

B.Sc.VI: Applied Zoology (ZOUFLT2)
(Lab. Exercises)

Ex.1. Morphological characterization of common fish species.

Aim: Identification of morphological characteristics of common fish species.

Fish identification depends mostly on the external morphological characters of the fish.

Depending upon the habits and habitats of the fish, variations in structure and shape are present in organs.

Snout

The anterior most part of a fish, which in most cases is rounded or obtuse. Variations are

- a) Pointed and sharp (Eels).
- b) With a groove across on top (*Shismatorhyn chosnukta*).
- c) Tubular with jaws at tips (Pipefish).
- d) Smooth in most cases covered with thin or thick skin but in some tubercles maybe present (*Gonoprok topterus*, *Barilius* species)
- e) Over hanging the mouth (Engraulids)
- f) Some have a proboscis developed (*Garranasuta*)

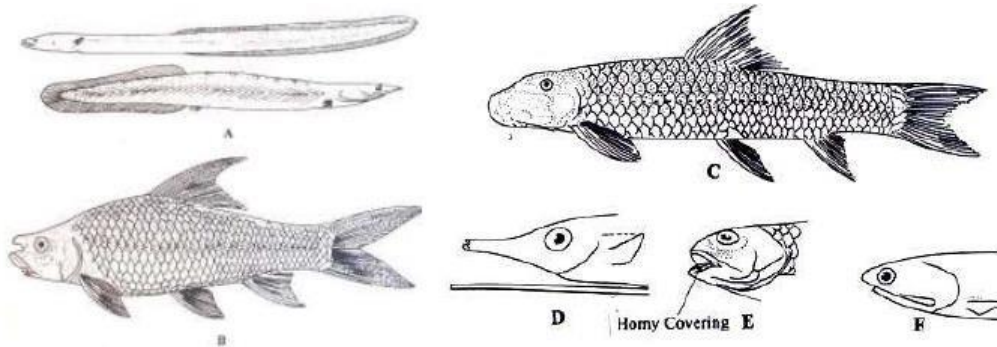
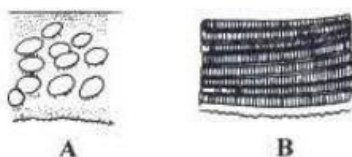


Fig.1. Shape of snout. A. Pointed and sharp. Eel. B. With a groove across on top. *Schimatorhynchos Nukta) nukta*. C. With a well-developed proboscis *Garranasuta*. D. Tubular with jaws at tips. Pipefish. E. With tubercles. F. Overhanging.

Lips

- The premaxillary and maxillary bones of the upper jaw are covered by the upper lip and the mandible on the lower jaw by the lower lip.
- Mostly these lips are thin smooth membranes but in some they may be with pores, stripes as in *Labeo dero* and *L.dyocheilus* respectively or modified to form a sucker-like disc as in *Garro* species.
- In some as in the Mahseer the lower and upper lips are continuous around the jaws and the labial fold (fold formed by the lips) is uninterrupted by the isthmus or interrupted.
- The lower lip may evenable prolonged as a flap called the mentum.
- In *Torprogenius* the upper lip is modified as a fan shaped structure.

Lip Structure



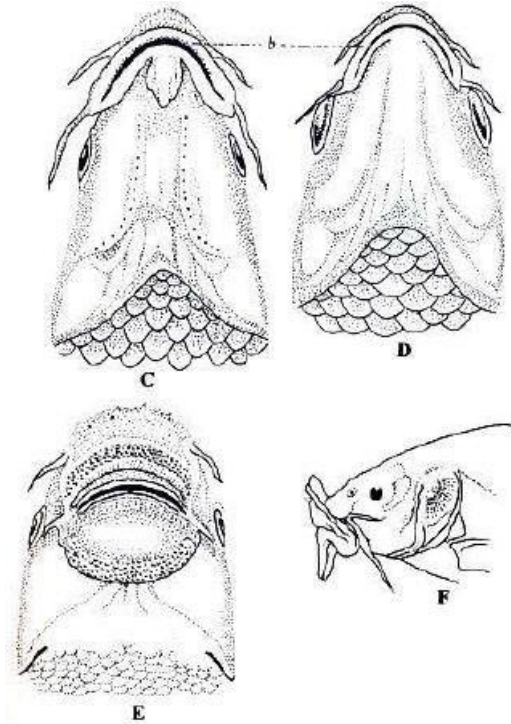


Fig. 2. Lip structure. A. *Labeo dero* with pores. B. *Labeo dyocheilus* with stripes. C. Labial fold continuous with metum. D. Labial fold interrupted. (b=Upper lip) E. With a suction disc on lower lip *Garra*. F. Upper lip with fan-shaped enlargement *Tor progenies*

