cm 4. 40 cm
300. The diameter of the aorta is
 1. 1/2 inches 2. 1.5 inches 3. 2 inches 4. 1 inch
301. The normal weight of the uterus
 1. 40 gm 2. 50 gm 3. 100 gm 4. 200 gm
302. The development of placenta is from
 1. foetal origin 2. Maternal origin
 3. Both 1 & 2 4. Paternal origin

303. At birth the normal umbilical cord contains

- | | |
|-------------------------|----------------------|
| 1. 2 umbilical arteries | 2. 2 umbilical veins |
| 3. Ductus venosus | 4. Vitelline duct |

304. Which is not included in hamstring muscles

- | | |
|-------------------|----------------------|
| 1. Semitendinosus | 2. Semimembranosus |
| 3. Biceps femoris | 4. Quadratus femoris |

305. Pace maker is

- | | |
|------------------|--------------------|
| 1. SA node | 2. AV node |
| 3. Bundle of His | 4. Purkinje fibres |

306. Which is not included in levator ani muscle

- | | | | |
|------------------|------------------|--------------|----------------------|
| 1. Pubococcygeus | 2. Ileococcygeus | 3. coccygeus | 4. None of the above |
|------------------|------------------|--------------|----------------------|

307. Fovea centralis contains

- | | | | |
|---------|----------|---------------|---------|
| 1. Rods | 2. Cones | 3. Both 1 & 2 | 4. None |
|---------|----------|---------------|---------|

308. The layers in cornea are

- | | | | |
|------|------|------|------|
| 1. 2 | 2. 3 | 3. 5 | 4. 6 |
|------|------|------|------|

309. Uterus is separated from rectum by

- | | |
|------------------------|---------------------|
| 1. Utero-vesical pouch | 2. Pouch of Douglas |
| 3. Morrison's pouch | 4. Hartman's pouch |

310. Fallopian tubes are derived from

- | | | | |
|-----------------|------------------|-------------------|-----------------|
| 1. Bellini duct | 2. Whartons duct | 3. Mullerian duct | 4. Wolfian duct |
|-----------------|------------------|-------------------|-----------------|

311. The distance between the cornea and retina is

- | | | | |
|---------|----------|----------|----------|
| 1. 16mm | 2. 24 mm | 3. 20 mm | 4. 30 mm |
|---------|----------|----------|----------|

312. Umbilical vein after birth changes into

- | | |
|-----------------------|-----------------------|
| 1. ligamentum venosum | 2. Ligamentum teres |
| 3. Round ligament | 4. Falciform ligament |

313. Angle of Louis is otherwise known as

- | | |
|---------------------|------------------|
| 1. Sternal angle | 2. Jugular notch |
| 3. Clavicular notch | 4. Apex beat |

314. Number of sandhis present in the *Greeva pratyurdhwa*

- | | | | |
|-------|-------|-------|-------|
| 1. 64 | 2. 59 | 3. 83 | 4. 84 |
|-------|-------|-------|-------|

315. Number of sandhis present in the *shirakapala*

- | | | | |
|------|------|------|------|
| 1. 3 | 2. 4 | 3. 5 | 4. 7 |
|------|------|------|------|

