A MANUAL OF PRACTICAL ALLIED ZOOLOGY

for

Developmental Zoology, Ecology, Animal Physiology and Evolution

(For I B.Sc. Chemistry)

By

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DEPARTMENT OF ZOOLOGY

NESAMONY MEMORIAL CHRISTIAN COLLEGE

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Syllabus

1. Mounting and observation of live sperms of vertebrate
2. Estimation of dissolved oxygen in two water sample and discuss the result
3. Qualitativetestforglucose,proteinand lipid.
4. Effect of temperature on the opercular movement of fish. Calculation of $Q_{10.}$
5. Museum specimens, slides, models and charts.

Developmental Zoology : Human sperms, Human ovum, Cleavage, Discoidal placenta, Cotyledonary placenta.

Ecology : Planktons – Lucifer, Sagitta, Echeneis and Shark, Hermit crab and sea anemone, Sacculina, Secchi's disc.

Animal Physiology :Intestinal villi, Nephron, Heart of mammal.

Evolution : Anconsheep

MOUNTING AND OBSERVATION OF LIVE SPERMS OF A VERTEBRATE

AIM

To make temporary squash preparation to observe live sperms using frog testis

MATERIALS REQUIRED

Male frog, glass slides, cover slip, needle, compound microscope and 10% Holtfreter's Solution.

PREPARATION OF 10% HOLTFRETER'S SOLUTION

Sodium Chloride (NaCl)	-	350 mg
Potassium Chloride (KCl)	-	5 mg
Calcium Chloride ($CaCl_2$)	-	10 mg
Sodium bicarbonate ($NaHCO_3$)	-	2 mg
Distilled water	-	100 ml

10% Holtfreter's solution is prepared by adding 10 ml of standard solution to 90ml of distilled water.

PROCEDURE

Take a fully matured male frog and pith it on a dissection board. Cut open the body wall using clean instruments. Expose the testis, removed and transfer it, to a Petri dish containing 10% Holtfreter's solution. The test was macerated in the Petri dish to release the sperms. A drop of this suspension was placed on a clean glass slide. Put a cover slip over it. Then observe the slide under the low power and then high power of the microscope.

OBSERVATION

A number of sperms with head and tail in active movements were observed.

COMMENTS

A mature spermatozoon of a frog is about 0.03 mm in length and has the following salient features. The spermatozoon of frog is a flagellate type as it contains a tail. It consists of a head, neck, middle piece and a tail.

Head

1. It is long and it is covered by a thin layer of cytoplasm.
2. The head contains the acrosome and the nucleus.

3. At the anterior tip of the nucleus, there is a cap like acrosome.
4. The acrosome is bounded by acrosomal membrane.
5. The acrosome plays a vital role in the penetration of sperm into the egg and also the activation of the egg during fertilization.

Middle Piece

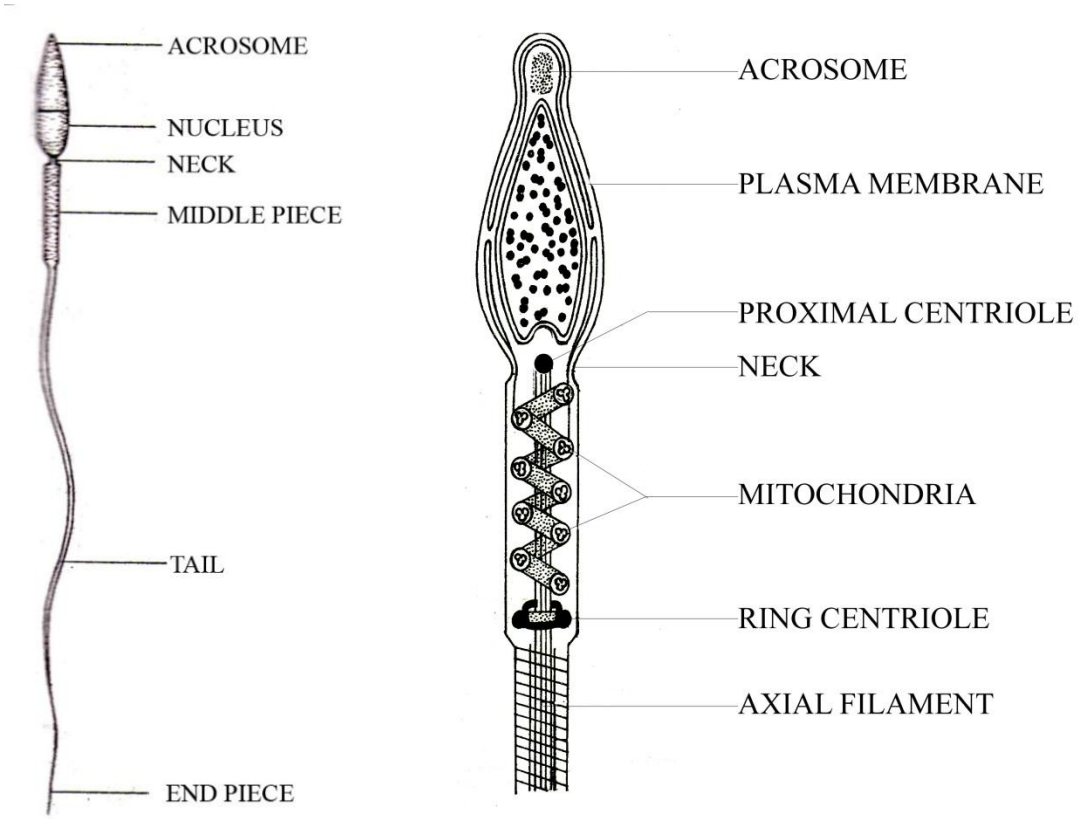
6. The head is followed by a distinct middle piece.
7. The middle piece has two centrioles a proximal centriole and a distal centriole.
8. The main half of the middle piece is composed of mitochondria.
9. The entire middle piece is surrounded by a peripheral layer of cytoplasm called manchette.

Tail

10. The tail has two distinct regions namely the main piece and the end piece.
11. The central core of the tail is formed of an axial filament.
12. The axial filament is composed of two central microtubules.
13. The entire tail is surrounded by a thin film of cytoplasm and a plasma lemma.

Functions of sperm

14. It activates the egg to initiate development.
15. It supplies a haploid nucleus to the embryo.



ESTIMATION OF DISSOLVED OXYGEN

AIM

To estimate the amount of dissolved oxygen content in the given samples 'A' and 'B'.