Mouth

- Mouth is the chief organ for feeding of the fish and based on the type of food it takes, the shape, position, size and form vary.
- In most cases it is terminal or slightly below subterminal. Surface swimmers as *Danio*, *Puntius*, and *Rasbora* species have a terminal mouth.
- On the other hand hill stream fishes as *Balitora*, *Bhavana*,
- *Garra* species have their mouth narrow and placed in the ventral side of the snout to suit their scratching of food from the rocks and boulders where they live without being washed away by the surging waters.
- Species of *Glyptothorax* have the terminal mouth placed slightly inferior.
- In Belontiidae (freshwater Gars) the mouth is superior, wide and the cleft extends to the border of the eyes (orbit).

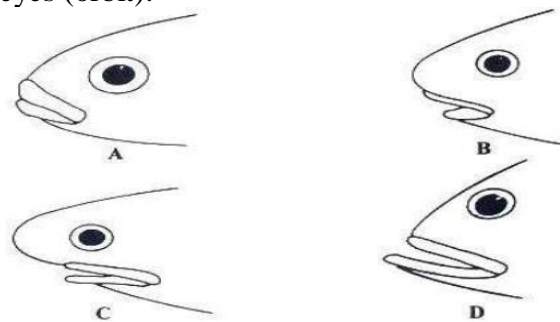


Fig.3. Shape of mouth. A. Terminal (*Danio*, *Rasbora*, *Putius*). B. Sub-terminal. C. Inferior (*Balitora*, *Garra*) D. Superior (Belontiids).

Teeth

- Teeth are borne on the jaws and palate. All fishes may not have teeth. The teeth are essentially meant for crushing, scraping the food that the fish takes and accordingly they are modified.
- Many as *Chanos chanos* (Milk fish), Cyprinids are without teeth (called edentate).
- Siluroids have sharp teeth.
- The teeth when present are mostly villiform (sharp), conical, molariform (Rita species), canine (*Pseud apocryptes* Goby).
- In Puffer fish (*Tetraodon* species) the teeth are formed like a beak- like dental plate. In most fishes the teeth on the lower jaw are in the form of an arrow or wide band, separated in the middle where as on the upper jaw it is uninterrupted and continuous.
- On the palate they may be in patches, discontinuous or continuous or as a single broad band. The band is nearly curved and may extend deep into the corner of the mouth.

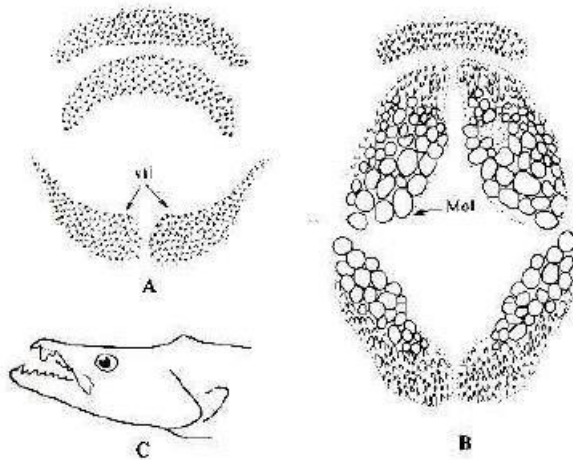


Fig. Teeth.A.Villiform.B.Molariform(*Rita*).C.Conical(*Gobies*).

