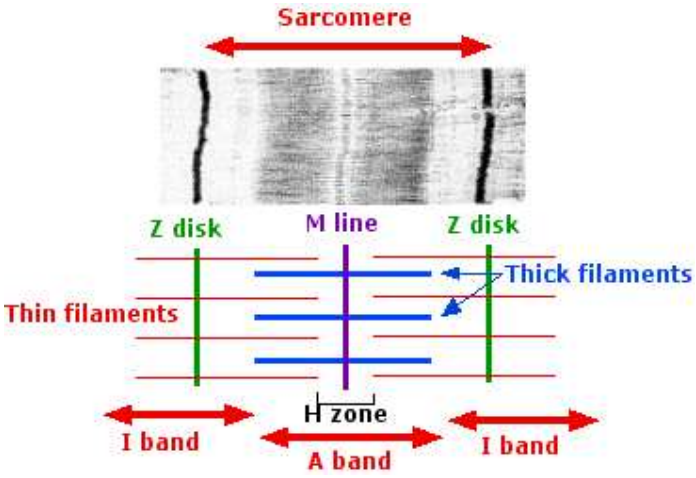
RABBIT- FUNCTIONAL ANATOMY - II

Musculo Skeletal System

Very Short Answer Questions

1. What is Sarcomere?

Ans. The length of myofibril present between two successive 'Z' lines is sarcomere.
An anisotropic band (A) with parts of isotropic bands (I) on either side are present in a Sarcomere.



2. Name different types of muscles found in a vertebrate body. Which of them are described as skeletal muscles?

Ans. The various types of muscles found in vertebrate body are :
(1) Striated muscles, (2) Unstriated muscles or smooth muscles, (3) Cardiac muscles.
Striated muscles are described as skeletal muscles.

3. Which substances are present thick and thin filaments?

Ans. Each Thick filament is made of 200 myosin molecules.
Each Thin filament composed of proteins i.e., actin, tropomyosin and troponin.

4. What is the substance that accumulates in an actively contracting muscle?

Ans. Lactic acid is the substance that accumulates in the actively contracting muscle. It causes muscle fatigue.

5. In which part of the muscle fibre, Calcium ions are stored?

Ans. Calcium ions are stored in the cisternae of sarcoplasmic reticulum of myofibril.

6. What is triad system in a skeletal muscle?

Ans. In a skeletal muscle the transverse tubule with terminal cisternae of sarcoplasmic reticulum on either side together from the triad system.

7. How much of lactic acid formed during muscle contraction becomes glycogen?

Ans. 80% of the lactic acid is converted into Glycogen in the liver. Remaining 20% of lactic acid is oxidized as Carbon dioxide and water. These events are known as Cori cycle.

8. What are the substances that accumulate in a muscle during fatigue?

Ans. lactic acid.

9. What are the components of the appendicular skeleton?

Ans. Bones of girdles and limbs are the components of appendicular skeleton.

10. Name the bone found in the ramus of lower jaw of rabbit.?

Ans. Lower jaw formed by two equal halves known as rami.
Each ramus is formed by a single, large bone called denary.

11. Write the digital formula of forelimb of rabbit.

Ans. The digital formula of forelimb of rabbit is 2-3-3-3-3.

12. What is a squamosal bone?

Ans. The occipital and parietal regions on the lateral side are separated by squamosal bone. It belongs to upper jaw.

13. Name the bones associated with the occipital region of cranium in the skull of rabbit.?

Ans. Occipital region is the posterior region of cranium in skull.
It has the bones like a) one dorsal Suproccipital
b) one ventral basioccipital
c) Two lateral exoccipitals.

14. Why is the skull of rabbit called dicondylic?

Ans. Rabbit skull has two occipital condyles. So it is called as dicondylic skull.

15. What is called the rib of rabbit double headed?

Ans. A rib of the rabbit is double headed.
Rib has two heads like tuberculum and capitulum.

16. Name the bones associated with olfactory capsule.?

Ans. The bones associated with olfactory capsules in rabbit are
a)Dorsal --- a pair of Nasals
b)Lateral --- premaxillae, maxillae and palatine bones of upper jaw.
c)ventrally --- Vomers.
Mesethmoid is vertical partition that separates olfactory capsules in to left and right parts.

17. What is cribriform plate? Write its significance.

Ans. Anterior margin of the cranial cavity is closed by a vertical bone known as cribriform plate.
It separates cranial cavity from olfactory capsules.

18. Distinguish between atlas and axis.

Ans.

Atlas	**Axis**
1. It is first vertebra of vertebral column	1. It is second vertebra
2. It consists of a large neural arch but reduced neural spine and centrum.	2. Neural spine is laterally compressed and ridge-like.
3. Wide upper neural canal with spinal cord and a small lower odontoid canal with odontoid process of axis.	3. It bears a peg-like odontoid process on centrum on which atlas rotates.
4. Zygapophyses are absent.	4. pre-zygapophyses are absent./

19. Write the importance of sternum in the axial skeleton of rabbit.

Ans. It is long and slender structure located on the mid ventral line.
Thorax of rabbit is bounded mid-ventrally by the sternum.

20. Name the three bones in the middle ear of rabbit.

Ans. The middle ear of rabbit consists of a chain of three bones,
(a) malleus, (b) incus and (c) stapes.

21. What is Zygomatic arch in the skull of rabbit? How is it formed?

Ans. A flat process form the posterior part of each maxilla passes backwards and joins with a squamosal and form the Zygomatic arch.

22. What are floating ribs?

Ans. Last three to four false ribs are not connected with the sternum and thus free ventrally. Hence they are known as floating ribs.

23. Distinguish between carpals and metacarpals.

Ans. Carpals are bones wrist of fore limb. They are 8 in number. They are

a) Proximal row -- radiale, intermedium and ulnare
b) Distal row --Trapezium, trapezoid, Centrale, Os magnu unciform

Metacarpals are the bones of palm. They are 5 long and slender bones..

24. Name the bones present in the upper arm and lower arm of the Fore limbs in rabbit.

Ans. In rabbit upper arm is supported by a long, stout bone called humerus. The lower arm of the forelimb is supported by radius and ulna.

25. Distinguish between tarsals and metatarsals.

Ans.i) Tarsals are 6 bones in three rows that support the Ankle.
ii) Instep is supported by four long and slender bones called metatarsals.

26. Name the bone present in the thigh and shank of the hind limb of rabbit.

Ans. Thigh is supported by a long and stout bone called femur.
Shank contains two bones are called, tibia and fibula. Tibia is the longest bone in the body. Fibula is a thin and weak bone.

27. Write the digital formula of hind limb of rabbit.

Ans. the digital formula of hind limb of rabbit is 0-3-3-3-3.

28. Define the term joint.

Ans. The junction between the ends of two bones is called a joint.

29. Name the fluid present in the joint capsule. What is its function?

Ans. Synovial fluid is present in the joint capsule.
It acts as a lubricant and prevents the friction and allows free movement of bones.

30. What type of movement is allowed by a pivotal joint? Give an example.

Ans. A pivotal joint causes rotatory movement.
Ex. In neck, the joint between the atlas (first vertebrae) and axis (second vertebrae). Axis has a peg like as odontoid process.

31. Which joint allows free movement in more than one plane? Give two examples for that type of joint.

Ans. Free movement in more than one plane is exhibited by Ball and Socket joint.
Ex. Shoulder joint, Hip joint.

32. Where are ginglymoid joints found in a mammalian body?

Ans. Ginglymoid joints or Hinge joint are found at
(1) Elbow joint, (2) Knee joint, (3) Joints of phalanges of digits. (i.e. fingers and toes)

33. On the functional basis, what are the different types of joints?

Ans. On the functional basis joints are divided into (1) Synarthroses (immovable), (2) Amphiarthroses (slightly movable) and (3) Diarthroses (freely movable).

34. Distinguish between synchondroses and syndesmoses.?

Ans. Synchondroses are slightly movable joints.
Syndesmoses are the immovable joints.

35. Distinguish between fibrous joints and cartilaginous joints.

Ans. Fibrous joints do not have synovial cavity. Articulating bones are held together closely by the dense fibrous connective tissue.
Cartilagenous joints lack the synovial cavity. Articulating regions are connected by either hyaline or fibrous cartilage.

<u>Short Answer Questions</u>

1. **Describe various types of movable joints in a mammalian body? Give suitable examples.**

Ans. Freely movable joints are considered as Diarthroses. They are:

a) Ball and Socket joint
b) Hinge joint (ginglymi)
c) Pivot joint
d) Saddle joint
e) Planar joint
f) Condyloid joint

a) Ball and Socket Joint:

-- In this type of joint, the head of one bone is ball like and fits into a socket or concavity of other.

-- It is a **Multiaxial diarthrose.**

-- Movement is angular and rotation. This joint allows free movement in more than one plane.

E.g. 1. Shoulder joint between head of humerus and glenoid cavity of pectoral girdle at shoulder.

2. Hip joint between head of femur and acetabulum at hip.

b) Hinge joint (ginglymi) : A protuberance (a condyle) at the end of one bone fits into a corresponding depression of the other.

--- It is a **monoaxial diarthrose.**It allows only the angular movement.

E.g. 1. Elbow joint: between radius- ulna of fore arm and humerus of upper arm at elbow.

2. Knee joint : between tibia-fibula of shank and femur of thigh at knee.

3. Joints of phalanges of digits (i.e. fingers and toes)

c) Pivot joint: One of the bones is fixed in its place and has a peg like elevation called **pivot.** The other bone fits over the pivot by a concavity and rotates freely around.

It is a Monoaxial diarthrose. Movement is rotation.

E.g. In neck, the joint between the atlas and axis.

Axis has a peg like **odontoid process** on which atlas rotates freely.

d) <u>Saddle joint</u> : Articular surface of one bone is saddle shaped. Articular surface of another bone sits into the saddle.

It is **biaxial diarthrose**. The movement is angular motion.

This joint is present only in primate mammals.

E.g. Joint between carpal and metacarpal of thumb. Hence the thumb enjoys greater freedom of movement than the other fingers.

e) <u>Planar joint</u> : In this type, articular surfaces of bones are flat or slightly curved.

It is **nonaxial diarthrose**. The motion is gliding.

This joint allows restricted movement in different planes.

E.g. 1. Joints between carpals (wrist bones)

2. Joints between tarsals (ankle bones),

3. Joints between the zygapohyses of successive vertebrae.

f) Condyloid joint: Articular surface of one bone is oval shaped.

It fits into the oval shaped depression of the other bone.

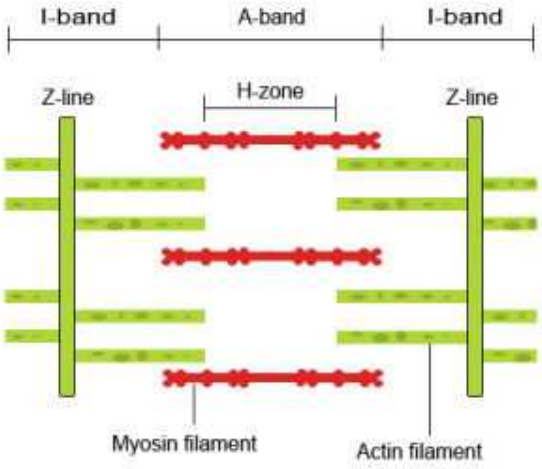
It is **biaxial diarthrose**. The movement is angular motion.

E.g. Radiocarpel and metacarpophalangeal joints.

2. Describe the structure of a sarcomere with a labeled diagram.?

Ans. **Structure of a sarcomere :**

- Myofibrils are the units of muscle tissue. The part of myofibril between two succuessive Z – lines of 'I' band is known as Sarcomere.
- Sarcomere is formed by thick and thin myofilaments. It has a complete dark band (A) and two halves of two different (I) Light Bands.



SARCOMERE

- Dark band or anisotropic band or A – band has thick and thin filaments. Middle of A – band has a paler zone known as Hensen's disc or H – zone. H-zone has thick filaments only. But the sides of A – band are overlapped by both thick and thin filaments. So H – zone is paler. Thick filaments are formed by myosin moleculs. H – Zone has M – line in the centre.
- Light band or Isotropic band or I – band has has thin filaments only. Thin filaments are composed of proteins like Actin, Tropomyosin and Troponin. Troponin has 3 subunits like T_nC, T_nT and T_nI.
- Each Myosin molecule has 6 polypeptide chains – 2 heavy and 4 light chains.

3. What are the biochemical changes that occur in a muscle during contraction?

Ans. **i) Bio-chemical changes:**

1) ATP is the immediate source for energy for the contraction of Muscle.
This energy is used in muscle contraction process.

ATP ➔ ADP + Pi

2) Phosphagen :

As the ATP content is very low, it is actively replenished by an energy rich muscle phospagen. It donates energy phosphate group to ADP. In vertebrates, muscle phosphagen in Creatine phosphate (CP).

CP is the immediate additional source of energy in muscle.

Creatine phosphate + ADP ➔ ATP + Creatine

This ATP is used in muscle contraction.

3) **<u>Oxidation of glucose and fatty acids</u>**.

When creatine phosphate gets exhausted, the next source of reserve energy is utilized. It is oxidation of glucose and fatty acids.

The energy liberated in this process is transferred to ADP and creatine. Thus ATP and CP are formed

MUSCLE FATIGUE:

During rapid activity of muscle, oxygen debt occurs (shortage of oxygen supply). It leads to anaerobic respiration of glycogen of muscle. Pyruvic acid is converted into lactic acid. Accumulation of Lactic acid leads to muscle fatigue. 80% of lactic acid is converted into glycogen by liver. 20% of lactic acid is oxidized into CO_2 and water in liver. It is explained by Cori cycle.

4. Describe the structure of a movable joint with the help of a diagram.

Ans. Movable joints are also known as synovial joints. The three components of synovial joints are **articular capsule, synovial fluid, accessory ligaments** and **articular disc**.

A) Articular capsule: It surrounds the synovial cavity. Articular capsule is made up of two layers.

The outer is the **fibrous dense irregular connective tissue** that connects the periostea of two bones. This layer contains the ligaments also. The strength of the ligaments holds the bones together.

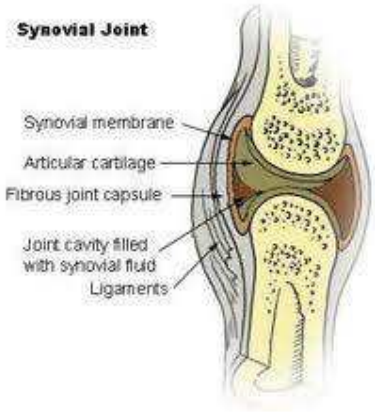
The inner layer is the **synovial membrane**. It consists of epithelium, areolar tissue with elastic fibres.