PRINCIPLE

WINKLER'S METHOD

Manganous Chloride is added to the sample to form Manganous Hydroxide. The Manganous Hydroxide gets oxidised to Manganic Hydroxide in the presence ofdissolved oxygen in the water. Addition of Alkaline Iodide along with concentrated Sulphuric acid liberates equal amount of Iodine as that of Oxygen. Hence the amountof Iodine liberated is a measure of dissolved oxygen in the sample. The amount ofiodine liberated can be estimated by titrating against 0.025N Sodium thiosulphate using 1% Starch solution.

$$\text{Sample} + MnCl_2 \longrightarrow Mn(OH)_2$$

$$Mn(OH)_2 + \text{Dissolved oxygen of the sample} \longrightarrow Mn(OH)_3$$

$$Mn(OH)_3 + 2\,Kl \longrightarrow MnSO_4 + K_2SO_4 + H_2O + I_2$$

$$I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$$

REAGENTS REQUIRED

1. Manganous Chloride
2. Alkaline Iodide
3. Concentrated Sulphuric acid
4. 0.025 N Sodium thiosulphate
5. 1% Starch solution.

APPARATUS REQUIRED

1. Burette
2. Pipette
3. Beaker
4. Winkler's bottle

PREPARATION OF REAGENTS

1. Manganous Chloride:

It was prepared by dissolving 40 grams of Manganous Chloride ($MnCl_2$) in100ml of distilled water.

2. Alkaline iodide:

It was prepared by dissolving 50 grams of Sodium hydroxide (NaOH) and16.6 grams of Potassium Iodide (KI) in 100ml of distilled water.

3. 0.025N Sodium thiosulphate:

It was prepared by dissolving 6.75grams of Sodium thiosulphate ($Na_2S_2O_3$)in 1 litre of distilled water.

4. 1% Starch Solution:

It was prepared by dissolving 1gram of starch in 100ml of distilled water.

PROCEDURE

A Winkler's bottle (250 ml) is taken and is filled with sample water. 2ml of Manganous Chloride is added with the help of a pipette followed by 2 ml of Alkaline Iodide. The bottle is shaken well, by inverting it for several times. Then add 1 ml of concentrated Sulphuric acid. 50 ml of the treated sample is transferred to aconical flask and then add 2 drops of 1% starch solution as indicator. A blue colour develops. The entire sample is then titrated against 0.025N sodium thiosulphate solution, till complete decolourisation occurs.The initial and final readings are noted.

$$\text{Dissolved oxygen content} = \frac{K \times 200 \times 0.698 \times \text{Vol. of } Na_2S_2O_3 \text{ used}}{\text{Volume of the sample}}$$

$$K = \frac{\text{Volume of the reagent bottle}}{\text{Vol. of the reagent bottle} - \text{Vol. of reagents}}$$

200 = N x E x 1000

N = Normality of $Na_2S_2O_3$ (0.025N)

E = Equivalent Weight of Oxygen (8)

1000 = Conversion factor to litre

0.698 = Conversion factor to convert parts per million to ml per litre

RESULT

1. Dissolved oxygen content in sample 'A' = _____ ml/litre

2. Dissolved oxygen content in sample 'B' = _____ ml/litre

DISCUSSION

Oxygen is essential for the survival of aquatic plants and animals. An aquatic ecosystem gets oxygen through atmospheric diffusion and photosynthesis. In general, the rate of diffusion of atmospheric oxygen is high in open environment such as ponds, rivers, lakes, sea etc. Oxygen from

water is depleted by respiration of aquatic plants and animals, the decomposition of dead organisms, due to high temperature and increase of salinity.

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TABULAR COLUMN

Samples	Trials	Volume of the sample used (ml)	Burette reading (ml)		Vol. of $Na_2S_2O_3$ used	Concordant Value
			Initial	Final		
A	1	50				
	2	50				
	3	50				
B	1	50				
	2	50				
	3	50				

CALCULATION

DISSOLVED OXYGEN CONTENT IN SAMPLE 'A'

$$\text{Dissolved oxygen content} = \frac{K \times 200 \times 0.698 \times \text{Vol. of } Na_2S_2O_3 \text{ used}}{\text{Volume of the sample}}$$

$$K = \frac{\text{Volume of the reagent bottle}}{\text{Vol. of the reagent bottle} - \text{Vol. of reagents}}$$

Volume of the reagent bottle = 250 ml

Volume of reagent used = 5 ml

$$K = 250 / (250 - 5)$$

$$= 250 / 245$$

$$K = 1.02$$

Volume of the sample = 50 ml

Volume of $Na_2S_2O_3$ used= _____ ml

$$\text{Dissolved oxygen content in Sample A} = \frac{K \times 200 \times 0.698 \times \_\_\_\_}{50}$$

$$= \_\_\_\_\_ \text{ ml/ l}$$

DISSOLVED OXYGEN CONTENT IN SAMPLE 'B'

$$\text{Dissolved oxygen content} = \frac{K \times 200 \times 0.698 \times \text{Vol. of } Na_2S_2O_3 \text{ used}}{\text{Volume of the sample}}$$

Volume of the sample= 50 ml

Volume of $Na_2S_2O_3$ used = _____ ml

$$\text{Dissolved oxygen content in Sample B} = \frac{K \times 200 \times 0.698 \times \_\_\_\_}{50}$$

$$= \_\_\_\_\_ \text{ ml/ l}$$

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QUALITATIVETESTSFORCARBOHYDRATES

EXPERIMENT	OBSERVATION		INFERENCE	
	Sample A	**Sample B**	**Sample A**	**Sample B**
BENEDICT'STEST Addeightdropsoftestsoulutionto0.5mlofBenedict'sreagentinatesttube.Boil it for two minutesandallowtocoolforttheappearanceofcolourspontaneously.Notethecolourchange.	Appearance of red, yellow or green colour.	No coloured precipitate appeared.	The colour shows the presence of glucose. The glucose reduces cupric hydroxide to red coloured cuprous oxide. The reducing property of glucose is due to the presence of free aldehyde or ketone. The colour depends on the concentration of sugar	Absenceofglucose. The given solution has no aldehyde or ketone group. Hence, no coloured precipitate appeared.
FEHLING'STEST Take few drops of test solution in a clean test tube. Add 0.5 ml of Fehling's solution A and 0.5 ml of Fehling's solution B to the test solution. Then boil for a few minutes and note the colour change	Appearance of brownish red or yellow colour.	No coloured precipitate appeared.	The colour shows the presence of glucose.	Absence of glucose.