Jaws

- The pre-maxillaries, maxillaries and mandible bones form the upper and lower jaws.
- The jaws are essentially mean to capture, hold and swallow the prey and the teeth help in munching, grinding and making it fit for passage through the gullet.
- They are united by a symphysis point which enables them to open and close the mouth.
- The jaws bear the teeth and act as the frame for the shape of them outh.
- The palate teeth are borne by the vomer bone, which is not a part of the jaw.
- In most fishes the jaws are more or less of equal length, but in some the upper jaw is longer than the lower.
- In Clupeidae the lower jaw is longer than the upper.
- In Engraulidae the upper jaw is projecting.
- In *Ctenopos* species both the jaws are elongated to form a somewhat pipe-shaped mouth.
- In *Hyporhamphus* species (*Hemiramphidae*) the lower jaw in the adult is elongated as along beak.
- In Pipe fishes (*Ichthyocampus* species) both the jaws are produced as a beak.
- In puffer fishes both jaws are divided by a median suture with a cutting edge and covered by ivory like substance.
- In some the lower jaw may be having a horny covering as in *Labeo fisheri*.

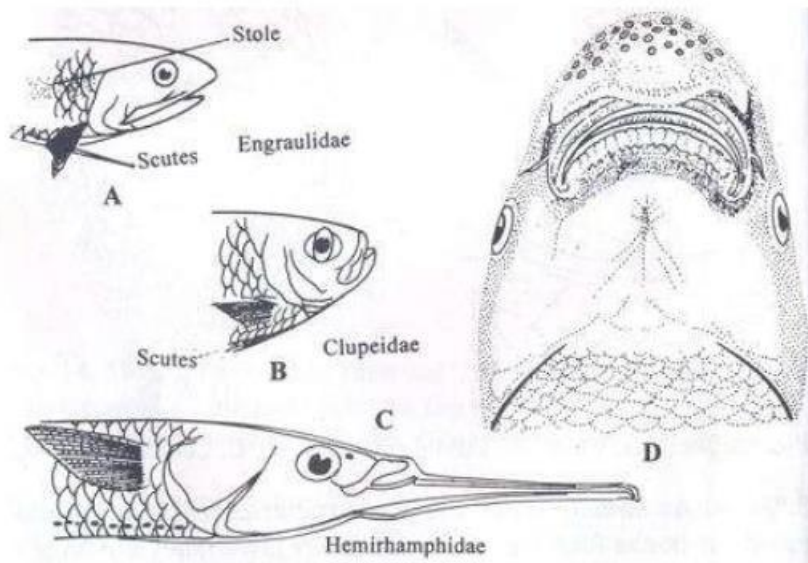


Fig. Jaws. A. Upper jaw longer than lower jaw (Engraulidae). B. Lower jaw longer than upper jaw (Clupeidae). C. Lower jaw elongated (Hemiramphidae). D. Jaw ridge horny (*Labeo fisheri*).

Barbels

- Barbels are flexible tactile filaments under the chin surrounding the mouth, on the snout, on the sides, on the ventral side and in between the nostrils.
- In cat fishes they play a very important role in identifying the food objects, locating the extent of the width in crevices and also as a defense organ.
- *Mystus bleekeri*, the fiddler fish of Mysore, erects its barbells in a threatening manner when disturbed.
- In the Ariid genus *Osteogobius* the only pair of maxillary barbels are thick and semi-osseous.
- Most siluroids carry four pairs of barbels, but it is not constant; it may be one, two or three.
- The Cyprinids also have barbells but not as long as in the catfishes.
- In *Nemacheilus* the barbells may be well developed and they are used as a sensory organ only.

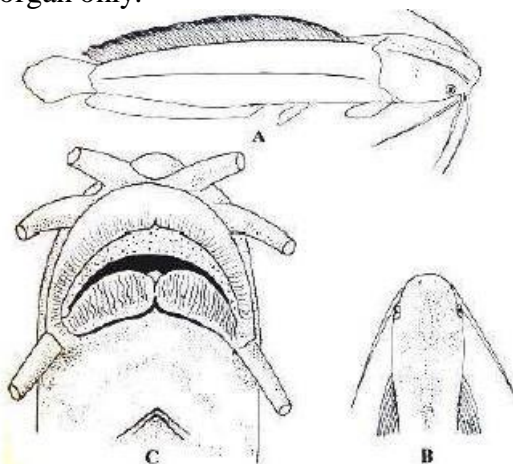


Fig. Barbels. A. Soft and muscular *Clarias batrachus*. B. Stiff and osseous *Osteogobius militaris*. C. Simple hollow short tubes. *Noemacheilus labeosus*.