B) Synovial fluid: The synovial membrane secretes synovial fluid. It contains phagocytic cells, hyaluronic acid and interstitial fluid.

It performs phagocytosis, reduces the friction and supplies the nutrients to articular cartilage. The ends of articulating bones are covered by hyaline cartilage.

C) Accessory Ligaments and Articular discs: Many synovial joints also contain accessory ligaments. These joints contain the articular discs called **menisci** that divide the synovial cavity into

Separate spaces.



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5. Describe the structure of pectoral girdle of rabbit.

Ans. . Pectoral girdle supports forelimbs and protects the soft parts.

- Pectoral girdle in rabbit is formed by scapula and clavicle.
- Scapula is thin, flat and triangular bone with apex dpwnwards and forwards and the base facing upwards and backwards.
- The dorsal surface of scapula bears a longitudinal ridge known as Acromial spine. This spine continued downwards as acromion proess that gives the metacomion process.

- The apex has a socket called glenoid cavity. The head of HUMERUS is articulated in this cavity and form a ball and socket joint.
- The base of scapula bears a cartilaginous supra-scapula.
- Clavicle is a slender and cruved bone attached to the manubrium of sternum with ligaments on one side and the other end is attached to acromion process of scapula.
- Anterior border of scapula is coracoids border and the posterior border is glenoid border.

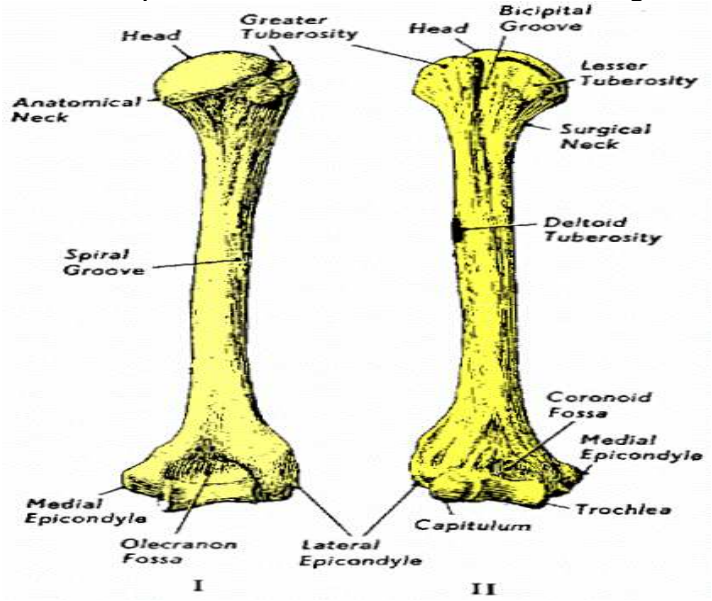
6. Explain the skeleton of forelimb of rabbit.

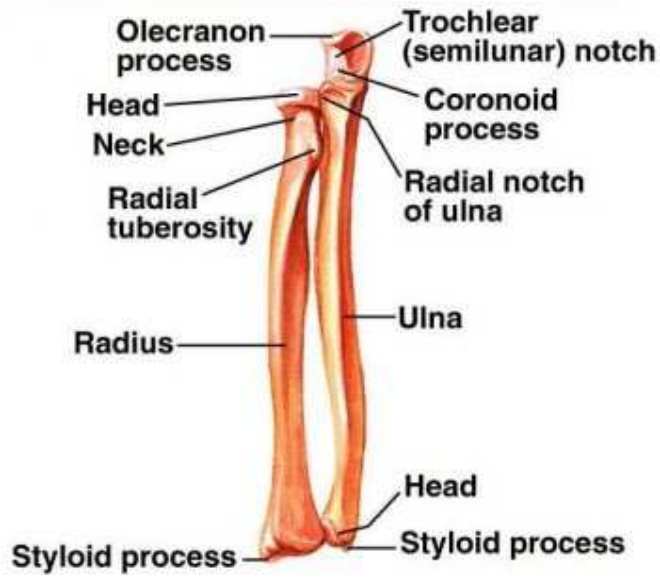
Ans. Forelimb of rabbit has the following parts:

a) Upper arm - Humerus
b) Fore arm - Radius-Ulna
c) Hand i) Wrist - Carpals
ii) Palm - Metacarpals
iii) Fingers -- Phalanges

a) **HUMERUS**: It is a long, stout bone of upper arm.

- Its proximal end has round head which is articulated with glenoid cavity and form the shoulder joint.
- Proximal end has bicipital groove and tubercles also.
- Its distal end has the outer pulley like Trochlea and the inner Capitulum, supratrochlear foramen and coronoid fossa on anterior side and Olecranon fossa on the posterior side.
- Trochlea is bordered by epicondyles.
- Middle part of humerus is Shaft with Deltoid ridge.





b) **RADIUS—ULNA** :

- These are the bones of the forearm.
- They are long, slender, slightly curved bones and firmly attached with one another long their length.
- Radius is shorter than ulna. Its proximal end articulates with trochlea of humerus.
- Ulna is prolonged beyond the radius roxiamally as an Olecranon process.
- Ulna has sigmoid notch which articulates with trochlea of humerus and form the elbow joint.
- Epiphyses of radius and ulna articulate with carpals distally.

c) **CARPALS:** These are the bones of wrist. They are 8 in number present in two rows.

- Proximal row has Radiale, Intermedium and Ulnare.
- Distal row contains Trapezium, Trapezoid, Centrale, Os magnum and Uniform.
- Wrist contains a small sesamoid bone pisiform bone which articulates with ulna and ulnare.

METACARPALS: These are five long and slender bone of palm.

PHALANGES: These are the bones of fingers or digits.
The first digit (Pollex) has two phalanges and the remaining four digits have three phalanges each.

DIGITAL FORMULA OF FORELIMB IS 2 – 3 -3 -3 -3.
*** Small sesamoid bones are present underside of the metacarpal and phalangeal joints and in between the 2nd and 3rd phalanges. They provide additional strength for burrowing by forelimbs.

Long Answer Questions

1. Describe in detail sliding filament theory with the help of neat labeled diagrams.

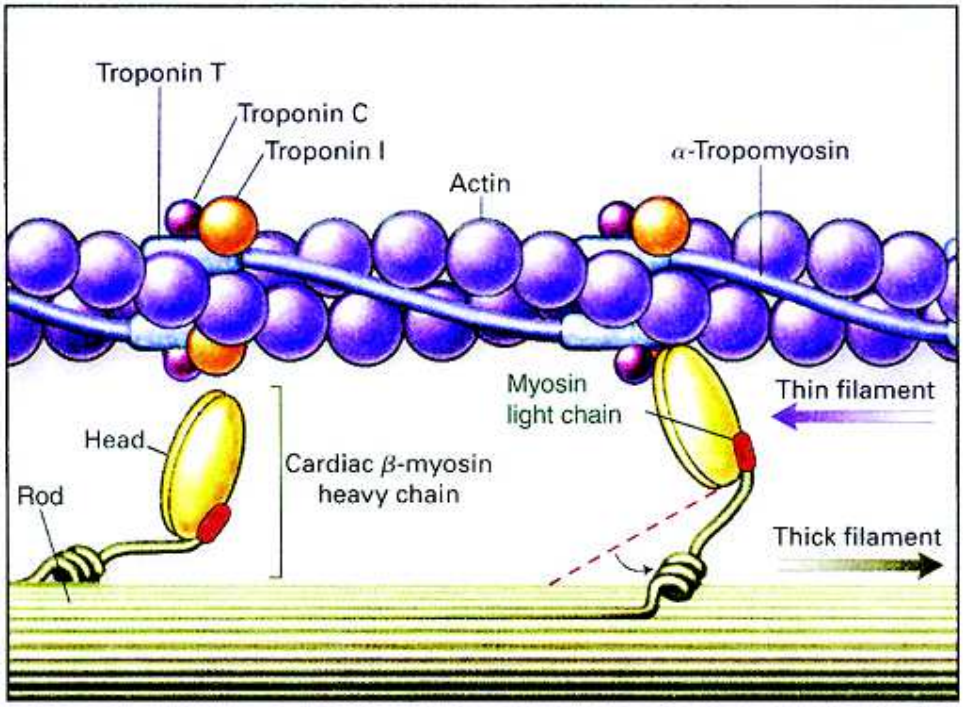
Ans. **I. Sliding Filament Hypothesis :** The sliding filament hypothesis of muscle contraction was put forth by Hugh Huxley and Hanson (1965).. During muscle contraction, thin filaments slide over the thick filament resulting in shortening of sarcomere. A series of events takes place during this process.

II. Stimulation of Muscle:

1. When a nerve impulse reaches the neuromuscular Junction, the sarcolemma of the muscle cell gets depolarized.
2. The depolarization extends into the T-tubule and cisternae of sarcoplasmic reticulum.
3. Hence Ca^{++} ions release into the sarcoplasm from cirternae of sarcoplasmic reticulum. These calcium ions diffuse into the thin laments.

III. Contraction of Muscle :

1. The Ca^{++} ions bind to the T_nC of troponin protein in the thin filament.
2. Binding of Ca^{++} to T_nC shifts the troponin-tropomyosin complex. So that, active sites are exposed in this filaments. The increase in the concentration of calcium ions causes the conformational changes in the myosin that permit the binding of myosin to the thin filament at active site.
3. In the absence of ATP, myosin head binds to the thin filament at the active site tightly and form the actomyosin complex.When ATP binds to the pocket of the myosin head, this bond weakens, ATPase present in the head of myosin filament hydrolyses the ATP. Hydrolysed ATP causes conformational changes in the head of myosin, so that head of myosin moves to a new position and recombines with the another active site of thin filament.



4. Actin-myosin-complex at the active site releases inorganic phosphorus. It swings the cross bridge towards the H-zone. It is called power stroke. Thin filament slides over the myosin filament. This power stroke is followed by the release of ADP. The conformation of myosin, which is with a pocket for ATP and tightly bound to the active site, is restored.

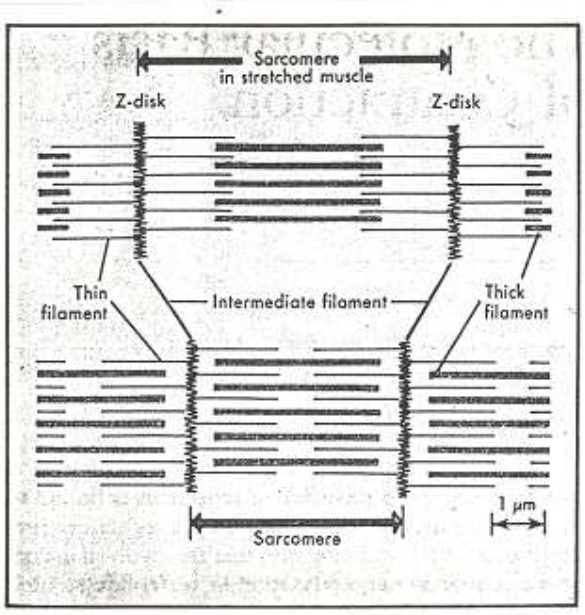
IV. Relaxation of Muscle:

1. Ca^{++} ions detach from the thin filaments and diffuse toward the sarcoplasmic reticulum.
2. Troponin permits the tropomyosin to cover the active site of thin filament.
3. Myosin-action cross bridges break.

The swinging movements and the attachment and detachment of the heads of cross bridge from action filaments is termed as rachet mechanism, which forms the basis of sliding filament hypothesis. It is also called walk along mechanism.

In the process of muscle contraction

a) there is no change in the length of A band
b) I band and H zone decrease in size or disappear.



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i) Bio-chemical changes:

1) ATP is the immediate source for energy for the contraction of Muscle.
This energy is used in muscle contraction process.

ATP ➔ ADP + Pi

2) **Phosphagen** :

As the ATP content is very low, it is actively replenished by an energy rich muscle phospagen. It donates energy phosphate group to ADP. In verterbrates, muscle phosphagen in Creatine phosphate (CP).

CP is the immediate additional source of energy in muscle.

Creatine phosphate + ADP ➔ ATP + Creatine

This ATP is used in muscle contraction.

3) <u>Oxidation of glucose and fatty acids</u>.

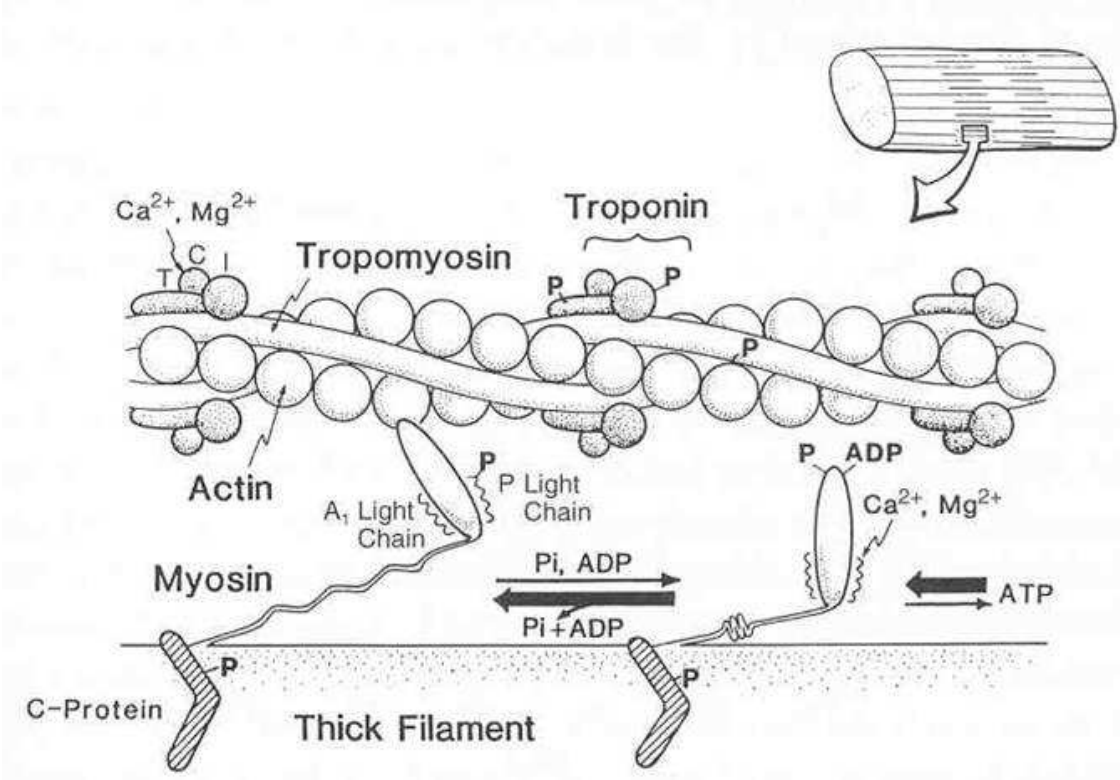
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MUSCLE FATIGUE:

During rapid activity of muscle, oxygen debt occurs (shortage of oxygen supply). It leads to anaerobic respiration of glycogen of muscle. Pyruvic acid is converted into lactic acid. Accumulation of Lactic acid leads to muscle fatigue.