QUALITATIVETESTFORPROTEIN

EXPERIMENT	OBSERVATION		INFERENCE	
	Sample A	**Sample B**	**Sample A**	**Sample B**
BIURETTEST Take 1 ml of test solution in a clean test tube. Add 1 ml of 10 % NaOH and 2 drops of 1 % copper sulphate solution.	Appearance of violet colour.	No violet colour.	The colour shows the presenceof protein. The compounds with large number of peptide bonds produce a violet colour due to the formation of complex within alkaline Copper Sulphate solution.	Absence of protein. No complex is formed due to the absence of peptide bonds.
XANTHOPROTEICTEST Take 2 ml of test solution in a clean test tube and add carefully 1 ml of conc. Nitric acid. A white precipitate is formed. Boil and colour changes to yellow. Cool the test tube and add 2 ml of 20 % Sodium hydroxide.	Appearance of yellow precipitate on addition of conc. Nitric acid and the change in orange colour was due to the addition of NaOH.	No yellow precipitate	The colour shows the presence of protein. The yellow precipitate of protein due to the formation of meta protein with the help of nitric acid. Meta protein in alkaline ionize freely and produce orangecolour.	Absence of protein. No metaprotein is formed

QUALITATIVETESTSFORFAT

EXPERIMENT	OBSERVATION		INFERENCE	
	Sample A	**Sample B**	**Sample A**	**Sample B**
1.GreaseSpotTest Put a drop of oil over a piece of ordinary writing paper	Appearance of translucent spot.	No translucent spot	The spot shows the presence of fat.	Absence of fat
2.SaponificationTest To 10 drops of oil in a test-tube add 20 drops of 40% sodium hydroxide solution and 2 ml. of glycerol. Gently boil for 3 minutes. If oil globules are visible, boiling must be continued.	A soapy appearance.	No soapy appearance	The appearance indicates the presence of fat, Oil or liquid fat when boiled with an alkali is hydrolysed and liberated fatty acids which form salt with the alkali.	Absence of fat
3.Sudan-IIITest Oil is treated with Sudan-III.	Appearance of red colour.	No red colour appeared	The colour indicates the presence of fat.	Absence of fat

EFFECT OF TEMPERATURE ON THE OPERCULARMOVEMENTOF FISH

Aim

To determine the effect of temperature on the rate of opercular movement of a fish and to calculate Q_{10}.

Materialsrequired

Alive fish, 500 ml beaker, Stop clock, Hot water, Thermometer etc..

Principle

Chemical reactions are speeded up by raising the temperature. This has been explained by Vant Hoffs rule. It states that the rate of chemical reactions is doubled for every 10^0C increase in temperature. This increase is represented as Q_{10}. In most biological process, Q_{10} ranges from 1.5 to 3.

Q10

Q_{10} is the temperature co-efficient in biological reactions. This is measured by the rate of speed of a reaction in relation to rise in temperature. Vant Hoff stated that an increase in temperature accelerates the rate of biological reaction which is approximately doubled by every increase in 10^0C. This increase is represented by Q_{10}. Q_{10} refers to the effect of temperature on reaction rate with certain limits for every 10^0C increase, the reaction rate is doubled. If the rate of reaction is known at two temperatures, Q_{10} can be calculated by using the formula,

$$Q_{10} \quad : \quad \frac{K_2}{K_1} \times \frac{10}{(t_2-t_1)}$$

Q_{10}	:	Temperature Co-efficient
K_1	:	Rate of activity at $t_1{}^oC$
K_2	:	Rate of activity at $t_2{}^oC$
t_1	:	Initial temperature
t_2	:	Final temperature

Procedure

A 500 ml beaker filled with 400 ml of bore well water was taken as the animal chamber. A healthy fresh water fish was gently introduced into the animal chamber. A thermometer was immersed in water and the temperature was noted and recorded. The fish was allowed to recover itself from the shock in the exposed medium by allowing the fish in this temperature for about 5 minutes undisturbed. After 5 minutes, stop clock was started and count 10 consecutive opercular movements. Then the stop clock was stopped and time taken for opercular movement was recorded. Three readings were taken and the average was calculated.

The temperature of the water was increased to 5^0C by adding hot water. Care must be taken to add hot water little by little to avoid stress to the animal. The experiment was repeated thrice and the average time taken was calculated. The same experiment was repeated in the same manner by raising the temperature to 10^0c. The reciprocal of time 1/t was calculated at every temperature and this was

the rate of opercular movement (K). A graph was drawn to show the relationship between temperature and opercular movement. Finally Q_{10} was calculated using theabove formula.

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CALCULATIONS

Sl.No	Temperature C	Timetakent(seconds)			Average time taken (t-Seconds)	Rate of Opercular movement 1/t
		Trial 1	Trial 2	Trial 3		
1						
2						
3						
4						

$$Q_{10} : \frac{K_2}{K_1} \times \frac{10}{(t_2-t_1)}$$

Q_{10} : Temperature Co-efficient

K_1 : Rate of activity at $t_1\,^oC$

K_2 : Rate of activity at $t_2\,^oC$

t_1 : Initial temperature

t_2 : Final temperature

K_1 :

K_2 :

t_1 :

t_2 :

Q10 =

=

=

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Result

Q_{10} value =

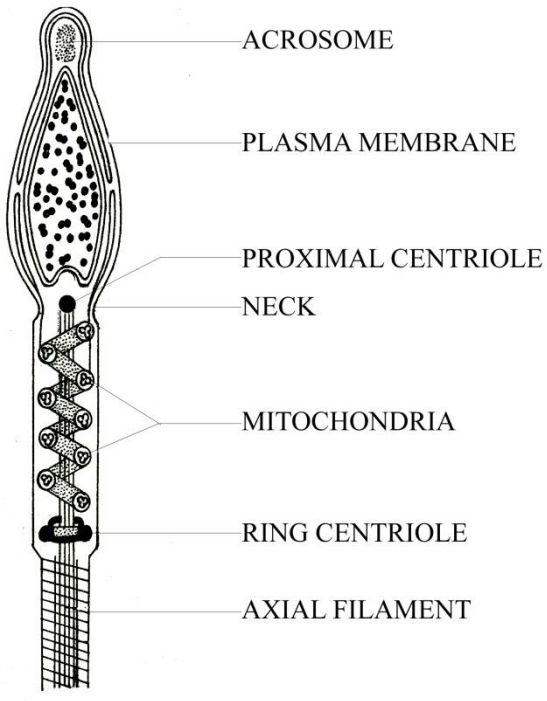
Comments

Temperature is an ecological factor which affects various physiological activities of the body. According to Vant Hoffs law, within certain limits, the speed of a chemical reaction is doubled or tripled for an increase of 10^0c. This is represented by Q_{10}. Q_{10} is the temperature co-efficient in biological process. Q_{10} is the ratio in between the metabolic rate of an animal at a particular temperature compared to that of 10^O C greater or lesser as the case may be. The present experiment clearly proves that rate of opercular movement is accelerated by increasing temperature and the temperature plays a major role in controlling the body activity. When the temperature of the medium in which the animal kept was increased, the metabolic activity of the animal also increased. The rate of activity is an index for the rate of metabolism.

The rate of opercular movement depends upon the temperature of the medium. If there is a change in the temperature, the opercular movement changes. Vant Hoffs law is found to be true in the case of opercular activity of fresh water fish which is poikilothermic. For most biological process Q_{10} ranges from 1.5 to 3.In the present experiment Q_{10} calculated was _____.