Nostrils

- Nostrils are a pair of apertures or slits on the snout which are the openings for the smell organs leading to the nasal canal on the skull.
- They are mostly small to medium and are sunk in the snout, often covered by mucous especially in catfishes.
- A pair of nasal barbells is often seen, which may be long, short or rudimentary and borne on the posterior one.
- They are generally well separated but in Sisoridae the nasal barbells are closely placed one behind the other, slit-like but separated.
- In Heteropneustidae the anterior nostril is placed on the tip of the snout and produced as short tube.
- In Ariidae they are closely placed and separated by a valve like structure.
- In some Nemacheilines a flap separates them.
- In *Oreonectes* the anterior nostril is prolonged as a long nasal barbel.

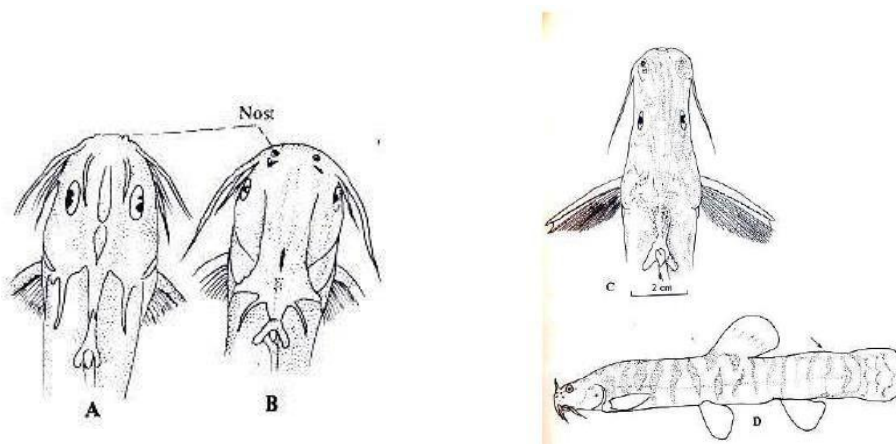


Fig. Nostrils. A. Placed wide apart Bagridae. B. Close together Sisoridae. C. Separated by a valve Ariidae. D. With a barbel in-between *Oreonectes (Oreonectes) evezardi*

Eyes

- Eyes mainly used for seeing food, enemies and predators are placed in most fishes dorso laterally (at the sides) along a mid-axis line of the body.
- However this position may vary depending upon the habitat of the fish. It may be superior or inferior.
- Many gobioid fishes have the eyes placed on the top of the head. Species of *Oxyurichthys*, *Bathygobius*, *Boleophthalmus* have the eyes placed on top of the head.
- *Mugil corsula* has protruding eyes on the top.
- In some catfishes the eyes are placed low so that they are visible from below the ventral surface.
- Chandramara chandramara, *Horabagrus brachysoma*, *Ompok* and *Ailia* species show this kind of placement.
- The cat fishes brow seat the bottom and hence the eyes are situated at this level.
- The eyes are generally large in size or moderate, but in the eels and hill-stream fishes they are, small; the latter being denizens of fast flowing shallow streams, with too much light penetrating, large eyes would be a disadvantage.
- In *Brachyam blyopuiburmanicus* (eel like goby) the eyes are minute and hidden.
- The eyes are subcutaneous and they may be circular, oval in shape. Some cave dwelling fishes are totally blind.