316.	Number of <i>sandhis</i> present in 1 <i>sakha</i>		
1. 17	2. 18	3. 19	4. 20
317.	Total number of <i>snayu</i>		
1. 500	2. 600	3. 700	4. 900
318.	Number of <i>snayus</i> present in 4 <i>sakhas</i>		
1. 400	2. 500	3. 600	4. 700
319.	Number of <i>snayus</i> present in <i>koshta</i>		
1. 130	2. 230	3. 330	4. 430
320.	Number of <i>snayus</i> present in <i>urdhwajatughata</i>		
1. 60	2. 70	3. 80	4. 90
321.	Teeth are included under		
1. <i>Ruchakasthi</i>	2. <i>Kapalasthi</i>	3. <i>Tarunasthi</i>	4. <i>Valayasthi</i>
322.	Number of sevanis present in <i>jihwa</i>		
1. 1	2. 2	3. 7	4. 6
323.	Number of <i>bahirmukha srotas</i> in case of male		
1. 9	2. 8	3. 11	4. 12
324.	Number of <i>bahirmukha srotas</i> in case of female		
1. 9	2. 8	3. 11	4. 12
325.	Length of intestine in case of male		
1. 3 <i>vyama</i>	2. 3.5 <i>vyama</i>	3. 2 <i>vyama</i>	4. 2.5 <i>vyama</i>
326.	Length of intestine in case of female		
1. 3 <i>vyama</i>	2. 3.5 <i>vyama</i>	3. 2 <i>vyama</i>	4. 2.5 <i>vyama</i>
327.	Formation of <i>kalala</i> takes place in		
1. 1 st month	2. 2 nd month	3. 3 rd month	4. 4 th month
328.	Formation of <i>hasta</i> , <i>pada</i> , <i>shiras</i> and 5 <i>pindika</i> takes place in		
1. 1 st month	2. 2 nd month	3. 3 rd month	4. 4 th month
329.	Manah <i>pratibuddhataram</i> occurs in		
1. 2 nd month	2. 3 rd month	3. 4 th month	4. 5 th month
330.	Origin of <i>buddhi</i> takes place in		
1. 2 nd month	2. 4 th month	3. 6 th month	4. 8 th month

331. Normal time of delivery according to Susruta
 1. 9th-12th month 2. 10-12th month
 3. 11-12th month 4. 8-10th month
332. According to shaunaka, which part of the body appears first
 1. *Shira* 2. *Hridayam* 3. *nabhi* 4. *pani & pada*
333. According to kritavirya,which part of the body appears first
 1. *Shira* 2. *Hridayam* 3. *nabhi* 4. *pani & pada*
334. Which part of the body appears first according to Parashara
 1. *Shira* 2. *Hridayam* 3. *nabhi* 4. *pani & pada*
335. Which part of the body appears first according to Markandeya
 1. *Shira* 2. *Hridayam* 3. *nabhi* 4. *pani & pada*
336. Which part of the body appears first according to Goutama
 1. *Shira* 2. *madhyama shareera*
 3. *nabhi* 4. *pani & pada*
337. Which part of the body appears first according to Dhanvantari
 1. *Shira* 2. all parts at a time 3. *nabhi* 4. *Hridaya*
338. *Stanayoh Krishna mukhata* is a sign seen during
 1. Menarche 2. Menopause
 3. During pregnancy 4. After delivery
339. Average age of menarche and menopause acc to Sushruta
 1. 12-50 2. 10-45 3. 12-45 4. 13-50
340. Duration of ritukala acc. to Susruta
 1. 4 days 2. 14 days 3. 12 days 4. 15 days
341. *Sasasrikpratimam* (rabbit blood), *na viranjayet* (which does not stain the cloth), *laksha rasaroopam* (looks like *laksha*) are related with
 1. Pure shukra 2. Pure *arthava* 3. Sign of haematuria 4. Infertile
342. Uncinate process present in
 1. Liver 2. Pancreas 3. Kidney 4. Ureter
343. Tuber omentale is related with
 1. Liver 2. Pancreas 3. spleen 4. prostate
344. Shape of pancreas is
 1. J-shaped 2. L-shaped 3. H-shaped 4. K-shaped

345 . Storage of RBC done by

- | | | | |
|-----------|----------|----------------|-----------|
| 1. Spleen | 2. Liver | 3. Bone marrow | 4. Kidney |
|-----------|----------|----------------|-----------|

346. Phagocytosis is done by

- | | | | |
|----------|-----------|-----------|-------------|
| 1. Liver | 2. spleen | 3. Kidney | 4. Pancreas |
|----------|-----------|-----------|-------------|