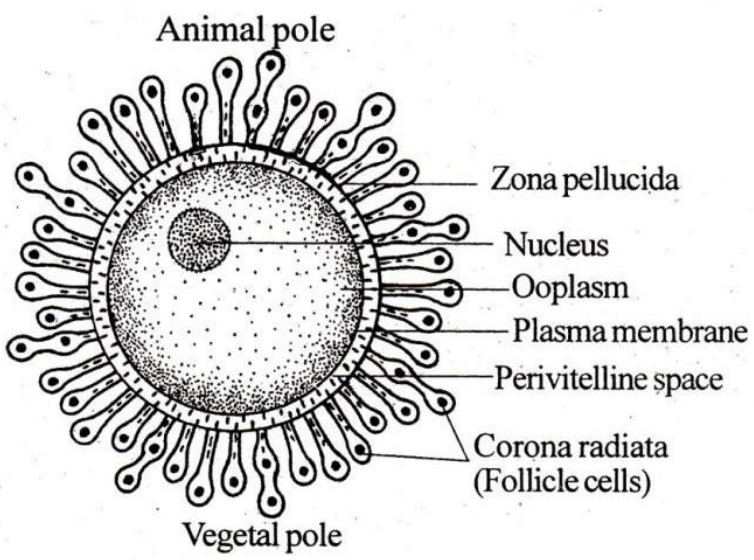
HUMAN SPERM

1. The sperm is the male gamete
2. It is **haploid**(N).
3. The sperm is microscopic.
4. The sperm is a modified cell. It is surrounded by a thin film of cytoplasm and plasmamembrane.
5. The sperm consists of four regions, namely head, neck, middle piece and tail.
6. The head consists of an **acrosome** and a **nucleus**.
7. The acrosome is in the form of a cap located at the anterior end. It is used for the penetration of the egg during fertilization.
8. The middle piece is connected to the head by a neck.
9. The middle piece contains **mitochondria** and two **centrioles**.
10. The mitochondria remain spirally coiled. They supply energy for the movement of sperm.
11. The tail has two regions, namely the main pieceand the end piece.
12. The middle piece and the tail contain a central core. The central core ismade up of an **axial filament** and nine **peripheral filaments**.
13. The sperm cell contributes the genetic material of the father to the baby.
14. The sex of the baby is determined by the sperm.
15. There are two types of sperms, namely male sperm and female sperm



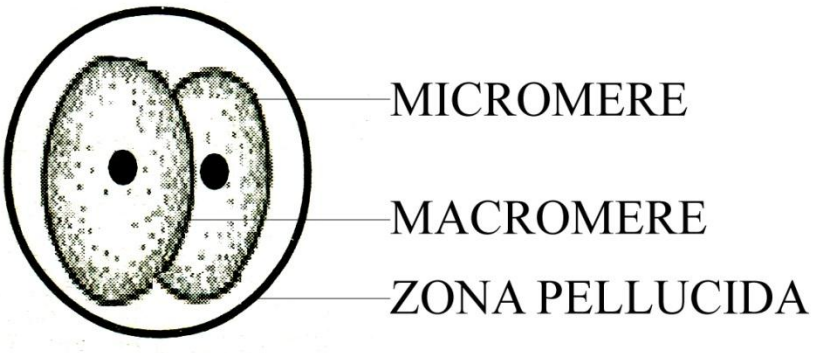
HUMAN OVUM

1. The egg is the female gamete.
2. The egg of mammal is the **alecithal** type as it contains no yolk.
3. It is microscopic. It is spherical in shape.
4. The egg is surrounded by the three egg membranes, namely an outer **corona radiata**, a middle **zona pellucida** and an inner **plasma membrane.**
5. The corona radiata is formed of **follicle cells**.
6. The zona pellucida corresponds to the **vitelline membrane**.
7. The space between the zona pellucida and the plasma membrane is called **perivitelline space**.
8. The cytoplasm of the egg is called **ooplasm**.
9. The ooplasm contains a nucleus on one side of the egg. The nucleus is **haploid**.
10. The side of the egg containing the nucleus is the animal pole. The opposite side is the vegetal pole.
11. The egg carries the chromosomes form the female parent.



CLEAVAGE

1. Cleavage is the division of the egg into blastomeres.
2. In man, the entire egg divides. Hence the cleavage is called **holoblastic**.
3. The blastomeres are dissimilar in size and hence the cleavage is unequal.
4. In man the cleavage is unusual is called rotational cleavage.
5. Cleavage occurs during the egg passes down to the oviduct.
6. The first cleavage furrow is vertical. It produces two unequal blastomeres. The small blastomere is called **micromere** and the large blastomere is called **macromere**. The balstomeres are held together by the **zona pellucida**.
7. The second cleavage in man in unique. In the macromere, the cleavage furrow passes through the polar axis and is **vertical**. But in the micromere the plane of cleavage is perpendicular to the polar axis and it is **horizontal.**
8. During the second cleavage the macromere divides to produce a 3-cell stage. This is followed by the division of the micromere to produce a 4-cell stage.
9. In man, the balstomeres divide at quite different rates. Hence the cleavage is **irregular**.
10. Then one of the macromeres divides into two, producing a five-cell stage. This is followed by the division of other macromere into two forming six-cell stage.
11. After a short time, one of the micromere divides to produce a seven-cell stage. This is followed by the division of the other micromere to produce an eight-cell stage.
12. Cleavage is completed in four days.
13. Cleavage leads to the formation of **morula.**

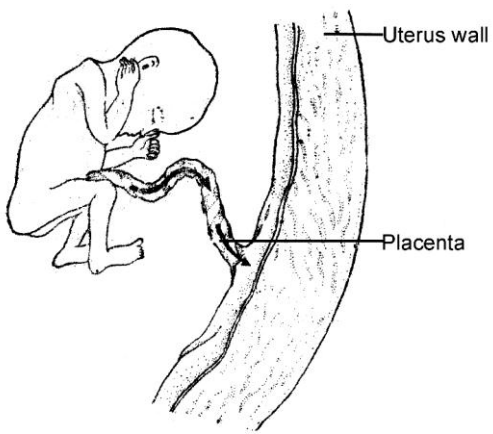


DISCOIDAL PLACENTA

1. Placenta is defined as a special kind of tissue connection between the motherand the foetus. Eg. **Monkey, rabbit** etc.
2. It is formed by the inner lining of uterus and the foetal membranes for thepurpose of physiological exchange of materials.
3. The placenta of rabbit is **chorio-allantoic**.
4. It is formed of chorion and allantois.
5. The villi are arranged on the chorion, has the shape of a disc.
6. It is called **monodiscoidal** placenta.
7. It is a **deciduate placenta**. Hence the union between the chorion and theuterine epithelium is much more intimate.
8. The chroionic villi are more branched like the roots of a tree. The villi are so intimately united with the uterine wall and hence a large part of the uterine tissues is lost along with the foetal membaranes. The uterine wall participating in the formation of placenta is called decidua.
9. The placenta of rabbit is **haemoendothelial** type because of the intimate connection between the blood capillaries of the foetus and the maternal blood.