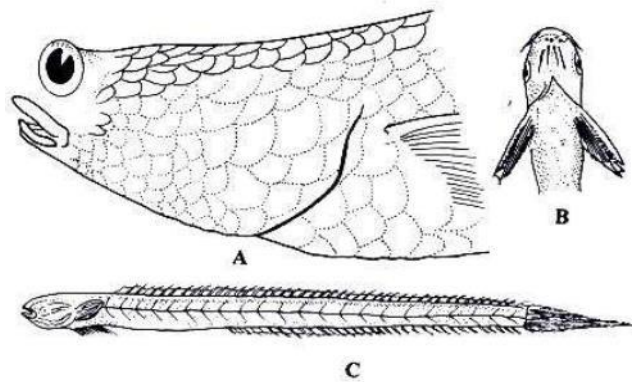
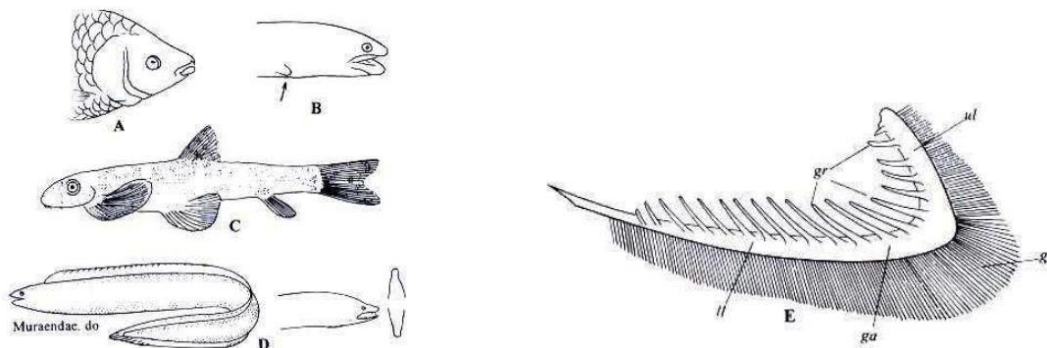


Fig. Eyes. A. Superior Mugil corsula. B. Inferior visible from below ventral surface Chandramara chandramara. C. Minute reduced, hidden Brachyamblyopus burmanicus.

Operculum and Gills

- Operculum and gills form part of the branchial apparatus. On either side of the fish.
 - The gill slits are situated which may be wide, narrow or even in the form of a small aperture as in the case of the eels.
 - In the snake eels (Ophichthyidae) the gill openings are in the pharynx as wide slits.
 - In Moray eels (Muraenidae) they are small, round openings only.
 - In hill stream fishes they are greatly restricted to the ventral side (*Bhavania australis*). Where the openings are wide they are covered by a group of flat thin opercular bones joined together by the skin which covers the gills inside.
- The concave pharyngeal margins of the branchial arches are fringed with a double series of either cartilaginous or bony tubercles or filaments called the gill rakers.
- The anterior row of gill rakers on each arch usually interdigitate with those of the posterior row on the preceding arch and in this way the two rows form a sieve like mechanism to prevent any solid particles entering the pharynx with the respiratory current of water and from passing into the gill clefts and clogging it.
- The gill arches carry the gill lamellae and gill rakers or branchiospines. The first branchial arch (the anterior-most one) carry rakers on the upper limb and filaments on the lower limb. Five gill arches are placed on either side of the head region.



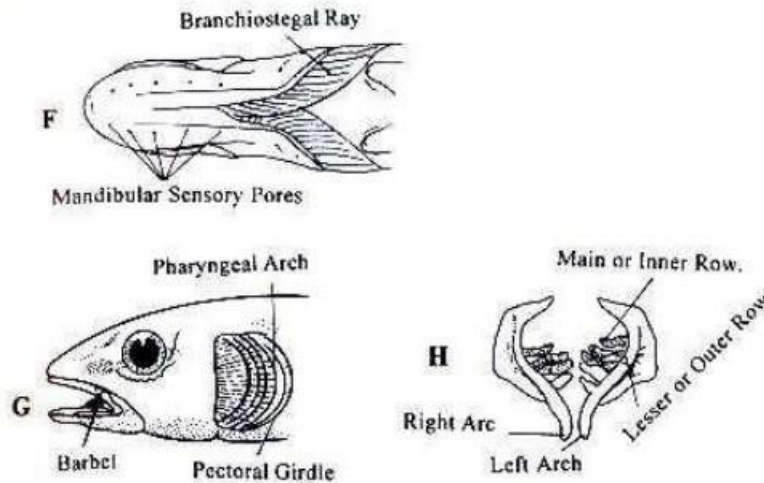


Fig. Operculum and gills. A. Normal. B. Eel as a moderate slit in pharynx near base of pectoral fin. C. Greatly restricted above base of pectoral fins *Bhavana australis*. D. Round and lateral in pharynx Mureanidae. E. Structure of gill. (u.) Upper limb. (gf) Gill filament. (ga) Gill arch. (ll). Lower limb. (gr) Gill rakers.