347. Storage of glycogen, iron, vit-A, D and fat is done by

- | | | | |
|----------|-----------|-----------|-------------|
| 1. Liver | 2. Spleen | 3. kidney | 4. pancreas |
|----------|-----------|-----------|-------------|

348. Fossa for the gall bladder present in

- | | | | |
|-------------|-----------------|----------|-------------|
| 1. Duodenum | 2. Gall bladder | 3. Liver | 4. Pancreas |
|-------------|-----------------|----------|-------------|

349. Bare area present in the

- | | | | |
|-------------|-----------------|----------|-------------|
| 1. Duodenum | 2. Gall bladder | 3. Liver | 4. Pancreas |
|-------------|-----------------|----------|-------------|

350. Right lobe of liver forms

- | | | | |
|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| 1. 5/6 th of liver | 2. 1/6 th of liver | 3. 2/6 th of liver | 4. 6/5 th of liver |
|-------------------------------|-------------------------------|-------------------------------|-------------------------------|

351. Cystic notch present in

- | | | | |
|----------|-----------------|-----------|-------------|
| 1. Liver | 2. Gall bladder | 3. Kidney | 4. Pancreas |
|----------|-----------------|-----------|-------------|

352. Synthesis of bile and prothrombin is the function of

- | | | | |
|----------|-----------------|-------------|-----------|
| 1. Liver | 2. Gall bladder | 3. Pancreas | 4. Kidney |
|----------|-----------------|-------------|-----------|

353. Vas deferens is otherwise known as

- | | | | |
|--------------------|------------------|-----------------|---------|
| 1. Ductus deferens | 2. Deferent duct | 3. Both 1 and 2 | 4. None |
|--------------------|------------------|-----------------|---------|

354. The average length of left thoracic duct and ductus deference is about

- | | | | |
|----------|----------|----------|----------|
| 1. 45 cm | 2. 50 cm | 3. 65 cm | 4. 75 cm |
|----------|----------|----------|----------|

355. Length of cervix is about

- | | | | |
|----------|-----------|-----------|-----------|
| 1. 2.5cm | 2. 3.5 cm | 3. 4.5 cm | 4. 5.5 cm |
|----------|-----------|-----------|-----------|

356. Abdominal ostium is related with

- | | | | |
|-----------|---------------|-------------------|-----------|
| 1. Uterus | 2. peritoneum | 3. Fallopian tube | 4. cervix |
|-----------|---------------|-------------------|-----------|

357. Tubectomy and vasectomy is done for

- | | | | |
|----------------|--------------|--------------------|--------------|
| 1. Infertility | 2. Pregnancy | 3. Family planning | 4. Sterility |
|----------------|--------------|--------------------|--------------|

358. Length of female urethra is about

- | | | | |
|---------|----------|---------|---------|
| 1. 3 cm | 2. 4. cm | 3. 5 cm | 4. 6 cm |
|---------|----------|---------|---------|

359. Length of male urethra is about

- | | | | |
|---------------|---------------|---------------|---------------|
| 1. 18 – 20 cm | 2. 20 – 25 cm | 3. 25 – 30 cm | 4. 30 – 35 cm |
|---------------|---------------|---------------|---------------|