80% of lactic acid is converted into glycogen by liver. 20% of lactic acid is oxidized into CO_2 and water in liver. It is explained by Cori cycle.



2. What a joint? Describe in detail various types of joints found in the mammalian body.

Ans. A joint is an articulation or arthrosis between two bones to facilitate movement. structurally joints are classified into fibrous joints, cartilaginous joints and synovial joints.

1. **Fibrous Joints:** These joints do not have synovial cavity. Articulating bones are held together closely by dense fibrous fibrous connective tissue. These are **sutures, syndesmoses** and **gomphoses**.

   a) SUTURES --- present in skull. Thin layer of dense fibrous Connective tissue connects the two flat bones.
   e.g.,Coronal suture between parietal and frontal bones

   b) SYNDESMOSES: the distance between the articulating bones is filled with fibrous connective tissue.
   e.g.,anterior tibiofibular ligament between tibia and fibula.

   c) GOMPHOSES: Cone shaped peg of one is articulates with socket of another bone by fibrous connective tissue.
   e.g., Dentoalveolar joint.

2. **Cartilaginous Joints:** They also lack synovial cavity. It allows little or no movement. Articulating regions are connected by either hyaline cartilage or fibrous cartilage. These are **synchondroses** and **symphyses.**

a) SYNCHONDROSES: Hyaline cartilage connects two articulating bone.
e.g.,epiphyseal plate which connects the epiphysis with diaphysis during growth.

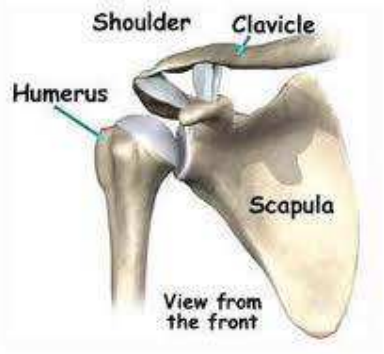
b**) SYMPHYSES**: ends of bone are covered with hyaline cartilage. Broad disc of fibrous cartilage connects the two articulating bones.
e.g., Pubic symphysis at hip, intervertebral discs.

3. **Synovial Joints:**

Freely movable joints are considered as Diarthroses. They are :

a) Ball and Socket joint
b) Hinge joint (ginglymi)
c) Pivot joint
d) Saddle joint
e) Planar joint
f) Condyloid joint





The shoulder joint

a) Ball and Socket Joint :

-- In this type of joint, the head of one bone is ball like and fits into a socket or concavity of other.

-- It is a **Multiaxial diarthrose.**

-- Movement is angular and rotation. This joint allows free movement in more than one plane.

E.g. 1. Shoulder joint between head of humerus and glenoid cavity of pectoral girdle at shoulder.

2. Hip joint between head of femur and acetabulum at hip.

b) Hinge joint (ginglymi): A protuberance (a condyle) at the end of one bone fits into a corresponding depression of the other.

--- It is a **monoaxial diarthrose.**It allows only the angular movement.

E.g. 1. Elbow joint : between radius- ulna of fore arm and humerus of upper arm at elbow.

2.Knee joint : between tibia-fibula of shank and femur of thigh at knee.

3. Joints of phalanges of digits (i.e. fingers and toes)

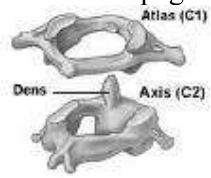


c) Pivot joint: One of the bones is fixed in its place and has a peg like elevation called **pivot.** The other bone fits over the pivot by a concavity and rotates freely around.

It is a Monoaxial diarthrose. Movement is rotation.

E.g. In neck, the joint between the atlas and axis.

Axis has a peg like **odontoid process** on which atlas rotates freely.

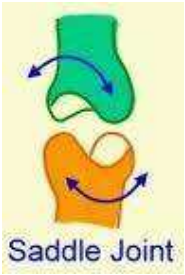


d) <u>Saddle joint</u>: Articular surface of one bone is saddle shaped. Articular surface of another bone sits into the saddle.

It is **biaxial diarthrose**. The movement is angular motion.

This joint is present only in primate mammals.

E.g. Joint between carpal and metacarpal of thumb. Hence the thumb enjoys greater freedom of movement than the other fingers.



e) <u>Planar joint</u>: In this type, articular surfaces of bones are flat or slightly curved.

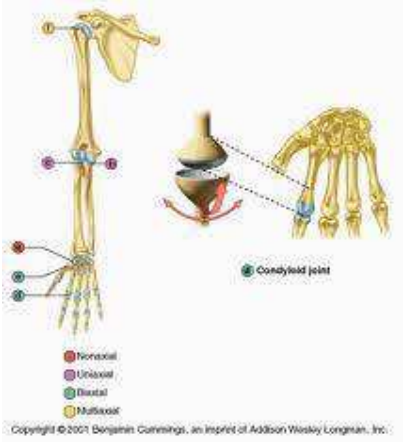
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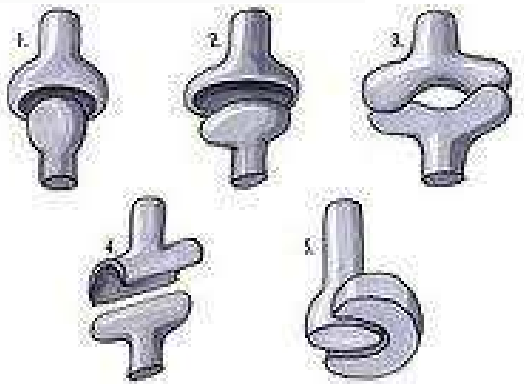
E.g. 1. Joints between carpals (wrist bones)

2. Joints between tarsals (ankle bones),

3. Joints between the zygapohyses of successive vertebrae.

f) Condyloid joint: Articular surface of one bone is oval shaped.
It fits into the oval shaped depression of the other bone.
It is **biaxial diarthrose**. The movement is angular motion.
E.g. Radiocarpel and metacarpophalangeal joints.

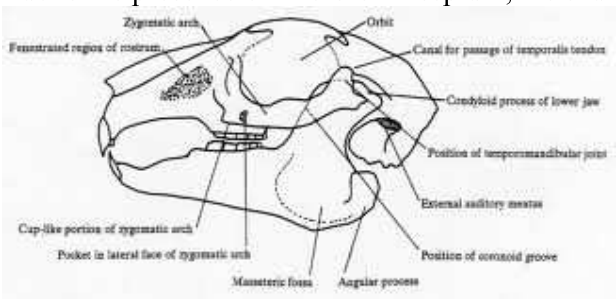




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3. Explain the structure of skull of rabbit.

Ans. The skull is dicondylic and tropibasic in rabbit.
Due to the presence of interorbital septum, the skull is tropibasic.



Skull is divided into five parts.
(A) Cranium, (B) Sense capsule, (C) Upper jaw, (D) Lower Jaw and (E) Hyoid apparatus.

A) Cranium: It is box like part and protects the brain. At the posterior side the cranium has wide opening called foramen magnum through which spinal card emerges out.
Foramen magnum is surrounded by four bones, supraoccipital, basioccipital and exoccipitals.
Roof of the cranium is formed by a pair of frontals anteriorly and a pair of parietals and a single interparietal posteriorly.

Floor of cranium is formed by a pre-sphenoid anteriorly and a basisiphenoid posteriorly.

The alisphenoids and orbitosphenoids form the sides of each cranium.

B) Sense capsule: sense capsules protect sense organs..

These are of three types.

(1) Olfactory capsule, (2) Optic capsule and (3) Auditory capsule.

1) **Olfactory capsule :** These capsules enclose the organs of smell. These are located in front of the cranium. They are dorsally bound by a pair of nasals. Laaterally by bones of uppr jaw like premaxillae, maxillae and palatines and ventrally by vomers.

Mesethmoid separates both olfactory capsules.

2) **Optic capsule:** These capsules round the eyes. They are present either side of the cranium. The inter-orbital septum formed by orbitosphenoids and presphenoid. Each orbit is dorsally bound by a frontal, anteriorly by maxillae and lacrimal . posteriorly by squamosal and alisphenoid and externally by zygomatic arch.

3) **Auditory capsule :** They enclose the hearing organs on posterior lateral parts of cranium. Each auditory capsule consists of a single bone called periotic. It is formby the fusion of pootic, opisthootic and epootic bones of embryo. It has two small apertures like anterior fenestra ovalis and posterior fenestra rotunda. The middle ear has three bones, (a) malleus, (b) incus and (c) stapes. Tympanic bone lies outside each periotic bone.

C) Upper jaw : Upper jaw consists of two halves bones called rami. The other bones are palatine, pterygoids and squamosal.

Premaxilla contain incisors. Maxilla lies behind pre-maxilla. Posteriorly, maxilla bears pre molars and molars. Between incisors and premolars, wide gap is present called diastema. It occurs due to the absence of canines.Palatine is a thin bone that lies behind maxilla. Squamosal lies on lateral sides of cranium.

D) Lower jaw : Lower jaw is also formed by two equal halves called rami. Each ramus is formed a large bone called dentary. It possess incisors anteriorly and premolars and molars posteriorly.

E) Hyoid apparatus : It lies in the floor of buccal cavity. It has median bony plate called basihyal and two pairs of anterior cornua and posterior cornua.

4. Describe different vertebrae found in rabbit.

Ans. The rabbit vertebral column consists of

(1) Cervical vertebrae, (2) Thoracic vertebrae, (3) Lumber vertebrae, (4) Sacral vertebrae and (5) Caudal vertebrae.

1) **Cervical vertebrae :** These are present in neck region

i) The first cervical vertebra is atlas. It has a wide neural canal. Anteriorly Centrum has two concavities to accommodate the occipital condyles of skull.

ii) The second cervical vertebra is axis. It has an odontoid process on Centrum, on which atlas rotates. There are no zygapophyses.

iii) The cervical vertebrae from third to sixth have two transverse process each.

iv) Seventh cervical vertebrae has a longer neural spine.

2) **Thoracic vertebrae :** Thoracic vertebrae are modified for articulation with ribs.

i) First nine thoracic vertebrae have long slender and backwardly directed neural spins. Transverse process is short and horizontal and have tubercular facets.. Centrum has capitulars demi facet at both ends.

ii) The remaining thoracic vertebrae have short and neural spines.

Centrum a complete caitualr facet. Transverse processes lack tubercular facets. Anterior ends have Metaophyses.

3) **Lumbar vertebrae : they are large and stout.** their size increases towards posterior side.The last but one is the argest.. Neural spines face forwards. Transverse process are directed forwards. Prezygophyses and postzygophysis are present.

   Centrum of first two to three lumbar vertebre have hypapophysis.

4) **Sacral vertebrae :** All sacral vertebrae are fused to form a single bone called sacrum. It support the pelvic girdle.
5) **Caudal vertebrae :** Caudal vertebrae are present in caudal region. They gradually decrease in size. Neural arches disappear towards posterior side. Neurla spiones are directed backwards.

Rabbit Excretory System

Very Short Answer Questions

1. **Differentiate vertebrates on the basis of nitrogenous waste products giving examples.**

Ans. Vertebrates are divided into three categories based on nitrogenous waste excretory products. They are

a. Ammonotelic animals: Nitrogenous waste products are Ammonia.
e.g. Some bony fishes

b. Ureotelic animals: Nitrogenous waste products are in the form of urea
e.g. Cartilagenous fishes, amphibians and mammals.

c. Uricotelic animals: Nitrogenous waste products are excreted in the form of uric acid. **e.**g. Reptiles and birds

2. Name the blood vessels that enter and exit the kidney.

Ans. Renal artery enters the kidney and renal vein comes out of the kidney.

3. What are renal pyramids and renal papillae?

Ans. The conical shaped medullary regions into calyces of kidney are the renal pyramids. Tips of the renal pyramids which open into pelvis are renal papillae.

4. Name the structural and functional unit of kidney. What are the two main parts in it?

Ans. The structural and functional unit of kidney is Nephrons. Two main parts are (1) Malpighian body, (2) Convoluted tubule.

5. Which part of nephrons is impermeable to water?

Ans. The ascending limb of Henle's loop is impermeable to water.

6. What are the columns of Bertini?

Ans. Cortical spreads among the renal pyramids are columns of Bertini.

7. Define glomerular filtration.

Ans. The process of filtration which occurs between glomerulus and Bowman's capsule due to difference in net pressure is glomerular filtration.
The filtered fluid which entered the Bowmans capsule is renal fluid or primary urine or glomerular filtrate which is hypotonic.

8. Distinguish between Cortical and medullary nephrons.

Ans. Cortical nephrons have renal corpuscle in the superficial renal cortex. They have short Loop of Henle but without vasa recta.
Renal corpuscles of juxtmedullary nephrons are located near the renal medulla. They have loop of Henle and vasa recta.

9. What is meant by augmentation? In which parts of nephron it occurs?

Ans. The secretion of materials from capillary net into lumen through the interstitial fluid is known as tubular secretion or augmentation. It occurs in distal convoluted tubule.

10. What is juxtaglomerular apparatus?

Ans. Macula densa together with juxtaglomerular cells form juxtaglomerular apparatus. It releases Renin.

11. Distinguish between juxtaglomerular cells and macula densa.?

Ans. The cells of the distal convoluted tubule are crowded in the region where DCT makes contact with afferent arteriole. These cells are known as 'Macula densa'.

Along side of the macula densa , the wall of the afferent arteriole contains the modified smooth muscle fibres calle 'juxtaglomerular cells'.

Macula densa along with JG ells form Juxtaglomerular apparatus.