FUNCTIONS

1. Placenta forms a physiological barrier, which may include two to six kinds of tissues.
2. Nutrients from the maternal blood pass into the blood of the embryo bydiffusion.
3. Waste materials from the embryo's circulatory system pass into the maternalblood by diffusion.
4. Placenta functions to elaborate two ovarian hormones, estrogen and progesterone together with chorionic follicle stimulating and luteinizinghormones.
5. Placenta serves as the external respiratory mechanism for the embryo.



COTYLEDONARY PLACENTA

1. Placenta is defined as a special kind of tissue connection between the mother and the foetus. Eg. **Sheep, cow, deer** etc.
2. It is formed by the inner lining of uterus and the foetal membranes for the purpose of physiological exchange of materials.
3. The placenta of sheep is **chorio-allantoic-placena.**
4. It is formed of chorion and allantois.
5. It is **indeciduate** or **nondeciduate** in nature.
6. The villi of the foetus keep loose connections with the crypts or depressions ofthe uterus.
7. Here the villi occur in groups or bunches called the **cotyledons**. They look like buttons.
8. The cotyledons fit into enlarged sockets called the **caruncles** on the uterus.Hence the placenta is cotyledonary type.
9. The chorion makes contact with maternal connective tissue (syndesmos).Hence the placenta is **syndesmochorial placenta**

FUNCTIONS

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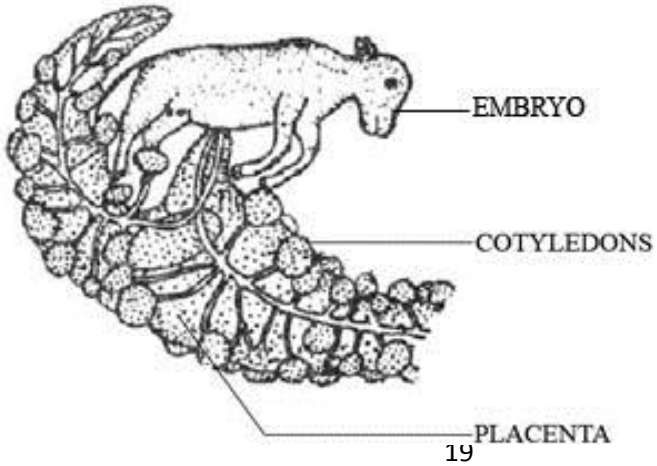
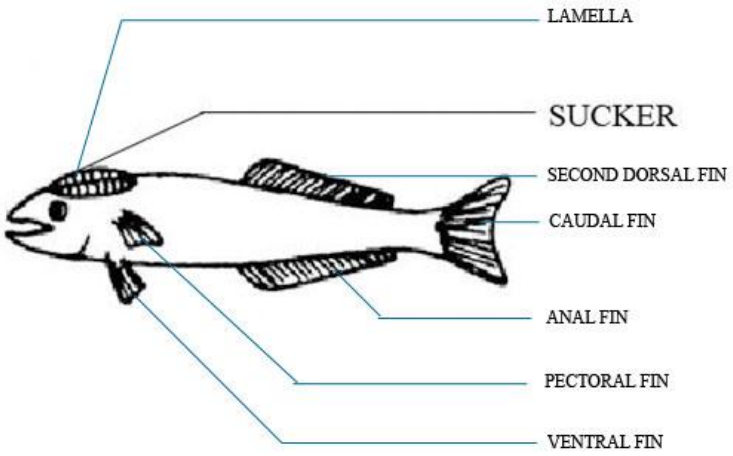


COMMENSALISM- SHARK AND ECHENEIS

PHYLUM : CHORDATA

CLASS : VERTEBRATA

1. It is a symbiotic interspecific relationship.
2. Here one partner is benefited the other partner is not harmed.
3. The suckerfish *Echenies* and shark is the important example.
4. *Echeneis* is commonly called sucker fish
5. The body is elongated, and cylindrical.
6. The scales are small.
7. The head is dorsoventrally flattened.
8. The head contains on its dorsal side a **sucker**. The sucker is the modified first **dorsal fin**. It is flat and oval in shape. It consists of a number of transverse ridges called **lamellae**.
9. The sucker is used for attachment. With the help of the sucker the fish is attached to boats, sharks, turtles and aquatic mammals and is carried from place to place free of cost.
10. The second dorsal and anal fins are long.
11. The tail is homocercal.
12. In Africa it is used for catching turtles.
13. It is an example for commensalism where the sucker fish is benefited and its partner is not harmed.



MUTUALISM- HERMIT CRAB AND SEA ANEMONE

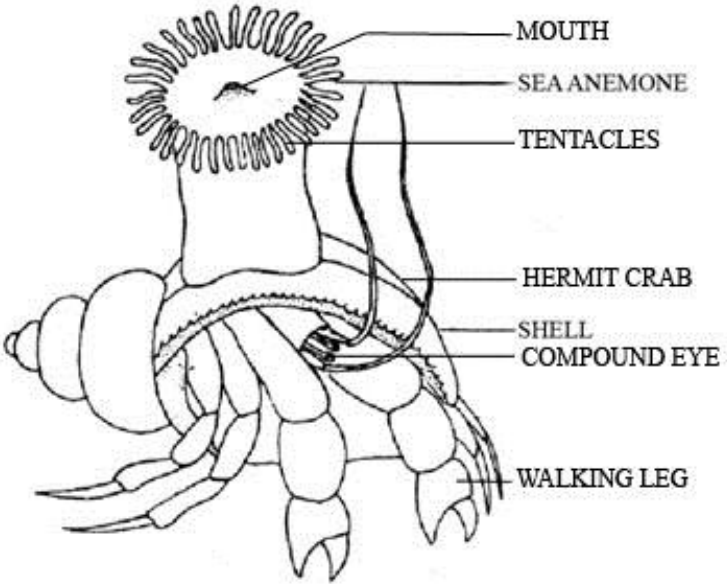
PHYLUM : ARTHROPODA

CLASS : CRUSTACEA

1. Mutualism is an interspecific symbiotic relationship.
2. Both the partners are benefited.
3. The very common example is hermit crab and sea anemone.
4. It lives in an **empty shell of gastropod**.
5. The outer surface of the shell is inhabited by **sea anemone**.
6. The body is divisible into **cephalothorax** and **abdomen**.
7. The abdomen is soft and is twisted spirally.
8. The abdominal appendages are lacking on the right side.
9. The last pair of abdominal appendages are hook-like to get attached to the shell.
10. The chelae are unequal in the first chelate legs.
11. Only one chela is used to close the mouth of the shell.
12. The last two pairs of thoracic legs are poorly developed.