360. Detrusor muscle is present in
1. Urinary Bladder 2. Uterus 3. Thorax 4. Kidney
361. Capacity of the urinary bladder in male
1. $120 = 320$ ml 2. $420 = 520$ ml 3. $520 = 620$ ml 4. $620 = 720$ ml
362. Which is the chief nerve of the perineum and external genitalia
1. Pudendal Nerve 2. Sciatic nerve
3. Vagus Nerve 4. Abducent Nerve
363. Supra Renal Gland is other wise known as
1. Kidney 2. Thyroid Gland
3. Para thyroid gland 4. Adrenal gland.
364. How many *phalanges* are present in the hand
1. 14 2. 15 3. 16 4. 17
365. How many *phalanges* are present in the thumb
1. 2 2. 3 3. 4 4. 5
366. The wind pipe is otherwise known as
1. Trachea 2. Pharynx 3. larynx 4. Oropharynx
367. First heart sound is produced by the closure of
1. Tricuspid – Bicuspid 2. Aortic – Pulmonary
3. Tricuspid – pulmonary 4. Bicuspid – Aortic.
368. Second heart sound is produced by closure of
1. Tricuspid – Bicuspid 2. Aortic – Pulmonary
3. Tricuspid – pulmonary 4. Bicuspid – Aortic.
369. Papillary muscles are present in the
1. Heart 2. Lungs 3. Liver 4. Kidney
370. The middle space left in the thoracic cavity in between the lungs is
1. Mediastinum 2. Heart 3. Pericardium 4. pleura.
371. In funnel shaped chest which is usually involved
1. Sternum 2. Heart 3. Lungs 4. pericardium.
372. Length of the sternum is about
1. $15 = 18$ cm 2. $20 = 22$ cm 3. $25 = 30$ cm 4. $30 = 32$ cm
373. Carpal tunnel syndrome usually affect
1. Radial Nerve 2. Median Nerve 3. Ulnar Nerve 4. Brachial plexus.

374. Erb's paralysis usually affect

- | | |
|-----------------|---------------------|
| 1. Radial Nerve | 2. Median Nerve |
| 3. Ulnar Nerve | 4. Brachial plexus. |

375. Which is the longest bone of the upper limb

- | | | | |
|------------|-------------|-----------|---------|
| 1. Humerus | 2. Clavicle | 3. Radius | 4. Ulna |
|------------|-------------|-----------|---------|

376. In Tennis elbow the pain usually felt in

- | | | | |
|----------------|-------------|-------------------|----------|
| 1. Elbow joint | 2. Fore arm | 3. Shoulder joint | 4. Neck. |
|----------------|-------------|-------------------|----------|

377. Opponens pollicis is related with

- | | | | |
|----------|--------------|-----------|------------|
| 1. Thumb | 2. Great toe | 3. Thorax | 4. Abdomen |
|----------|--------------|-----------|------------|

378. How many pairs of the salivary glands are present

- | | | | |
|------|------|------|------|
| 1. 2 | 2. 3 | 3. 4 | 4. 5 |
|------|------|------|------|

379. Which is the largest salivary gland

- | | | | |
|------------|-------------------|----------------|----------|
| 1. Parotid | 2. Sub mandibular | 3. Sub lingual | 4. None. |
|------------|-------------------|----------------|----------|

380. The last and lowest ventricle of the cerebrum

- | | |
|------------------------------|------------------------------|
| 1. 3 rd ventricle | 2. 4 th ventricle |
| 3. Right lateral ventricle | 4. Left lateral ventricle |

381. Which organ is coming under Digestive and Respiratory system

- | | | | |
|------------|-----------|------------|------------|
| 1. Pharynx | 2. Larynx | 3. stomach | 4. trachea |
|------------|-----------|------------|------------|

382. Average length of the pharynx

- | | | | |
|---------|----------|----------|---------|
| 1. 12cm | 2. 22 cm | 3. 32 cm | 4. 2 cm |
|---------|----------|----------|---------|

383. Which is the 2nd bone next to clavicle, to ossify in the body

- | | | | |
|------------|---------|------------|--------------|
| 1. Scapula | 2. Ribs | 3. Sternum | 4. Mandible. |
|------------|---------|------------|--------------|

384. Strangulation or throttling causes fracture of

- | | | | |
|---------------|------------|-----------|----------------|
| 1. Hyoid bone | 2. Pharynx | 3. Larynx | 4. Oesophagus. |
|---------------|------------|-----------|----------------|