12. Distinguish between rennin and rennin enzymes.

Ans. Renin is digestive enzyme produced by gastric juice of vertebrates having the power to convert the milk into curd.

Renin enzyme stimulates the conversion of angiotensinogen synthesized by the liver, into angiotensin I.

13. Distinguish between obligatory and facultative water re-absorption.?

Ans. The cells in the proximal convoluted tubule have high capacity for the reabsorption of water is known as obligatory water re absorption.

In distal convoluted tubule water is absorbed by principal cells under the influence of anti diuretic hormone. It is called facultative water reabsorption.

14. What is the role of atrial natriuretic peptide in the regulation of urine formation?

Ans. A large increase in blood volume promotes the release of atrial natriuretic peptide form the heart.

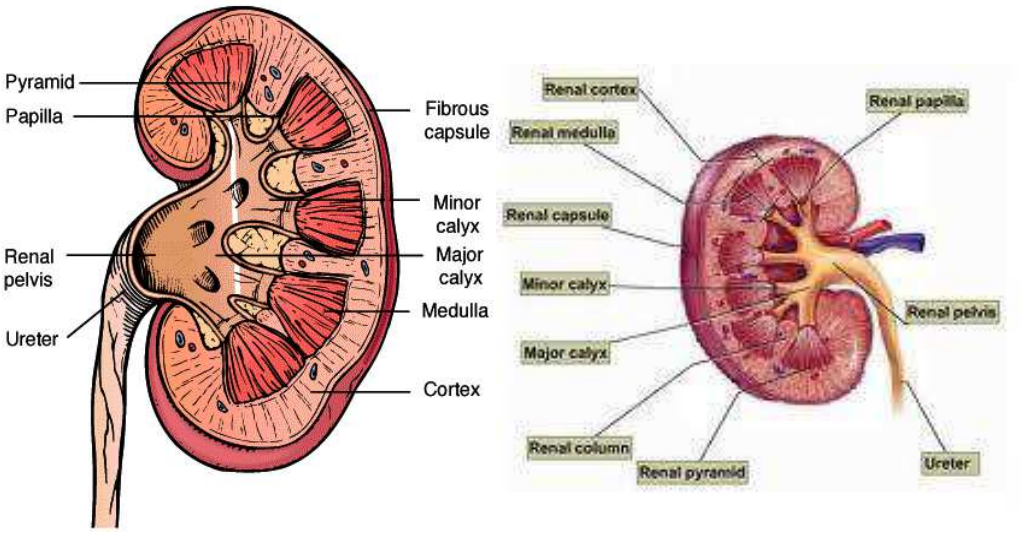
Atrial natriuretic peptide decreases the absorption of water. Na^+ from PCT.

Short Answer Questions

1. Describe internal structure of kidney of rabbit.

- The outer surface of kidney is convex and inner surface is concave, where it has a notch known as hilum with a opening known as Hilus.
- The kidney is demarcated into outer Cortex and inner Medulla.
- The ureter is expanded as funnel shaped cavity known as Pelvis.
- Free end of Pelvis has many cups like cavities like Calyces.
- Medulla projects into the calyces as conical processes known as Renal Pyramids..
- The tips of pyramids are Renal papillae.
- Cortex spreads among the renal pyramids as Columns of Bertini.
- Each kidney is composed of numerolus, munite Nephrons and ducts.
- Nephrons are the structural and functional units of kidney. They are present in loose connective tissue.

- In addition, kidneys contain a network of blod capillaries, lymph sinuses , nerves and interstitial fluid in intercellular speaces.



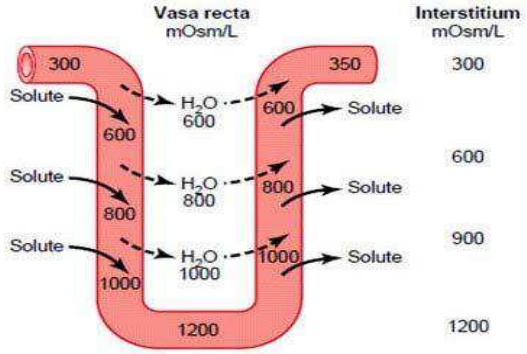
The kidney gets blood supply through renal artery and blood form kidney is carried out by renal vein. Ureter carries urine into urinary bladder.

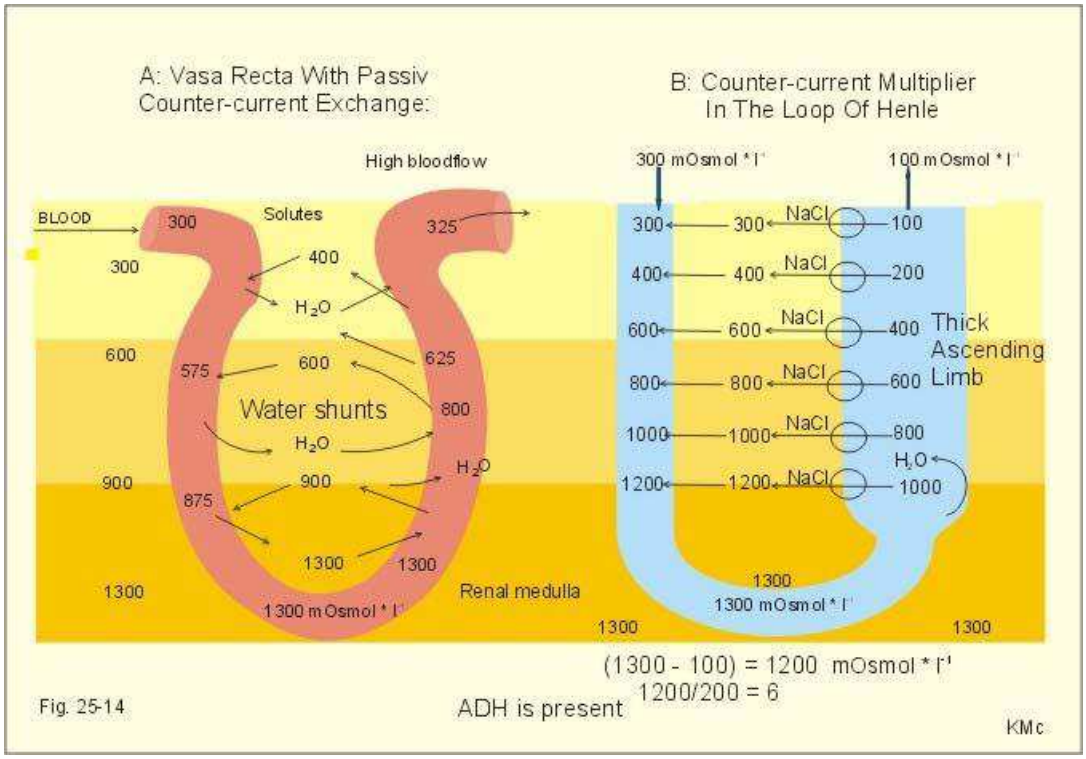
4. Write short note on counter current hypothesis.

- The osmolarity increased from outer medulla to the inner medulla of kidney. It is maintained by counter current mechanism. It is of two types.

A) **Counter current Multiplier**: It occurs in loop of Henle.
The flow of renal fluid in loop of Henle as well as the flow of bod in vasa recta is counter flow (flow in opposite directions). The operation in loop of Henle as counter current multiplier produces the ascending gradient of hyperosmolarity in the medullary interstitial fluid.

B) Counter current exchange: It is the operation in Vasa recta. It also maintains hyperosmotic gradient in the medullary interstitium. Na, Cl and urea are reabsorbed into the blood of vasa recta in the descending limb. So osmolarity of blood increases towards the tip in the descending limb. Water is reabsorbed into the blood of ascending limb of vasa recta. So osmolarity of blood decreases in the blood of ascending limb towards the cortex. Osmotic gradient in medulla is useful to produce the concentrated urine**.**





5. Describe the structure of Nephron of rabbit.?

The function unit of Rabbit kidney is nephron. Each kidney is made by about one million nephrons.

Structure of Nephron :

Nephron consists of I) Malphigian body or Renal corpuscle
II) Renal tubule

I) MALPHIGIAN BODY / RENAL CORPUSCLE :

It begins in the cortex of the kidney. It contains Bowman's capsule and glomerulus.

- Bowman's capsule is a thin walled, double layered cup. It consists of simple squamous epithelial cells known as Podocytes.
- The glomerulus is a dense network of capillaries in the cup of Bowman's capsule. Afferent arteriole of renal artery enters the cavity of Bowman's capsule and splits into fine branches. They unite and come out of the Bowman's capsule as an efferent arteriole. The net work of capillaries of both arterioles appears like a net known as Glomerulus.
- The blood in glomerular capillaries and the fluid of lumen of Bowman's capsule are separated by a very thin barrier i.e., squamous epithelium of Bowman's capsule and endothelium of blood capillaries of glomerulus.

II) RENAL TUBULE: it is a narrow, delicate tubule arise form the posterior part of Bowman's capsule known as neck. It opens into a long, narrow convoluted tubule with three parts like PCT, LOOP OF HENLE & DCT.

A) **PROXIMAL CONVOLUTED TUBULE (PCT)**: `It is lined by simple cuboidal epithelium with brush border to increase the area of absorption.

B) **LOOP OF HENLE**: It is a hair pin like (U-shaped) tubule presen in medulla. It consists of a descending limb and an ascending limb. The walls of descending limb and lower end of ascending limb are very thin and lined by simple squamous epithelium.

The distal part of ascending limb is thick and is lined by simple cuboidal epithelium.

C) **DISTAL CONVOLUTED TUBULE**: It is present in cortex. It is lined by simple cuboidal epithelium. The late distal convoluted tubule is lined by two types of cuboidal epithelial cells – Principal cells and intercalated cells. Terminal part of DCT is the collecting tubule or connecting segment.

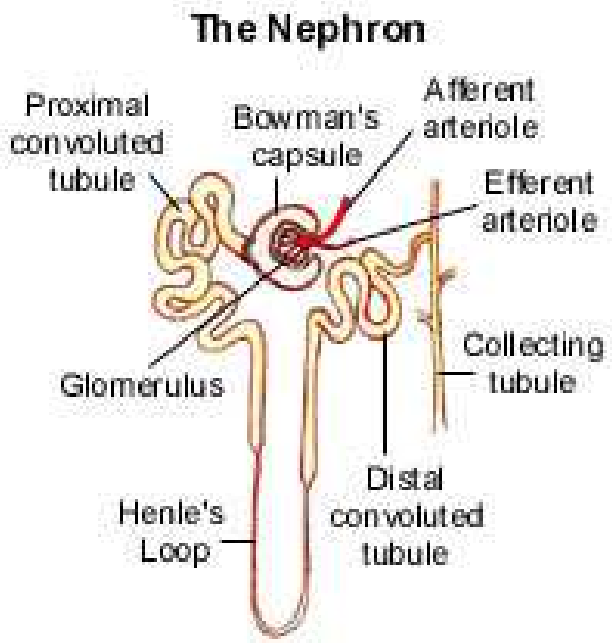
- The cells of the distal convoluted tubule are crowded in the region where DCT makes contact with afferent arteriole. These cells are known as 'Macula densa'.
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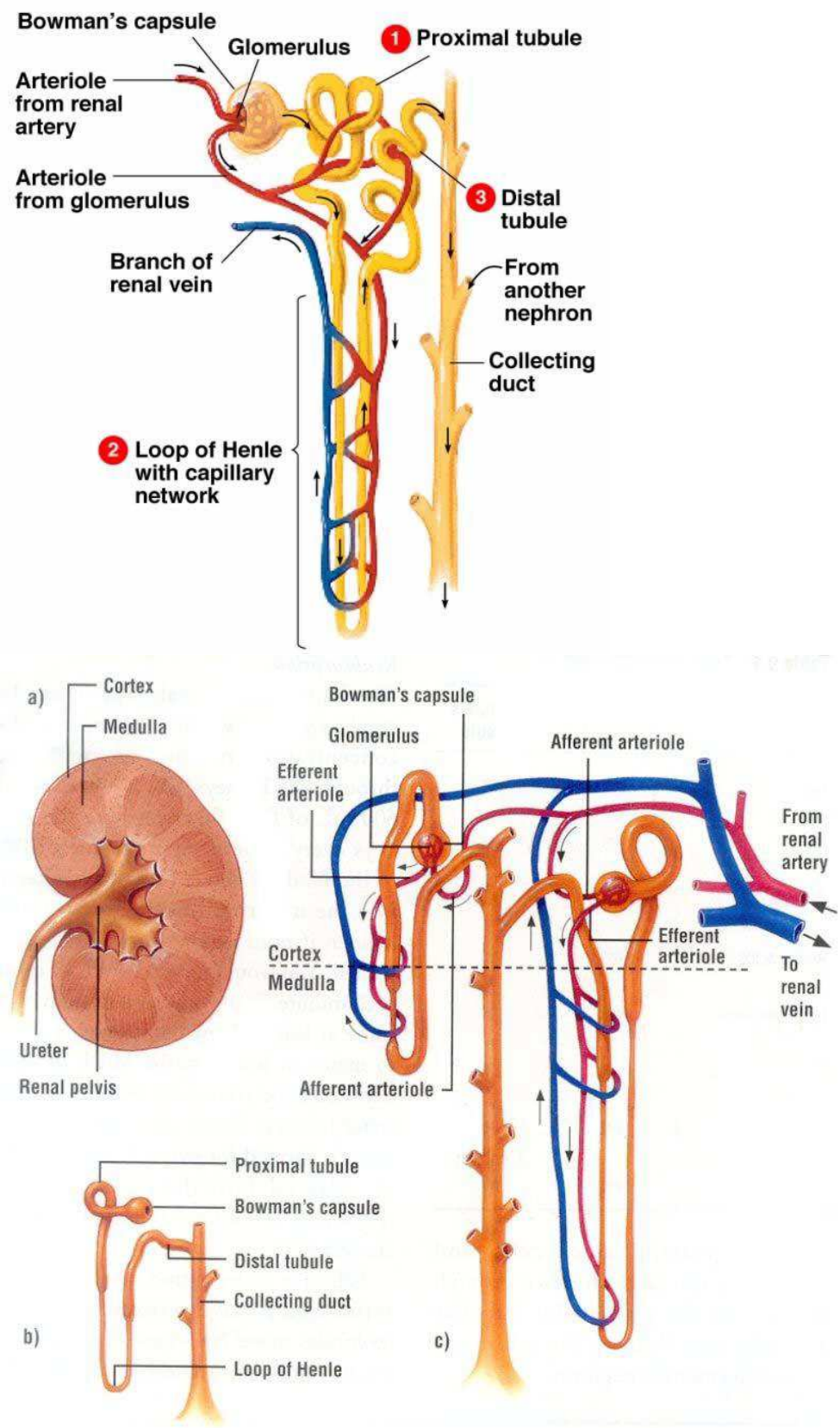
2) COLLECTING SYSTEM:

Several collecting tubules open into collecting ducts. They descend into the renal medulla and merge to form the duct of Bellini. It opens at the end of renal papilla.