Significance

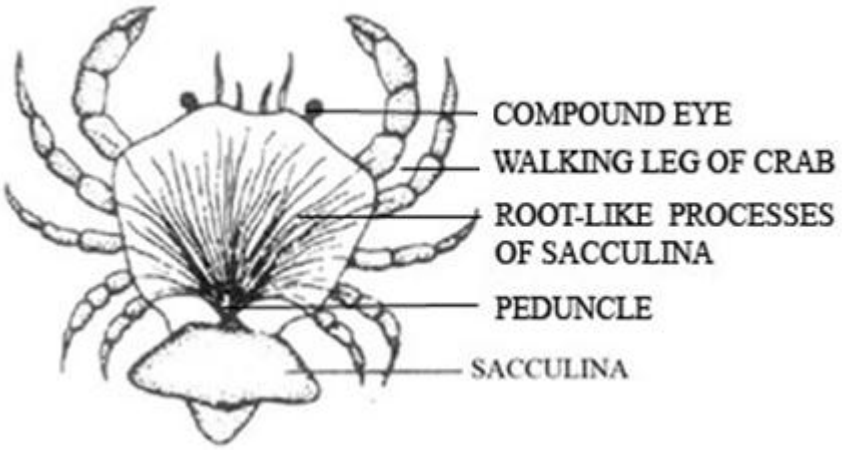
1. The hermit crab is protected from enemies by the stinging cells of sea-anemone.
2. The sea anemone gets two benefits: (i) It is transported from place to place (ii)It shares the food captured by the crab



PARASITISM- SACCULINA ON CRAB

PHYLUM : ARTHROPODA

CLASS : CRUSTACEA



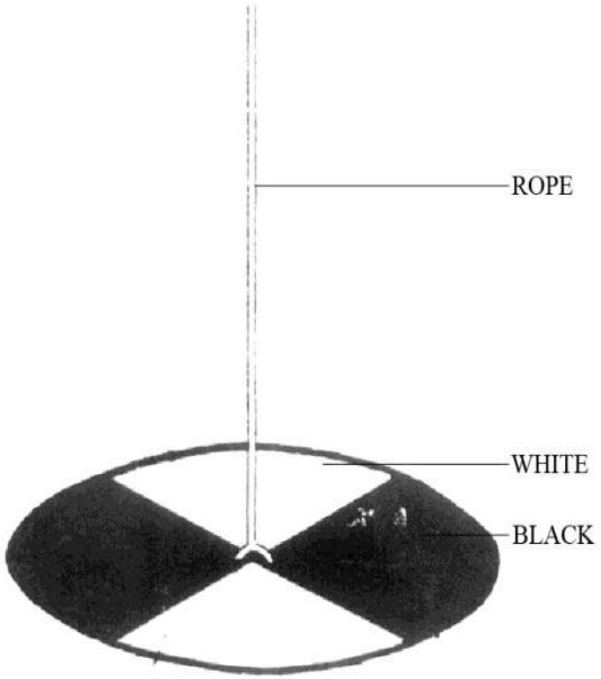
1. *Sacculina* is an ectoparasitic on crab.
2. The parasitic life leads to the degeneration of many arthropodan characters of *Sacculina.*
3. It looks like a fleshy tumour attached to the abdomen of the crab by a **peduncle**.
4. The peduncle divides into **many branched roots** and these roots ramify the bodyof the crab. The roots absorb nutritive materials from the crab.
5. The posterior end of the parasite has an opening called cloacal aperture.
6. The cloacal aperture opens into a brood chamber filled with eggs.
7. The digestive system and circulatory system are absent.
8. *Sacculina* is a hermaphrodite.
9. The fertilization is internal.
10. The life history of *Sacculina* is significant because the arthropodan character of *Sacculina* is exhibited in the life cycle only.
11. **Retrogressive metamorphosis** occurs.
12. *Sacculina* causes parasitic castration in crabs. When a male crab is infected by *Sacculina*, it changes its sex-characters '**from maleness to femaleness'**.

PARASITIC ADAPTATIONS

1. Parasites are covered with thick cuticle.
2. The parasites are provided with organs of attachment.
3. Presence of Anaerobic respiration.

SECCHI DISC

1. **Transparency** is the property to water by which it allows light to pass through so that objects in the depth can be seen.
2. In fresh water transparency is decreased by suspended materials like clay, silt, water plants, plankton blooms, etc. These objects cause turbidity.
3. Turbidity prevents the penetration of light into the water. This reduces photosynthesis and productivity of an aquatic environment.
4. Transparency is measured by a simple ecological instrument called Secchi disc.
5. This instrument was designed by **Secchi in 1865.**
6. It is **circular** in shape.
7. It has **four quarters**.
8. Two alternate quarters are black in colour and the other two are white in colour.
9. The disc has a hook in the center, from which a rope arises.
10. To measure transparency, the disc is slowly dropped in water and the depth, at which the disc disappears is noted. Similarly, the disc is slowly lifted.
11. The depth at which the disc appears is noted.
12. The average of the two readings is the transparency of water.



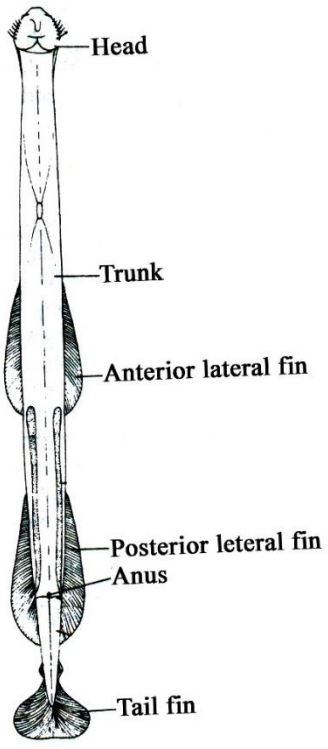
SAGITTA

PHYLUM : CHAETOGNATHA

1. Commonly it is called **arrow worm**.
2. The body is elongated thin and filament like.
3. The body is divisible into small round head, long trunk and tail.
4. The trunk bears **two pairs of fins** and a **caudal fin**.
5. Anterio ventrally a slit like mouth is present.
6. On either side of the mouth, the **bristles** serve as jaws.
7. The body is covered by thin **cuticle**.
8. Gentle movement is effected by contraction of lateral muscles.
9. Alimentary canal is a straight tube ending in anus.
10. Head is provided with a pair of eyes.
11. Sagitta is a **hermaphrodite**.

Planktonic Adaptations

1. Shape of the plankton makes them float on the surface of water.
2. Presence of elongated appendages.
3. They are active swimmers.
4. Presence of uncalcified or calcified exoskeleton



LUCIFER

PHYLUM : ARTHROPODA

CLASS : CRUSTACEA

1. It is marine plankton.
2. It is the most aberrant member of decapoda.
3. Body is very small, thin, slender and delicate.
4. The body is divisible into **cephalothorax** and **abdomen**.
5. The head region is extremely elongated.
6. The head is provided with a pair of long antennules antennae and stalked ayes.
7. Cephlathorax is smaller than abdomen.
8. Thoracic appendages are **non chelate**.
9. Appendages are absent in the last two thoracic segments.
10. Abdomen is large with distinct **biramous appendages**.
11. A distinct large uropod is present posteriorly in the abdomen.
12. The body is covered by uncalcified **chitious exoskeletion**.
13. Lucifer is a **filter feeder**.