385. What are the typical cervical vertebra

- | | | | |
|---------------------------------------|--|---|--|
| 1. 3 rd to 6 th | 2. 1 st , 2 nd , 7 th | 3. 2 nd , 3 rd ,4 th | 4. 5 th , 6 th , 7 th . |
|---------------------------------------|--|---|--|

386. What are the Atypical vertebra

- | | | | |
|---------------------------------------|--|---|--|
| 1. 3 rd to 6 th | 2. 1 st , 2 nd , 7 th | 3. 2 nd , 3 rd ,4 th | 4. 5 th , 6 th , 7 th . |
|---------------------------------------|--|---|--|

387. Cranial cavity contains

- | | | | |
|----------|-------------|-----------------|-----------------|
| 1. Brain | 2. Meninges | 3. Both 1 and 2 | 4. Skull bones. |
|----------|-------------|-----------------|-----------------|

388. Who is the master of Endocrine orchestra

- | | |
|------------------------|------------------------|
| 1. Pituitary | 2. Thyroid |
| 3. Posterior pituitary | 4. Anterior pituitary. |

389. The length of the optic Nerve

- | | | | |
|---------|---------|----------|----------|
| 1. 4 cm | 2. 8 cm | 3. 12 cm | 4. 14 cm |
|---------|---------|----------|----------|

390. Which cranial nerve supplies the muscles of the tongue.

- | | | | |
|----------|---------------|-----------|----------------|
| 1. Vagus | 2. Oculomotor | 3. Facial | 4. Hypoglossal |
|----------|---------------|-----------|----------------|

391. How many para nasal sinus are present in the nasal cavity

- | | | | |
|-------|------|------|-------|
| 1. 2. | 2. 4 | 3. 5 | 4. 6. |
|-------|------|------|-------|

392. How many cartilages are present in larynx.

- | | | | |
|------|------|-------|------|
| 1. 7 | 2. 9 | 3. 10 | 4. 6 |
|------|------|-------|------|

393. How many paired and unpaired cartilages are present

- | | | | |
|----------|----------|----------|-----------|
| 1. 3 – 3 | 2. 2 – 2 | 3. 2 – 3 | 4. 3 – 2. |
|----------|----------|----------|-----------|

394. How many papillae are present in the tongue.

- | | | | |
|------|------|------|------|
| 1. 1 | 2. 2 | 3. 3 | 4. 7 |
|------|------|------|------|

395. Who is separating the external acoustic meatus and the middle ear.

- | | |
|--------------------|----------------------|
| 1. Inner ear | 2. Ear ossicles |
| 3. tympanic antrum | 4. tympanic membrane |

396. The saccule and utricle related to

- | | |
|-----------------|----------------------|
| 1. External ear | 2. Middle ear |
| 3. Inner ear | 4. Tympanic membrane |

397. Which cranial nerve supplies the Inner ear.

- | | | | |
|--------------------|--------------------|--------------------|---------------------|
| 1. 7 th | 2. 8 th | 3. 9 th | 4. 10 th |
|--------------------|--------------------|--------------------|---------------------|

398. Ophthalmic nerve originates from

- | | | | |
|----------|---------------|-----------|---------------|
| 1. Optic | 2. oculomotor | 3. Facial | 4. Trigeminal |
|----------|---------------|-----------|---------------|

399. Maxillary nerve is originated from

- | | | | |
|----------|---------------|-----------|---------------|
| 1. Optic | 2. oculomotor | 3. Facial | 4. Trigeminal |
|----------|---------------|-----------|---------------|

400. Mandibular nerve is originated from

- | | | | |
|----------|---------------|-----------|---------------|
| 1. Optic | 2. oculomotor | 3. Facial | 4. Trigeminal |
|----------|---------------|-----------|---------------|