3) CAPILLARY NET OF NEPHRON.

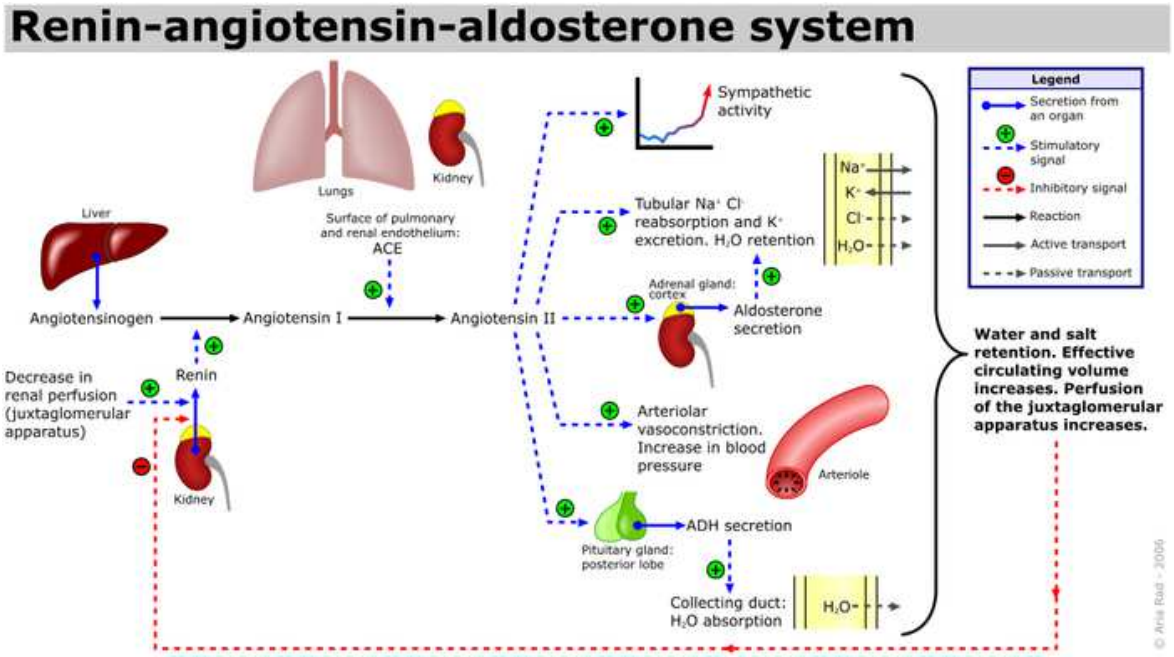
Efferent arteriole forms a net of capillaries around renal tubule. The capillary net close to the proxiamal and distal convoluted tubules is Peritubular net and the network present close to the loop of Henle is Vasa recta. Capillaries of these nets join to form a renal venule. All venules unite and form a renal vein.





6. Describe the hormonal control of urine formation.

- Angiotensin II and aldosterone hormones regulate solute reabsorption.
- Water reabsorption is regulated by Anti diuretic hormone (ADH).
- Atrial natriuretic peptide inhibits the absorption of water and solutes
- Angiotensin II an active hormone, decreases the glomerular filtration rate enhance the reabsorption of Na^+, Cl^- and water in proximal convoluted tubules.
- Aldosterone stimulates principal cells to absorb Na^+, Cl^- and secretion of H^+.
- ADH hormone regulates the facultative reabsorption of water. It increases the permeability of principal cells.
- At the time of dehydration more ADH is secreted, hence more water is absorbed into the blood.



Long Answer Questions

1. Describe the excretory system in rabbit giving the structure of nephrons.?

Ans. In rabbit excretory system consists of a pair of kidneys, ureters and urinary bladder.

1. Kidneys: Rabbit have a pair of bean shaped, dark red kidneys are present. These are situated either side of vertebral column in the abdominal region. They are covered by peritoneum on ventral side. So they called retro peritoneal organs. Kidney having fibrous renal capsule is present. Capsule surrounded by perirenal fat. Right kidney is place somewhat more anterior to the left kidney. The outer surface kidney is convex and inner concave. A notch called hilum. It is opening in hilus. Renal artery enters the kidney and renal vein and ureters leave the kidney at hilus.

2. Ureters : Each kidney is continued as ureters and emerges out at hilus. Ureters is along and muscular tube. Each ureters open into the urinary bladder.

3. Urinary bladder: It is thin walled, pear shaped, white transparent sac like structure. It is present in the pelvic region on ventral to rectum. It temporarily stored the urine. Urinary bladder opens into urinogenital canal. In males, it is called urethra and in females vestibule. Urethra opens out through urinogenital aperture at the tip of penis. Vestibule opens out through vulva.

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2. Explain the physiology of urine formation.

Ans. Elimination of waste materials like nitrogenous compounds like ammonia, urea, uric acid, excess water , salts etc., is known as excretion.

The process of formation of urine occurs in 3 stages like

a) Glomerular filtration
b) Selective reabsorption
c) Tubular secretion (Augmentation)

A) **GLOMERULAR FILTRATION**:

Hydrostatic pressure of the blood while flowing in the glomerulus is 70 mm Hg.

It is opposed by i) blood colloidal osmotic pressure (BCOP) of 35 mm Hg. &
ii) Capsular hydrostatic pressure (CHP) of 25 mm Hg.

- It results the net filtration pressure of 10 mm Hg. (70 – (35+25)).
- It causes the pressure filtration of blood in glomerulus. Endothelial cells of capillaries of glomerulus and podocytes of Bowman's capsule form the filtration membrane.
- By the result of glomerular filtration, renal fluid / Primary urine is collected in lumen of Bowman's capsule. Renal fluid contains metabolic wastes like urea, uric acid, creatinine, toxins and others like water, amino acids, glucose and salts of Na, K,Ca , Mg. etc. It is Hypotonic to cortical fluid.
- Renal fluid passes through renal tubule.

B) **SELECTIVE REABSORPTION**: Essential substances of renal fluid are reabsorbed into the blood.

I) in PROXIMAL CONVOLUTED TUBULE (PCT) : It is highly permeable to water and solutes.

* 65% of water and Na and lower % of filtered chlorine are reabsorbed.
* Water is reabsorbed by osmosis. This reabsorption is known as **OBLIGATORY WATER REABSORPTION.**
* Na ions, glucose, amino acids, Cl, K, Ca , Mg are also reabsorbed into the blood.
* Organic acids and bases like bile salts, oxalates, hippuric acid and rates are secreted into renal fluid.
* H^+ ions are also secreted into lumen. Renal fluid is ISOTONIC TO CORTICAL FLUID AND BLOOD.

II) in **DESCENDING LIMB** : It is highly permeable to water but moderately permeable to solutes.

- It allows the diffusion of substances.
- 15 % of water is reabsorbed by osmosis.(Obligatory).
- Urea diffuses into lumen. It results the gradual increasing of osmolarity of renal fluid.
- Renal fluid is ISOTONIC to the medullary fluid. (Maximum osmolarity at hairpin turn of loop.)

III) **in ASCENDING LIMB** : It has thin and thick segments. Both are impermeable to water. But thin segment is less permeable to ions and thick part is more permeable to ions.

- Ions like Na, Cl, Mg, K, HCO_3 and Ca are reabsorbed in thick region.
- H^+ ions are secreted. Renal fluid is progressively diluted.
- Renal fluid is HYPOTONIC to medullary fluid.

IV) in DISTAL CONVOLUTED TUBULE (DCT) : It is permeable to water and ions.

- Principal cells reabsorb Na and secrete K. Aldosterone helps in the reabsorption of Na.
- Principal cells reabsorb 9 % of Water with the influence of antidiuretic hormone (ADH).
- This is known as FACULTATIVE WATER REABSORPTION.
- Intercalated cells secrete H^+ ions and reabsorb K^+ and HCO_3^- ions.
- Renal fluid is ISOTONIC_ to cortical fluid and blood.

V) in COLLECTING DUCT :

* 10 % of water and Na are reabsorbed in collecting ducts of cortical and medullary parts.
* ADH helps in the reabsorption of water (FACULTATIVE REABSORPTION).
* Urea is also reabsorbed in medullary collecting duct.
* H^+ ions are secreted into lumen.
* Concentration of renal fluid reaches high at the end of collecting duct.
* This renal fluid is now known as URINE.
* It is HYPERTONIC to blood & ISOTONIC to medullary fluid.

C) TUBULAR SECRETION (AUGMENTATION):

* It is the secretion of materials from capillary net into the lumen through interstitial fluid.
* K ions, H ions, ammonia, Hippuric acid etc., are secreted into the lumen of tubule.

FORMATION OF HYPERTONIC URINE:

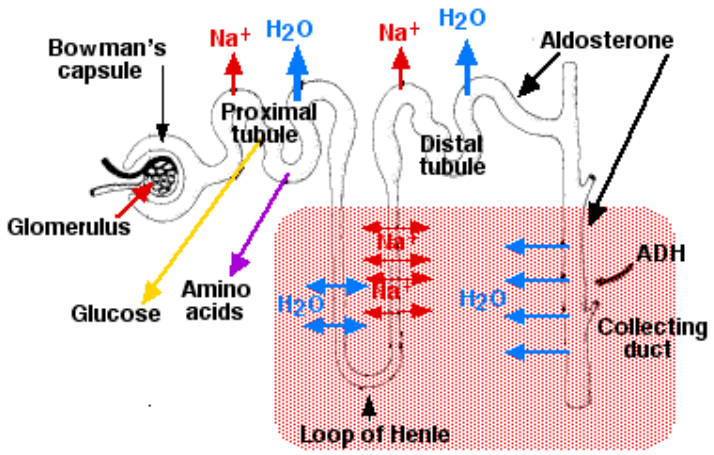
-- Osmotic gradient in medulla is useful in producing the concentrated urine.

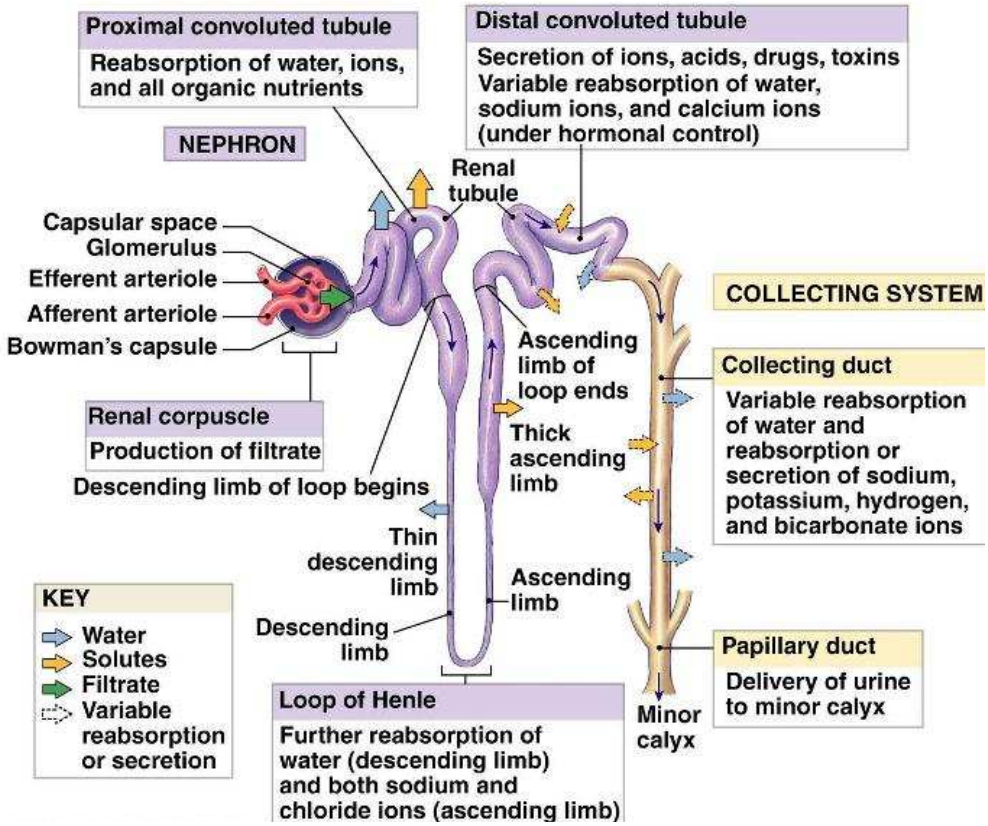
-- Osmotic gradient in medulla is maintained by 2 factors ….