Median groove

- Median longitudinal groove or fontanel are two longitudinal-externally visible long depressions on the head and covered by skin in catfishes.
- They may be single or double and are in the center of the head extending from near the snout to the base of the occipital process.
- When single it is a continuous depression without a break. When double it is interrupted in the middle by a short bone. These represent the passage for the cranial nerves in the skull. When covered with thick skin its extent can be found by inserting a needle and dragging

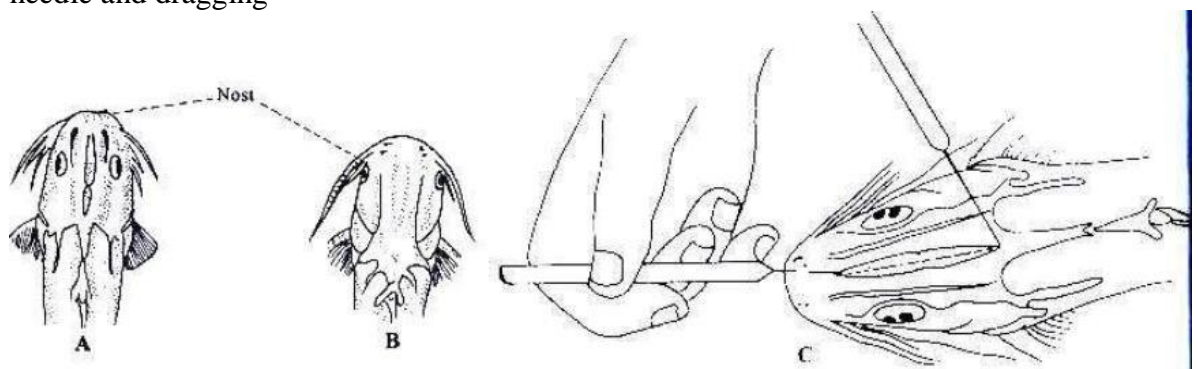


Fig.21 Median groove. A. Continuous. B. Interrupted as two fontanelles. C. Extent and identification of fontanel.

Body

The Body of the fish carries the paired and unpaired fins, scales, lateral line and internal organs as already started. The main features are

1. Paired fins

The pectoral, pelvic fins are the paired fins since they are two in numbers placed side by side.

Pectoral fins- are inserted in most cases laterally may be horizontally (Psilorhynchidae, some Homalopterids) or even above the ventral profile (perches, gobies).

They bear the fin rays, simple and branched and in cat fishes the pectoral spine. In some case the fin rays may be elongated as long filaments (*Ctenops nobilis*).

Pelvic fins(sometimes called ventral fins), are inserted in most cases ventrally and are placed with a distance in between them.

In Gobiidae they are united.

In *Sicyopterus* they are united in the form of a cup shaped disc. The fins bear the simple and branched rays.

In Syngnathids they are much reduced.

The fins are absent in some (eels, Mastacembelidae, Puffer fishes).

In perches the fins when present may be thoracico-jugular in position and bear spines.

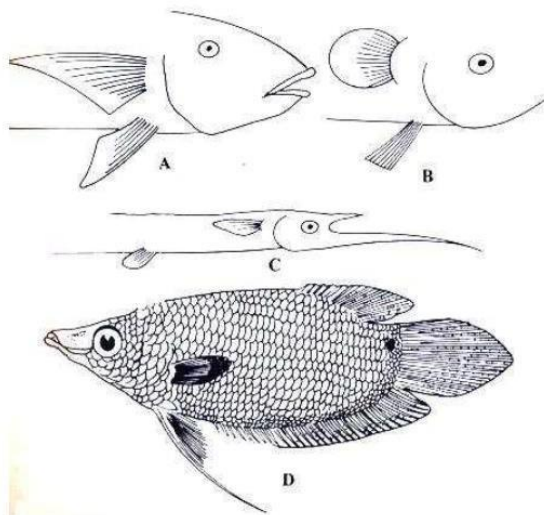


Fig. Pectoral fin insertion. A. Thoracic. B. Jugular. C. Abdominal. D. with filaments *Ctenopsnobilis*.