Planktonic Adaptations

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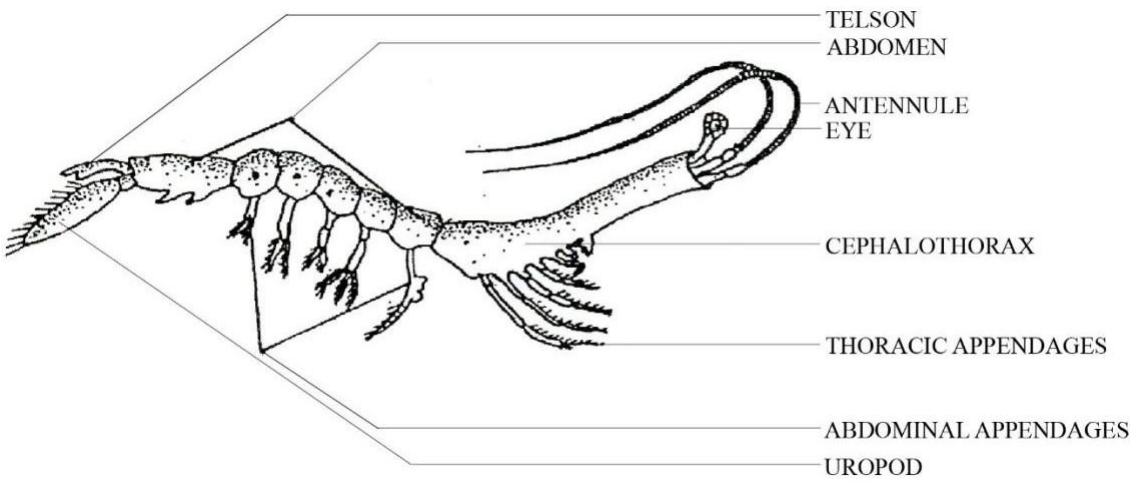
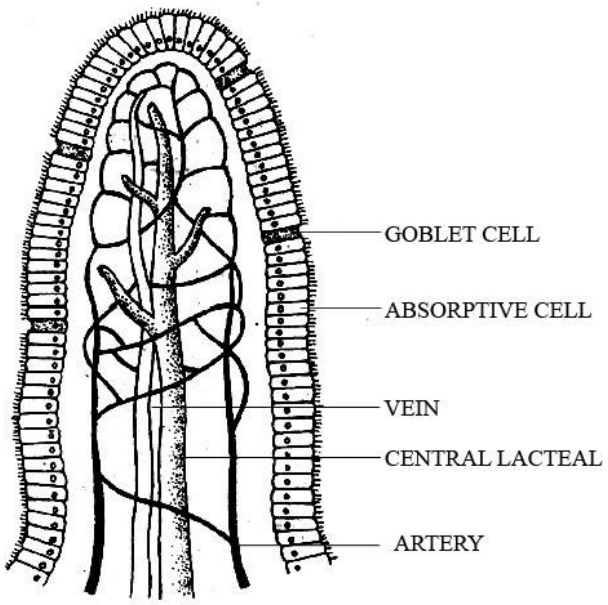
5.

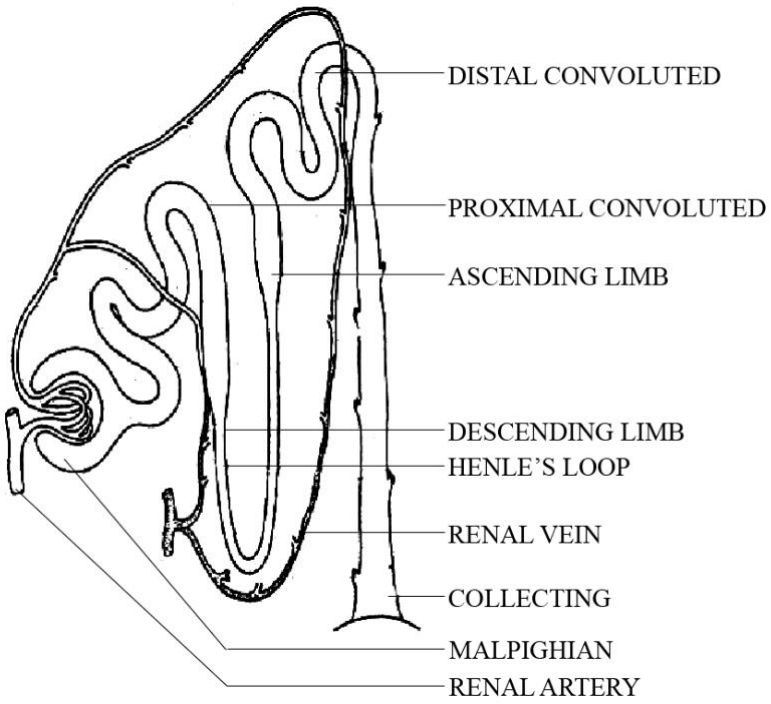


INTESTINAL VILLI

1. The mucous membrane of intestine is produced into numerous finger-like structures called ***villi***.
2. The number of villi is about 20 to 40 per sq. m.m. There are about 50 lakhs villi in human intestine.
3. Each villus has a lymph vessel called the ***lacteal*** in the centre. It contains a milky fluid rich in fat.
4. The lacteal is surrounded by a network of ***capillaries***.
5. It is surrounded by a layer of mucous epithelial cells containing tall columnar epithelial cells and few goblet cells.
6. The free end of each columnar cell has a characteristic ***brush border***.
7. The brush border is formed of ***microvilli***.
8. Digested lipids are absorbed into the lacteal and sugars and amino acids are absorbed into the capillaries.
9. The end products of carbohydrates and proteins (glucose and amino acids) are absorbed by the blood capillaries and are transported through the portal system.
10. The end products of fats, fatty acids and glycerol are absorbed by the lactealsand are transported through the **lymphatics.**