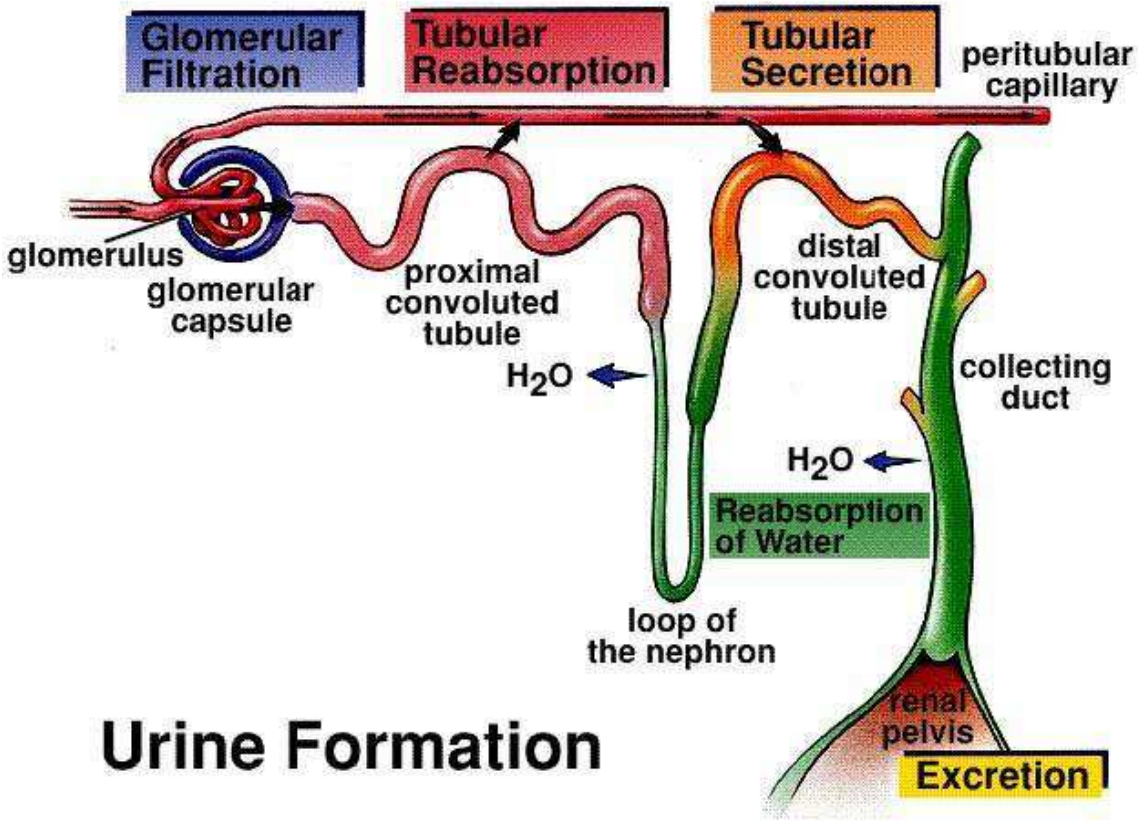
i) Active transport of ions from the ascending limb through symporter, facultative reabsorption of water in collecting duct, and passive transport of urea from collecting duct and build up of urea in the medulla.

ii) Countercurrent mechanism: a) Counter current multiplier in loop of Henle

b) Counter current exchange in vasa recta.







Urine Formation

Reproductive System in Rabbit

Very Short Answer Questions

1. **Where are the testes located in rabbit? Name the protective covering(s) of each testis?**

- In the embryonic stage, testis are present in the abdominal cavity near kidneys. But before birth they descend into the scrotal sacs through inguinal canals.
- The protective coverings around the testis are double layered mesothelium, Tunica vaginalis and Tunica albugenia.

2. **Name the canals that connect the cavities of scrotal sacs and abdominal cavity. Name the structures that keep the tests in their position.?**

Ans. Inguinal canals connect the cavity of scrotal sacs and abdominal cavity. Spermatic cord keeps the testis in their position.

3. **What are the functions of Sertoli cells and Leydig cells of seminiferous tubules in rabbit?**

Ans. Sertoli cells provide nourishment to the sperms. Sertoli cells secrete Inhibin which inhibits the secretion of FSH.

Leydig cells or interstitial endocrinocytes secrete the male sex hormone testosterone.

4. **What are the three parts of epididymis of rabbit?**

Ans. A) Caput epididymis --- connects with dorsal abdominal wall by spermatic cord.

B) Cauda epididymis --- middle of epididymis.

C) Corpus epididymis --- Joins with scrotal sac by a short, thick, elastic cord known as Gubernaculum.

5. **Name the accessory glands associated with male reproductive system of rabbit.?**

ANS : (1)Prostate glands (2) Cowper's glands

(3) Perinneal glands (4) Rectal glands.

6. **Name the copulatory structure of male rabbit. What are the three columns of muscles in it?**

Ans. Penis is the copulatory structure in male rabbit.

The three columns are two corpora cave rnosa and a single corpus spongiosum with urethra.

7. **What is meant by ovulation?**

Ans. Releasing of secondary oocyte in to body cavity from the Graafian follicle of the ovary is known as ovulation.

8. **Name the yellow material accumulated in empty follicle of the ovary. Name the hormone secreted by it and what its function?**

Ans. The yellow material formed is corpus luteum.

It secretes progesterone which stops ovulation after fertilization.

This hormone also prepares the uterus for implantation and maintains the uterus during pregnancy.

9. **In rabbit what are the structures that collect ova from the abdominal cavity? Where are they fertilized?**

Ans. Ova are collected by oviducal funnels.

Ova are fertilized in the fallopian tube.

10. **Define gestation period. What is the duration of gestation of rabbit?**

Ans. The intra uterine development is known as gestation period.
Gestation period in rabbit is 30 days.

11. **What is implantation?**

Ans. The attachment of the blastocyst to the endometrial layer in the wall of the uterus of female is known as implantation.

12. **What is capaciation of sperms?**

Ans. The changes which activate the sperms are referred to as capacitation.
They occur in female reproductive tract after copulation.
The changes occur in this process are
i)Removal of cholesterol,glcoproteins nd some proteins from the plasma membrane of sperm.
ii)Rapid beating of tail of sperm and the plasma membrane of sperm is ready to fuse with the plasma membrane of ovum.

13. **What is compaction in the development of rabbit?**

Ans. The morula (solid mass of cells) gets two cell types , peripheral cells and inner cell mass by the process known as compaction.

14. **What is an induction in the development of rabbit?**

Ans. The inducing tissue stimulates the development of unspecialized tissue into specialized tissues is called induction.
Notochordal rudiment plays an important role in induction during development of rabbit.

15. **Distinguish between epiblast and hypoblast.?**

Ans. The cell layer that separates from inner surface of embryonic disc is known as hypoblast. It forms the future extra embryonic endoderm.
The remaining part of embryonic disc is known as Epiblast which forms the embryo.

16.Distinguish between involution and ingression in the development of rabbit.?

Ans. The replacement of the hypoblast by epiblast to form the endoderm of the embryo is called ingression.
Future mesodermal cells converge towards primitive folds, primitive groove and reach between epiblast and hypoblast is called involution.

17. What is neurulation?

Ans. The process of formation of the neural tube in a chordate embryo is called neurulation.

18. Distinguish between deciduas basalis and deciduas capsularis.?

Ans. After implantation the uterine endometrium undergoes changes to become decidua . it is of three types….
a)Decidua basalis : lies between embryo and uterine myometrium .
b)Decidua capsularis : present between embryo and lumen of uterus.
c)Decidua parietalis : Remaining endometrium.

19. What are the derivatives of hypomere and epimere in the development of rabbit?

Ans a) Hypomere :Mesoderm near the gut is called hypomere. Hypomere splits into outer somatic layer and inner splanchnic layer.
Coelom is formed between these two layers.
b)Epimere : The longitudinal column of mesoderm adjacent to the notochord and neural tube is called epimere.

It organizes into linear somites. Each somite differentiates in to

i) Myotome --- develops in to skeletal muscles.

ii) Dermatome --- forms connective tissue.

iii) Scleratome --- forms vertebrae.

20. What are the four extra embryonic membranes of rabbit?

Ans. The extra embryonic membranes are

(1) Amnion, (2) Allantois, (3) Yolk sac and (4) Chorion.

21. What is meant by parturition?

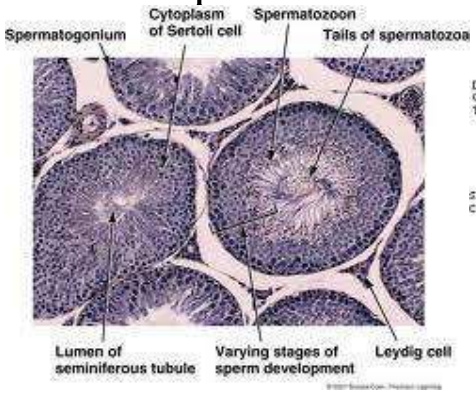
Ans. The process of birth is known as parturition. It is helped by

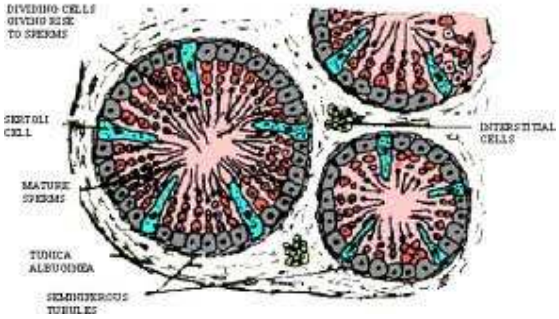
a)Oxytocin of hypothalamus _ enhances contraction of smooth muscle cells in the wall of the uterus.

b) Relaxin of corpus luteum and placenta -- relaxes pelvic ligaments.

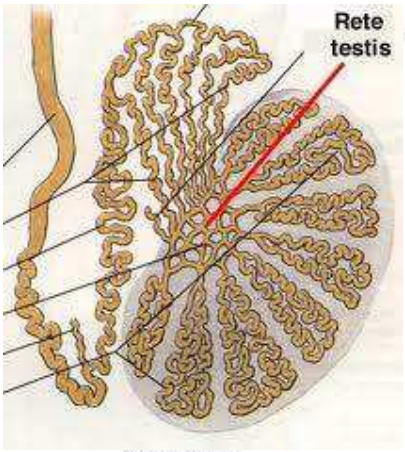
Short Answer Questions

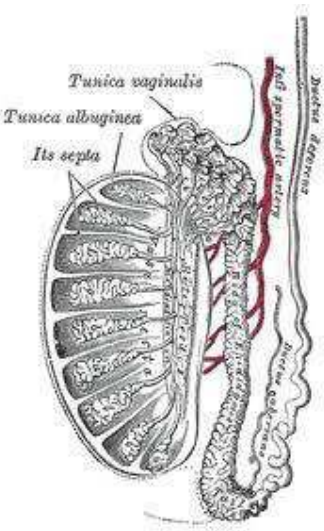
1. Describe microscopic structure of testis of rabbit.?

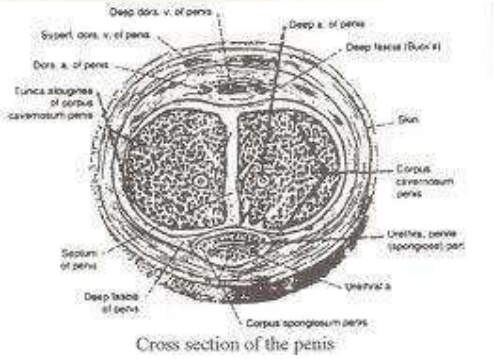




- Male rabbit has a pair of oval, pinkish testes present in scrotal sacs outside the abdominal cavity.
- Testes descend into scrotal sacs before birth through inguinal canals.
- Testes are kept in their position by *spermatic cords*.
- The outer covering of testis is known as tunica albuginea. It is surrounded by doubkle layer of mesthellium known as tunica vaginalis. The outer layer is parietal layer and inner layer is visceral layer.
- Tunica albuginea projects inwards as septa and divides the testis into many lobules. They contain long seminiferous tubules lined by germinal epithelium.
- Germinal epithelial cells produce sperms by a process called spermatogenesis.
- Sertoli cells nourish the sperms. Sertoli cells secrete a protein called inhibin which inhibits the secretion of Follicle Stimulating hormone. Leydig cells are the interstitial endocrinocytes which secrete male sex hormone, testosterone.
- All the seminiferous tubules open into a network called rete testis.
- It opens into fine ductules known as Vasa efferntia.
- Vasa efferentia open into epididymis.



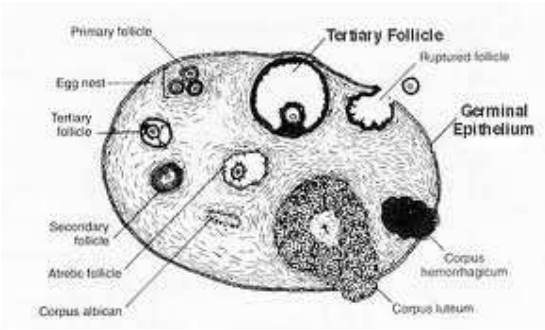




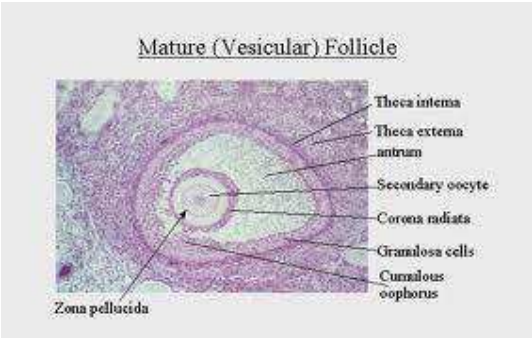
Cross section of the penis

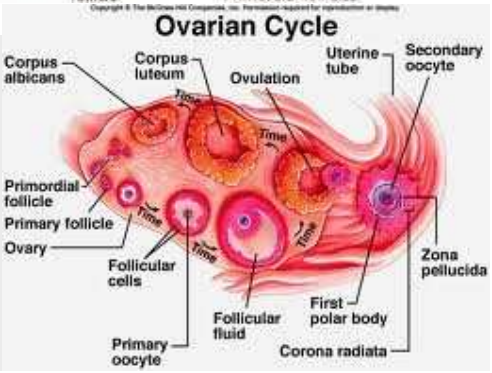
2. Describe microscopic structure of ovary of rabbit.?

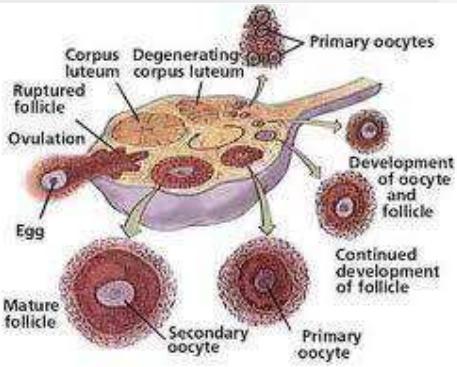
- Rabbit has a pair of oval flattened and whitish ovaries.
- Ovary has four regions…
  a)inner Medulla – with large blood vessels and lymph vessels
  b)cortex -- with ova at various stages of development
  c)Tunica albuginea __ connective tissue layer
  d)Germinal epithelium - covers the ovary.
- Ovaries are attached to the inner surface of dorsal abdominal wall by double layered peritoneum known as Meosvarium.
- From the surface of mature ovary, Graffian follicles appear as round projections. Each graffian follicle has a secondary oocyte.
- Secondary oocyte is covered by the following layers and cavities…
  a)Zona pellucida --- glycoporotein layear surrounds the oocyte.
  b)Corona radiata
  c)Discus proligerous
  d)Antrum - cavity between discus proligerous and membrane granulosa
  e)Membrana granulosa
  f)Theca
- Graffian follicle migrates to periphery of ovary and projects out as a small round structure.
- Graffian follicle bursts and releases secondary oocyte into body cavity by the process known as ‘Ovulation’.
- After ovulation, the granular cells in follicle transform into a yellowish substance known as corpus luteum.