ANSWERS

1	2	35	3	69	4	103	4
2	3	36	2	70	1	104	1
3	2	37	4	71	1	105	4
4	4	38	1	72	4	106	1
5	2	39	1	73	1	107	2
6	1	40	2	74	1	108	3
7	1	41	2	75	2	109	1
8	4	42	3	76	3	110	3
9	2	43	4	77	1	111	1
10	4	44	1	78	4	112	4
11	2	45	2	79	2	113	4
12	4	46	3	80	3	114	4
13	4	47	3	81	2	115	2
14	1	48	4	82	3	116	1
15	3	49	3	83	4	117	1
16	2	50	4	84	4	118	1
17	1	51	3	85	4	119	1
18	4	52	1	86	2	120	2
19	2	53	3	87	1	121	1
20	1	54	4	88	1	122	1
21	3	55	3	89	2	123	4
22	1	56	4	90	2	124	1
23	3	57	2	91	3	125	1
24	2	58	4	92	2	126	3
25	1	59	1	93	4	127	4
26	4	60	1	94	1	128	4
27	2	61	2	95	2	129	1
28	2	62	1	96	3	130	1
29	1	63	1	97	1	131	1
30	1	64	3	98	3	132	4
31	4	65	3	99	4	133	4
32	2	66	3	100	3	134	1
33	3	67	2	101	4	135	1
34	3	68	3	102	4	136	1

137	1	173	1	209	2	245	3
138	1	174	1	210	3	246	2
139	2	175	4	211	2	247	3
140	1	176	2	212	2	248	2
141	2	177	1	213	3	249	2
142	4	178	2	214	4	250	4
143	3	179	1	215	4	251	3
144	2	180	2	216	3	252	1
145	1	181	3	217	2	253	2
146	3	182	3	218	2	254	1
147	4	183	2	219	2	255	3
148	3	184	1	220	3	256	1
149	1	185	3	221	3	257	1
150	2	186	3	222	4	258	4
151	2	187	2	223	3	259	1
152	2	188	1	224	4	260	2
153	3	189	1	225	1	261	1
154	3	190	2	226	1	262	1
155	4	191	3	227	1	263	4
156	2	192	1	228	4	264	3
157	3	193	2	229	4	265	3
158	4	194	1	230	1	266	4
159	2	195	1	231	2	267	3
160	4	196	2	232	3	268	4
161	4	197	2	233	2	269	1
162	4	198	3	234	1	270	1
163	4	199	1	235	1	271	3
164	1	200	3	236	1	272	1
165	1	201	3	237	4	273	2
166	1	202	1	238	2	274	3
167	3	203	1	239	1	275	3
168	1	204	3	240	2	276	2
169	4	205	4	241	1	277	4
170	4	206	3	242	2	278	2
171	2	207	3	243	2	279	2
172	3	208	2	244	3	280	1



COLLECTION OF VARIOUS
→ HINDUISM SCRIPTURES
→ HINDU COMICS
→ AYURVEDA
→ MAGZINES

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281	2	311	2	341	2	371	1
282	2	312	2	342	2	372	1
283	2	313	1	343	2	373	2
284	1	314	3	344	1	374	4
285	1	315	3	345	1	375	1
286	4	316	1	346	2	376	1
287	1	317	4	347	1	377	1
288	2	318	3	348	3	378	2
289	3	319	2	349	3	379	1
290	2	320	2	350	1	380	2
291	3	321	1	351	1	381	1
292	4	322	1	352	1	382	1
293	1	323	1	353	3	383	4
294	2	324	4	354	1	384	1
295	4	325	2	355	1	385	1
296	3	326	1	356	3	386	2
297	3	327	1	357	3	387	3
298	1	328	3	358	2	388	1
299	1	329	4	359	1	389	1
300	4	330	3	360	1	390	4
301	1	331	1	361	1	391	2
302	1	332	1	362	1	392	2
303	1	333	2	363	4	393	2
304	4	334	3	364	1	394	3
305	1	335	4	365	1	395	4
306	3	336	2	366	1	396	3
307	2	337	2	367	1	397	2
308	3	338	3	368	2	398	4
309	2	339	1	369	1	399	4
310	3	340	3	370	1	400	4