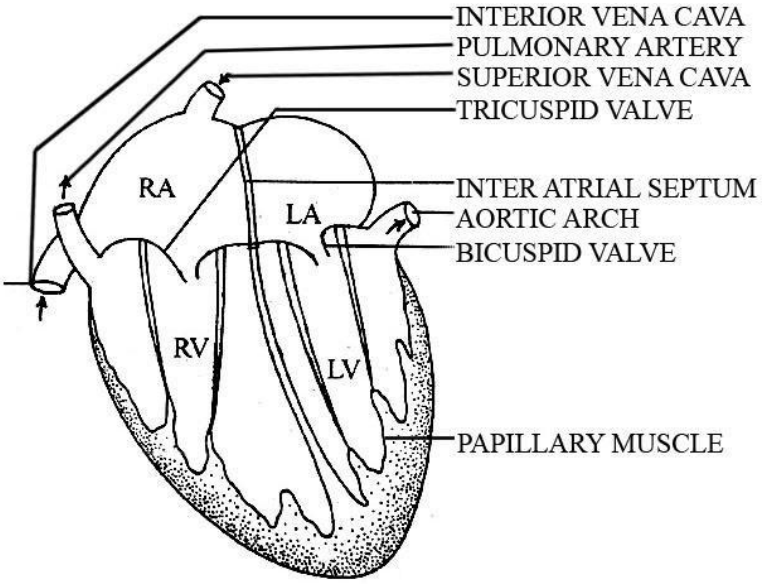
NEPHRON



1. **Nephron** or **uriniferous tubule** is the functional unit of the kidney.
2. A nephron consists of a twisted tubule closed at one end, open at the other end.
3. Each nephron is a coiled tubule having a length of 3 cm.
4. One end of the nephron is formed of **Bowman's capsule**.
5. It is a double – walled cup. The space lying between the two walls is called **capsular space**.
6. The cavity of the cup contains a network of capillaries called **glomerulus**.
7. The glomerulus receives blood through a small arteriole called **afferent vessel**.
8. The blood comes out from the glomerulus through another arteriole called **efferent vessel**.
9. The glomerulus and Bowman's capsule are together called **Malpighian corpuscle**.
10. The proximal portion of the tubule arising from the **Bowman's capsule** is thrown into many coils called **proximal convoluted tubule**.
11. It leads into an U shaped portion called **Henle's loop**. It has three regions namely, a proximal **descending limb**, a middle thin segment and a distal **ascending limb**.

12. The ascending limb leads into another coiled portion called distal **convolutedtubule**.
13. It opens into a common tubule called **collecting tubule** or **collecting duct**.
14. Each kidney receives arterial blood through a **renal artery** and the venous bloodleaves the kidney through **renal vein**.

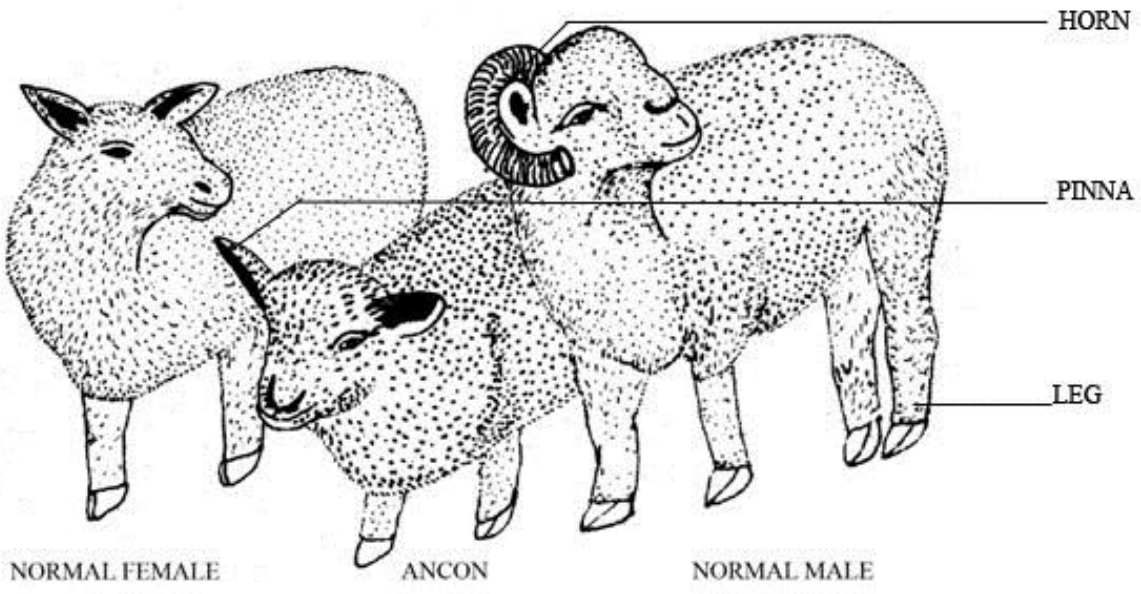
HEART OF MAMMAL



1. The heart is a **four-chambered** muscular pump.
2. The heart is conical in shape and is **mesodermal** derivative.
3. The adult human heart is roughly about the size of a closed fist. It is a **myogenic**heart. The heart is covered by a fibrous sac called **pericardium**.
4. The heart is formed of four chambers, namely two auricles and two ventricles.
5. The auricles are named as right and left auricles. The ventricles are named as right and left ventricles.
6. The right and left auricles are separated by a fibrous partition called **inter atrialseptum.**
7. The two ventricles are separated by an **interventricular septum**.
8. The auricles are separated from the ventricles by an **auriculo ventricular septum**.

9. The right auricle opens into the right ventricle by a right auriculo ventricular aperture.
10. The left auricle opens into the left ventricle by a left auriculo-ventricular aperture.
11. The right auricle receives deoxygenated blood through three veins, namely **inferior vena cava, superior vena cava** and **coronary vein**.
12. The left auricle receives oxygenated blood from the lungs through **pulmonaryveins**.
13. One large aortic arch (aorta) carries blood from the left ventricle to the variousparts of the body.
14. The pulmonary aorta carries blood from the right ventricle to the lungs.
15. The heart contains three types of valves. They are bicuspid valves, tricuspidvalves and semilunar valves.
16. The left auriculo-ventricular aperture is guarded by a valve called bicuspidvalve.
17. The right auriculo-ventricular aperture is guarded by a tricuspid valve.

ANCON SHEEP



1. Ancon sheep was short bowed legs of male lamb appeared in the flock of **Seth Wright**, a farmer in England during **1891**.
2. Ancon sheep is an individual with mutations called mutant. The mutation theory was proposed by **Hugo De Vries**. Ancon sheep forms an example to **mutation theory**.
3. Seth Wright reared Ancon sheep and bred from it the Ancon breed of sheep.
4. The adults were clumsy cripples that could neither run nor jump over an ordinary stone wall or fence.
5. Short legs limited the sheep's ability to run so that they were less active, more gentle and gained weight.
6. Ancon sheep is a product of a pathological condition called **achondroplasia**. It is a type of genetic dwarfism, which results in the failure of the development cartilage between the joints to develop.
7. The other abnormalities include looser leg joint articulations, abnormal spines and skulls, flabby scapular muscles and crooked bent inward forelegs.
8. Ancon breed became extinct later. Unsuitable mutants are destroyed by Naturalselection.
9. **Charles Darwin** was the first person to use the Ancon breed as evidence for evolution.