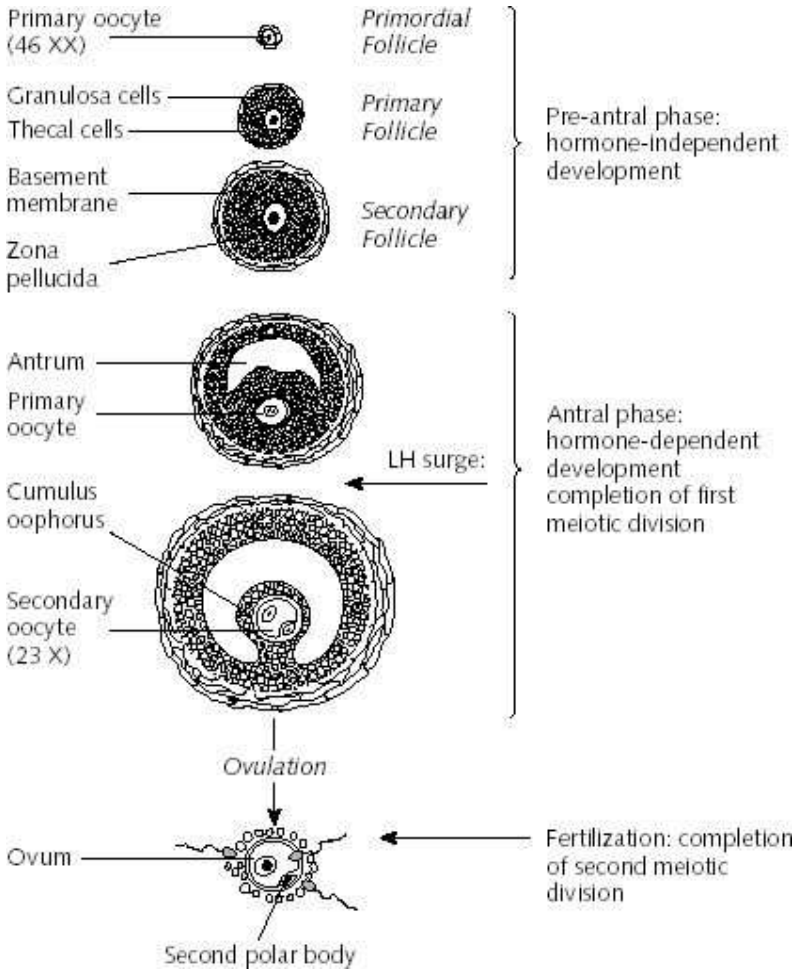

Primary follicle
Tertiary Follicle
Ruptured follicle
Egg nest
Tertiary follicle
Germinal Epithelium
Secondary follicle
Atretic follicle
Corpus hemorrhagicum
Corpus albican
Corpus luteum


Tunica albuginea ovarii
Cortex
Primary follicles
Surface epithelium
Medulla
Secondary follicle
Hilus
Secondary (vesicular) follicle
Primordial follicles


Mature (Vesicular) Follicle
Theca interna
Theca externa
antrum
Secondary oocyte
Corona radiata
Granulosa cells
Cumulous oophorus
Zona pellucida


Ovarian Cycle
Corpus albicans
Corpus luteum
Ovulation
Uterine tube
Secondary oocyte
Primordial follicle
Primary follicle
Ovary
Follicular cells
Zona pellucida
Follicular fluid
First polar body
Primary oocyte
Corona radiata


Primary oocytes
Corpus luteum
Degenerating corpus luteum
Ruptured follicle
Ovulation
Development of oocyte and follicle
Egg
Continued development of follicle
Mature follicle
Secondary oocyte
Primary oocyte



3. Write notes on epididymis.?

- Epididymis is a long, narrow and highly convoluted tubule. Vasa efferentia open into the epididymis.
- Epididymis is divisible into three parts (1) Caput epididymis, (2) Corpus epididymis, (3) Cauda epididymis.

I)Caput epididymis : It is the anterior part which connects with testis by vasa efferentia. It is also connected to the dorsal abdominal wall by spermatic cord.

II)Corpus epididymis : It is the middle part of epididymis.

III)Cauda epididymis : It is the posterior part of epididymis. It is joined to scrotal sac by gubernaculums.

- Epididymis stores and nourishes the sperms.

4.Describe the accessory glands associated with male reproductive system of Rabbit.?

- ACCESSORY GLANDS : Secretions of these glands along with that of epididymis form semen.

i) SEMINAL VESICLE : It is a sac like part lined by glandular epithelium. It secretes most of Semen. Seminal fluid contains Fructose and prostaglandins.

Fructose helps in the production of ATP molecules by sperms.

Prostaglandins help in sperm motility and viability in the vagina and stimulate the contraction of smooth muscles in female.

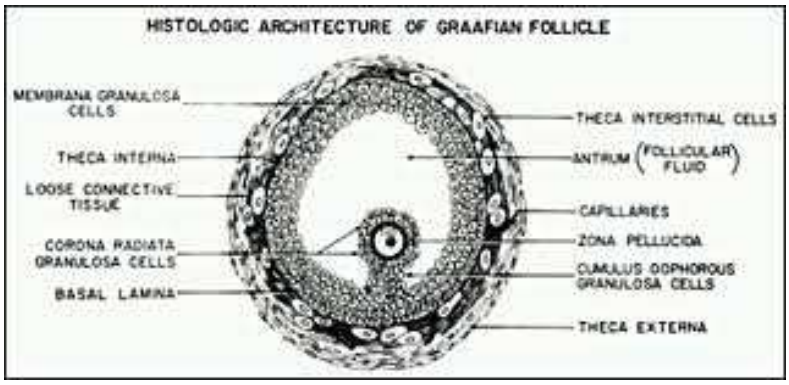
ii) PROSTATE GLAND : It is a large gland present around the base of seminal vesicle. It secretes citric acid. It enters the Kreb's cycle to generate ATP molecules.

iii) COWPER'S GLANDS : A pair of cowper's glands present posterior to prostate glands. These are known as Bulbourethral glands also. Their secretions neutralize the urinary residue and vaginal acidity.

iv) PERINEAL GLANDS : a pair of perineal glands present behind the cowper's glands. Their secretions give characteristic smell.

v) RECTAL GLANDS : a pair of rectal glands present at the sides of rectum. Their function is not known.

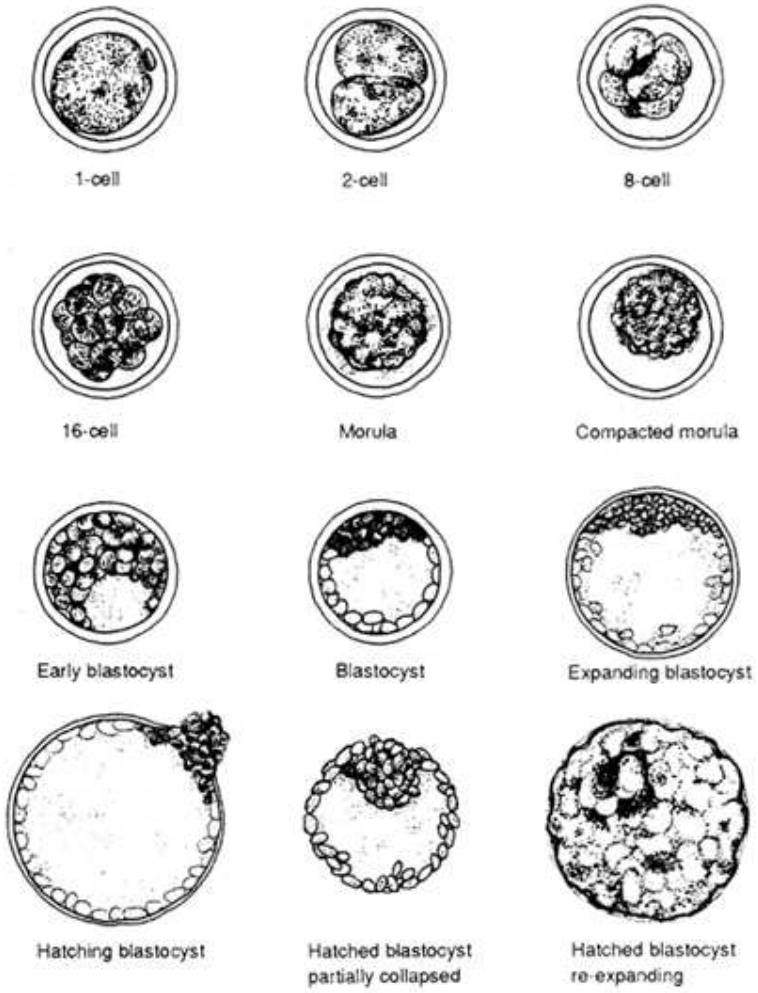
5. Describe the structure of Graafian follicle in rabbit.?



Ans. From the surface of ovary, several round projections appear and they are known as Graafian follicles. Each Graaffian follicle has a secondary oocyte. Graffian follicles are formed in the following manner….

- In the ovary, many oogonia are formed during foetus stage.
- oogonia undergo mitosis and form primary oocytes. They remain at prophase – I of meiosis – I till the animal is sexually mature.
- The earliest follicle formed in ovary is Primordial follicle surrounded by a single layer of squamous epithelial cells.
- Later Primary follicle is formed with cuboidal cells. It has primary oocyte surrounded by Zona pellucida and Corona radiata.
- A small cavity known as Antrum is formed between Membrana granulosa and discus prolegerus. The follicle with antrum is known as Secondary follicle with primary oocyte.
- During breeding season, primary oocyte completes meiosis –I and forms secondary oocyte. This mature follicle is known as Graafian follicle. Secondary oocyte begins Meiosis II, but stopped at metaphase II.
- Graafian follicle now migrates towards the periphery of ovary and projects out as a small round structure.
- Graafian follicle bursts and releases the secondary oocyte into the body cavity by the process known as Ovulation.
- After ovulation, the granular cells in the follicle proliferte and transformed into a yellowish substance known as Corpus luteum. It acts as a temporary endocrine gland and secretes Progesterone.

6. Write notes on cleavage and formation of morula in rabbit?



- Eggs of rabbit are microlecithal with very less amount of yolk. So cleavages are holoblastic type.

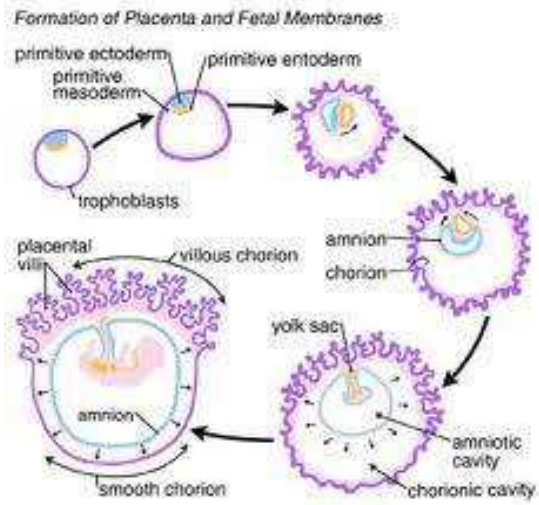
I) Cleavages :

- The first cleavage is meridional (vertical).It forms two blastomeres.
- The second cleavage is also meridional but at right angles to the first cleavage. It results in the formation of 4 blastomeres.
- The third cleavage is horizontal. It gives 8 blastomeres.
- from 4th cleavage, the cleavages are irregular and results in the formation of a small pinhead sized solid mass of cells known as Morula. It develops in fallopian tube and reaches uterus .

II) Morula :

- Morula is a solid mass of cells.
- It undergoes compaction, by which two cells types are distinguished. The outer or peripheral cells and the inner cell mass.
- Superficial flat cells form the trophoblast that gives rise to the extra embryonic trophoctoderm. This trophoblast helps to attach the embryo with the uterine wall. The inner cell mass constitute formative cells.

7. Describe the placenta in rabbit.?



Ans. The placenta is formed by the tissue of developing embryo and the tissues of uterus in mother. The mother tissue are uterine epithelium, uterine connective tissues and endothelium of blood vessel in the uterus and blood of the mother.

- ❖ The placenta of rabbit is chorioallantoic placenta as Allantois fuses with the Chrorion for vascularisation.
- ❖ It is interstitial placenta as implantation occurs in the wall of uterus.
- ❖ The placenta is deciduous as some parts are eroded and extensive haemorrhage occurs during parturition due to forceful removal of chorionic viii from the uterus.
- ❖ Placenta is discoidal as the villi are restricted in the dorsal surface of the blastocyst as a disc.
- ❖ Placenta is haemoendothelial as foetal blood vessels are directly present into the blood of mother.
- ❖ Through the placenta exchange of materials takes place between mother and embryo.

8. Describe the neurulation in rabbit.?

- ► The process of formation of the nerve cord in the embryo is known as neurulation.
- ► The neural ectodermal cells converge towards Hensen's node and form a neural plate externally above the notochordal rudiment.
- ► Neural folds raise from the neural plate due to the sinking of cells.
- ► These neural folds meet and form the neural tube.
- ► The anteriror broad part of the neural tube forms the brain and posterior part form the spinal cord.

9. Describe the mesoderm formation and its derivative in rabbit.?

- ► The future mesodermal cells converge towards primitive folds, involute through the primitive groove and each between epiblast and hypoblast.
- ► This mesoderm is separated from the epiblast.
- ► Remaining epiblast forms into ectoderm.
- ► Embryonic disc contains endoderm, mesoderm and ectoderm at this stage of the rabbit.
- ► Mesoderm spreads in all directions between outer ectoderm and inner endoderm.
- ► The longitudinal column of mesoderm adjacent to the notochord and neural tube is Epimere.

- ► The mesoderm near the gut is the hypomere. Mesoderm in between epimere and hypomer is Mesomere.
- ► Epimere orgnises into linear somites. Each somite differentiates into Mytome, sclerotome and dermatome.
  - i) Myotome --- develops in to skeletal muscles.
  - ii) Dermatome --- forms connective tissue.
  - iii) Scleratome --- forms vertebrae
- ► Mesomere forms the excretory organs and genital ducts.
- ► Hypomere splits into outer somatic layer and inner splanchnic layer. Coelom is formed between these two layers.