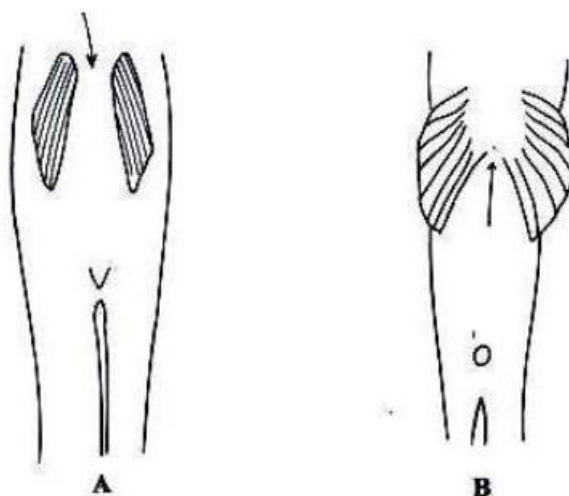


Fig.25. Pelvic fins: A. Free. B. United as a cup (Gobioids).

2. Unpaired fins

The dorsal, anal and caudal fins are unpaired in the sense that they are single and not in pairs.

Dorsal fin-in most fishes is single, concave in shape with smooth or serrated spine with simple and branched rays.

- There may be a procumbent spine in some *Mystacoleucus*.
- In *Megalops cyprinoides* the last ray is prolonged as a Filament.
- In Perches there are two dorsal fins one after the other with the first one separated either by a short or long gap from the second fin or may even be united; both may bear spines and also soft and branched rays.
- In mugils the first fin is with spines only, separated from the second one by a distance.
- In Synbranchids (Swampeels) the dorsal fin is vestigial in the form of ridges only. In *Mastacembelus* the fin is in two parts; the first one with 32 to 40 short depressible spines and 46 to 90 rays.
- In *Sillaginopsis* the second dorsal spine is prolonged as a long filament.
- The fin may be in different positions on the dorsal profile, mostly at the center, but in many may be far posterior above the anal fin. The fin may be free or even confluent with the caudal fin.
- An adipose dorsal fin is present in siluroids and salmon; it is generally smooth, free and not united with the rayed dorsal fin though the inter space between the two may belong or short.
- In *Sisorrhodophorus* the adipose fin is reduced in the form of a spine.
- In *Chaca chaca* and some other fishes it is confluent with the caudal fin

Anal fin- is inserted on the ventral side and is with simple and branched rays.

- Generally the fin is free, short, but exceptions are there as in the case of *Horabagrus*, *Clarias*, *Heteropneustes*, Schilbeids, Pangasids., Plotosids.
- In Claridae and Heteropneustidae though long, it is separated from the fin by a short distance. In *Horaichthys* the fin is modified into two parts; the first six rays are separated as an independent gonopodium.
- In *Garnbusia*an intromittent organ present. In both cases Only the males show this adaptation.

Caudal fin or the tail fin- is the propeller for the fish and acts as a rudder.

- It is the posterior most part of the fish body. It is of varying shapes and is always a single fin, rounded. with or without margins, truncate, furcate or slightly emarginate, forked, lunate or lanceolate, wedge or paddle shaped, notched, rounded or ovate,etc.

Lateral line

- The Lateral line is the sensory line formed along each side consisting of sensory pores to tiny tubes in scales or skin.
- Most fishes have the lateral line, but in some it is absent (Mugilidae).
- It is generally continuous, but in some Cyprinids and Perches it may be discontinuous or in two levels.
- Generally it stops at the base of the caudal fin but in *Latescal carifer* it extends beyond into the caudal fin.
- In *Toxotes chatareus* it is interrupted.