Long Answer Questions

1. Describe female reproductive organs of rabbit with labeled diagram.?

Ans. Female reproductive system of rabbit :

The female reproductive system consists of a pair of ovaries, a pair of oviducts, a pair of uteri, vagina, vestibule, clitoris and accessory glands.

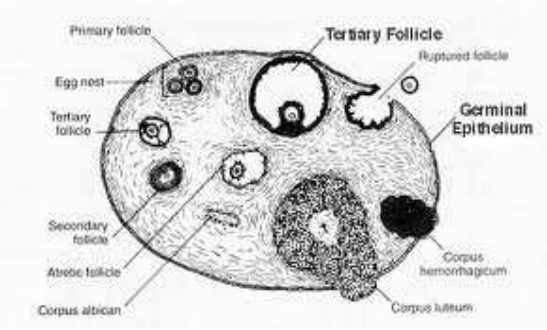
A) Ovaries : Rabbit has a pair of oval flattened and whitish ovaries.

Ovary has four regions…

a)inner Medulla – with large blood vessels and lymph vessels
b)cortex -- with ova at various stages of development
c)Tunica albuginea __ connective tissue layer
d)Germinal epithelium - covers the ovary.

- ❖ Ovaries are attached to the inner surface of dorsal abdominal wall by double layered peritoneum known as Meosvarium.
- ❖ From the surface of mature ovary, Graffian follicles appear as round projections. Each graffian follicle has a secondary oocyte.
- ❖ Secondary oocyte is covered by the following layers and cavities…

  a)Zona pellucida --- glycoporotein layear surrounds the oocyte.
  b)Corona radiata
  c)Discus proligerous
  d)Antrum - cavity between discus proligerous and membrane granulosa
  e)Membrana granulosa
  f)Theca
- ❖ Graffian follicle migrates to periphery of ovary and projects out as a small round structure.
- ❖ Graffian follicle bursts and releases secondary oocyte into body cavity by the process known as ‘Ovulation’.
- ❖ After ovulation, the granular cells in follicle transform into a yellowish substance known as corpus luteum.



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B) Oviducts : a pair of oviducts is present. Each has three regions.

► I)Oviducal funnel : It is the anterior part of oviduct. It is a wide funnel present near the outer border of ovary. The opening of funnel is Ostium and edges are fimbriated. Oviduct receives the ova.

► II)Fallopian tube : Oviducal funnel leads into a short, narrow, convoluted tube. It is lined by ciliated epithelium. Fertilizaion takes place in this tube. Fallopian tube is attached to the abdominal wall by a mesentery known as Mesosalpinx.

► III)Uterus : It is a wide , long, thick walled muscular tube. It is highly distensible. Blastocyst is implanted in uterus. Uterus is attached to dorsal body wall by Meosmetrium. Uteri of both sides open into the vagina through separate openings. Hence uteri of rabbit are described as Duplex type.

C) Vagina and vestibule : The uteri of both sides unite into a long wide duct called Vagina. It lies dorsally to the urinary bladder. It unites with the neck of urinary bladder and forms a common passage known as Urinogental canal or Vestibule.

Vestibule extends posteriorly, ventral top rectum and opens out through a slit-like aperture known as Vulva.

The vagina receive the penis of made during copulation.

Clitoris : It is a small rod like structure lies at athe anterior wall of vestibule inside the vulva. It is homologous to the penis of male.

D) Accessory glands :

a) Bartholin's glands : A pair of these glands is embedded in the dorsal wall of vestibule. Their secretion lubricate the vaginal passage. They are similar to Cowper's glands of male.

b) Perineal glands : a pair of these glands are present. Their secretion produe characteristic smell.

c) Rectal glands : present on sides of rectum. Function is not known.

2.Describe male reproductive system of Rabbit. Draw labeled diagram.?

ANS ; Male reproductive system of rabbit consists of a pair of testes, epididymis and vasa deferentia, Urethra, penis and associated glands.

A) TESTES :

- One pair of oval , pinkish testes present in scrotal sacs outside the abdominal cavity. They descend into scrotal sacs through inguinal canals before birth.
- Testes are kept in position by spermatic cords. Spermatic cord contains an artery, vein, lymphatic vessels, vas deferens and a nerve .
- Tunica albuginea is a connective tissue coat present as the outer covering of testis. It is covered by double layer of mesothelium known as tunica vaginalis.

- Tunica albuginea projects inwards as septa and divides the testis into many lobules. These lobules contain long, convoluted seminiferous tubules.
  They are lined by germinal epithelium.
- Germinal epithelial cells produce sperms by spermatogenesis.
- Sertoli cells in epithelium nourish the sperms. Sertoli cells secrete a protein, INHIBIN which inhibits the secretion of FSH.
- LEYDIG cells are present in connective tissue and secrete TESTOSTERONE.
- All seminiferous tubules open into a network known as RETE TESTIS.
  It opens into VASA EFFERENTIA. They open in Epididymis.

B) EPIDIDYMIS ::

- It is a long, narrow and highly convoluted tubule. It stores the sperms temporarily and nourishes.
- It has 3 distinct parts …..

a)CAPUT EPIDIDYMIS : anterior part. It connects with testis by vasa efferentia. It connects wit h dorsal abdominal wall by spermatic cord.

b)CORPUS EPIDIDYMIS : Middle part.

c) CAUDA EPIDIDYMIS : Posterior part. It joins to scrotal sac by thick, elastic cord, Gubernaculum.

C) VASA DEFERENTIA :

- Caput epididymis leads into a long, muscular tube known as VAS Deferens.
- Vasa deferens of each side passes through inguinal canal, enters the abdominal cavity, curves around ureter and opens into urethra as an ejaculatory duct.

D) URETHRA :

- Neck of urinary bladder, ejaculatory ducts and prostate gland open into Urethra/Urinogenital canal.
- It is straight, muscular duct. Uterus masculinus is a dorsal diverticulum arises from neck of urethra.
- Urethra opens at the tip of penis through a male urinogenital aperture.
- Urethra is a common passage for urine and semen.

E)PENIS :

- It is the copulatory organ. It is a cylindrical, erectile organ hanging from the ventral wall of abdomen in front of anus.
  Penis is covered by a loose sheath of skin.
- Prepuce is the skin that hangs over the tip of the penis.
- This tip of penis is known as Glans penis.
- Penis is composed of 3 longitudinal columns namely, Two columns of CORPORA CAVERNOSA (upper) and one column of CORPUS SPONGIOSUM .
  Urethra is present in the middle of corpus spongiosum.
- Penis becomes stiff and enlarged due to the filling of blood spaces with blood during sexually excite.
- Penis transfers the sperms into the vagina of female during sexual intercourse.

F)ACCESSORY GLANDS : Secretions of these glands along with that of epididymis form semen.

i) SEMINAL VESICLE : It is a sac like part lined by glandular epithelium.
It secretes most of Semen. Seminal fluid contains Fructose and prostaglandins.
Fructose helps in the production of ATP molecules by sperms.
Prostaglandins help in sperm motility and viability in the vagina and
stimulate the Contraction of smooth muscles in female.

ii) PROSTATE GLAND : It is a large gland present around the base of seminal vesicle. It secretes citric acid. It enters the Kreb's cycle to generate ATP molecules.

iii) COWPER'S GLANDS : a pairs of cowper's glands present posterior to prostate glands. Their secretions neutralize the urinary residue and vaginal acidity.

iv) PERINEAL GLANDS : a pair of perineal glands present behind the cowper's glands. Their secretions give characteristic smell.

v) RECTAL GLANDS : a pair of rectal glands present at the sides of rectum.

3. Write an essay on different events that occur during development of Rabbit.?

Ans. Development of Rabbit :

- Eggs of rabbit are microlecithal with very less amount of yolk. So cleavages are holoblastic type.

I) <u>Cleavages</u> :

- The first cleavage is meridional (vertical).It forms two blastomeres.
- The second cleavage is also meridional but at right angles to the first cleavage. It results in the formation of 4 blastomeres.
- The third cleavage is horizontal. It gives 8 blastomeres.
- from 4th cleavage, the cleavages are irregular and results in the formation of a small pinhead sized solid mass of cells known as Morula. It develops in fallopian tube and reaches uterus .

II) <u>Morula</u> :

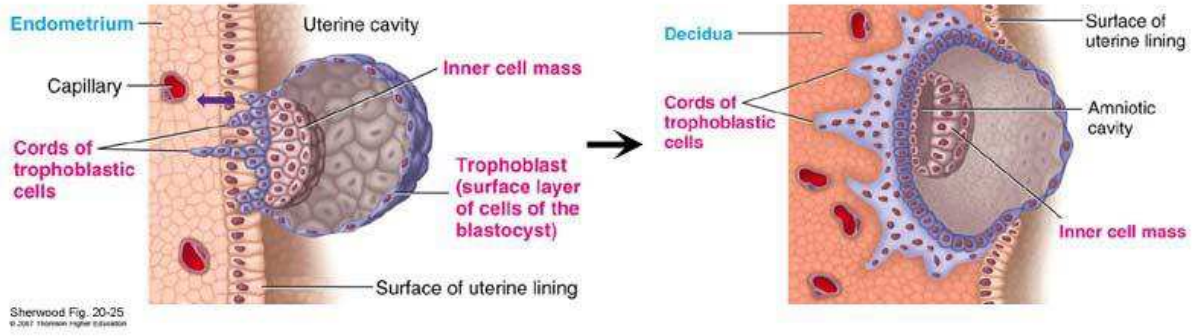
- Morula is a solid mass of cells.
- It undergoes compaction, by which two cells types are distinguished. The outer or peripheral cells and the inner cell mass.
- Superficial flat cells form the trophoblast that gives rise to the extra embryonic trophoctoderm. This trophoblast helps to attach the embryo with the uterine wall. The inner cell mass constitute formative cells.

III) Blastocyst :

- Crevices appear between the formative cell mass and trophoblast cells and form a cavity. It enlarges and lifts trophoblast from inner cell mass. But inner cell mass attaches with trophoblast near embryonic pole.
- The cells of trophoblst above the region of formative cells are Cells of Rauber. Now the embryo is known as blastocyst.

IV) Implantation :

- Zona pellucida disappears and the cells of trophoblast contact with uterine epithelium (endometrium). The trophoblasts cells invade the uterine tissue till maternal bood vessels are reached and breached.
- The process of intimate attachment of embryo with uterine wall is known as implantation. After implantation, the uterine endometrium changes to become decidua. It is of 3 types like decidua basalis , deciduas capsularis and deciduas parietlis.



❖ PROCESS OF IMPLANTATION

V)Discoblastula :

❖ It is the disc shaped blastocyst. Its inner cell mass is embryonic disc.

❖ Some cells of embryonic disc get separated by delamination and form a cell layer which develops into Hypoblast.

❖ The cells of hypoblast encloses a cavity which is similar to yolk sac.

VI) Gastrulation

❖ It involves the rearrangement and migration of cells from epiblast.

❖ A primitive streak is formed along the long axis of embryonic disc.

❖ A longitudinal furrow , Primitive groove forms along the middle of streak. Primitive folds appear on both sides.

❖ Anteriorly prikitive streak has a shallow primitive pit.. It has primitive knot or Hensen' node.

a) Endoderm, Mesoderm formation :

- ♦ The ingression of epiblast cells replace the hypoblast and form the endoderm of the embryo.
- ♦ The future mesodermal cells, converge towards primitive folds, involute through the primitive groove and reach between epiblast and hypoblast. Thus mesoderm is separated from the epiblast.

  Remaining epiblast forms into ectoderm. Embryonic disc contains endoderm, mesoderm and ectoderm at this stage.

b). Formation of Notochord and Nerve Tube :

- ♦ Some mesodermal cells converge towards Hense's node, involute and extend anteriorly as notochordal rudiment.
- ♦ It plays an important role in induction. Induction is the process by which one tissue i.e., inducing tissues stimulates the development of unspecialized tissue into specialized tissues.
- ♦ The neural ectodermal cells converge towards Hensen's node and form a neural plate externally.
- ♦ Neural folds raise from the neural plate due to the sinking of cells.
- ♦ These neural folds meet and form the neural tube.

c)Mesoderm Differentiation and Coelom formation :

- ► Mesoderm spreads in all directions between outer ectoderm and inner endoderm.
- ► The longitudinal column of mesoderm adjacent to the notochord and neural tube is Epimere.
- ► The mesoderm near the gut is the hypomere. Mesoderm in between epimere and hypomer is Mesomere.
- ► Epimere orgnises into linear somites. Each somite differentiates into Mytome, sclerotome and dermatome.

  i) Myotome --- develops in to skeletal muscles.

  ii) Dermatome --- forms connective tissue.

iii) Scleratome --- forms vertebrae

- ► Mesomere forms the excretory organs and genital ducts.
- ► Hypomere splits into outer somatic layer and inner splanchnic layer. Coelom is formed between these two layers.

d)Extraembryonic Membranes :

- ♦ From exposed blastodisc amniotic folds develop as somatopleure from which amnion and chorion are formed.
- ♦ Amnion encloses the embryo. The outer walls of amniotic folds become chorion. The inner walls become the amnion.
- ♦ Amniotic cavity is filled with amniotic fluid, which acts as a shock absorber. It protects the embryo from desiccation and prevents malformations in the embryo.
- ♦ From the hindgut, allantois is formed. It stores the waste material.
- ♦ Allantois and chorion are fused to form chorioallantoic membrane.
- ♦ Yolk sac encloses a fluid filled cavity. It is connected to mid gut. It has no nutritive role.
- ♦ Allantois and yolk sac are derived from splanchnopleure.

e)Placenta :

The placenta is formed by the tissue of developing embryo and the tissues of uterus in mother. The mother tissue are uterine epithelium, uterine connective tissues and endothelium of blood vessel in the uterus and blood of the mother.

- ❖ The placenta of rabbit is chorioallantoic placenta as Allantois fuses with the Chrorion for vascularisation.
- ❖ It is interstitial placenta as implantation occurs in the wall of uterus.
- ❖ The placenta is deciduous as some parts are eroded and extensive haemorrhage occurs during parturition due to forceful removal of chorionic viii from the uterus.
- ❖ Placenta is discoidal as the villi are restricted in the dorsal surface of the blastocyst as a disc.
- ❖ Placenta is haemoendothelial as foetal blood vessels are directly present into the blood of mother.
- ❖ Through the placenta exchange of materials takes place between mother and embryo.

f)Gestation : The period of intra uterine development is known as gestation period. At the end of gestation a miniature of adult is born.

The process of birth is known as parturition.

Gestation period in rabbit is about 31 days.