Scales

The body of fish is usually covered with scales, which provide protection. There are four basic types of scales:

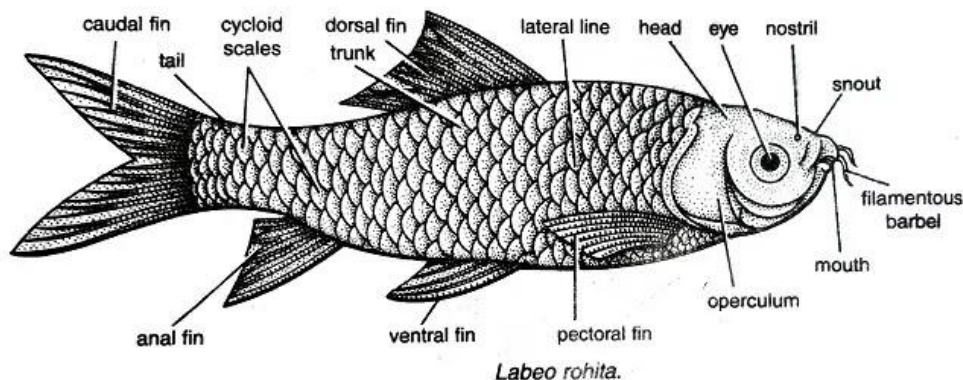
- Placoid scales (pointed, analogs of vertebrate teeth, e.g., in Elasmobranchii);
 - Cosmoid scales (probably evolved from the fusion of placoid scales, e.g., in Family Ceratodontidae);
 - Ganoid scales (rhomboid shaped, modified cosmoid scales; e.g., in Family Lepisosteidae); and
 - Elasmoid scales, separated into cycloid (circular with smooth edges) and ctenoid (circular with combed edges) scales, e.g., in Actinopterygii.

Abdomen

- The **Abdomen** of a fish is mostly rounded except in flat fishes, hill stream fishes and deep sea fishes where they are flat.
- In most Cyprinids the abdomen may be keeled with no barbell surrounded with barbels.
- In Clupeids the ventral profile may be with serrations.
- In the Sisorid fish *Glyptothorax* an adhesive apparatus is developed in which the paired fins, pectoral and pelvics, may be plaited

Ex.2. Identification of two major carps – *Labeo rohita* and *Catla catla* and their life cycles.

1. *Labeo rohita* (Ham.): Rohu (Teleostomi :Cypriniformes), Family : Cyprinidae



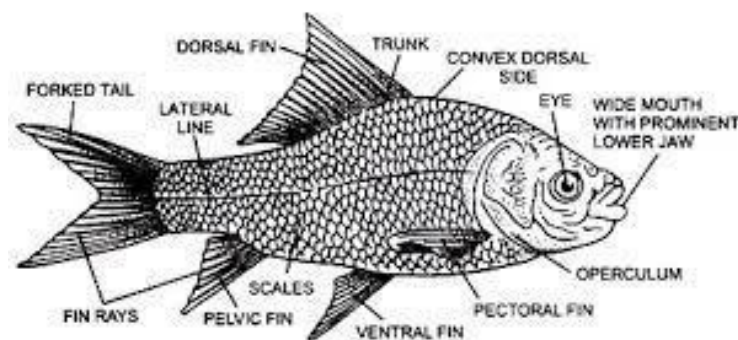
-Characters:

- Most popular and valuable carp distributed throughout Indian plains except southern region
- It develops faster comparatively
- Generally elongated body -Abdomen is rounded
- It is column feeder and feeds upon vegetation and plankton
- Dorsal profile is slightly convex
- Mouth is sub-terminal and semi-oval muscular lips and snout projected forward
- Operculum is comparatively small
- One pair small maxillary barbels
- Fins are concave, dark grey in colour and well developed
- Dorsal fin originates between the midway of snout and base of caudal fin
- Usually a red mark is present on the small sized scales
- lateral line is clear
- Confined water is suitable for cultivation but does not breed in stagnant water

- Spawning period in N. India is June to September
- Fry and fingerlings are collected for stock
- In one year, it measures about 35-45 cm (675 gm). Attains maximum length about 90 cm in about 03 years
- Cultivated in association with other carps and production is increased from 1,100 to 2000 Kg/hect/year.

Fin Formula : D 16(3/13); P 17; V 9; A 7(2/5); C 19; LL 40-41, L Tr. 6 ½- 7 ½ /9, Barbles 1 pair.

2. *Catla catla* (Ham.) : (Teleostomi : Cypriniformes), Family : Cyprinidae



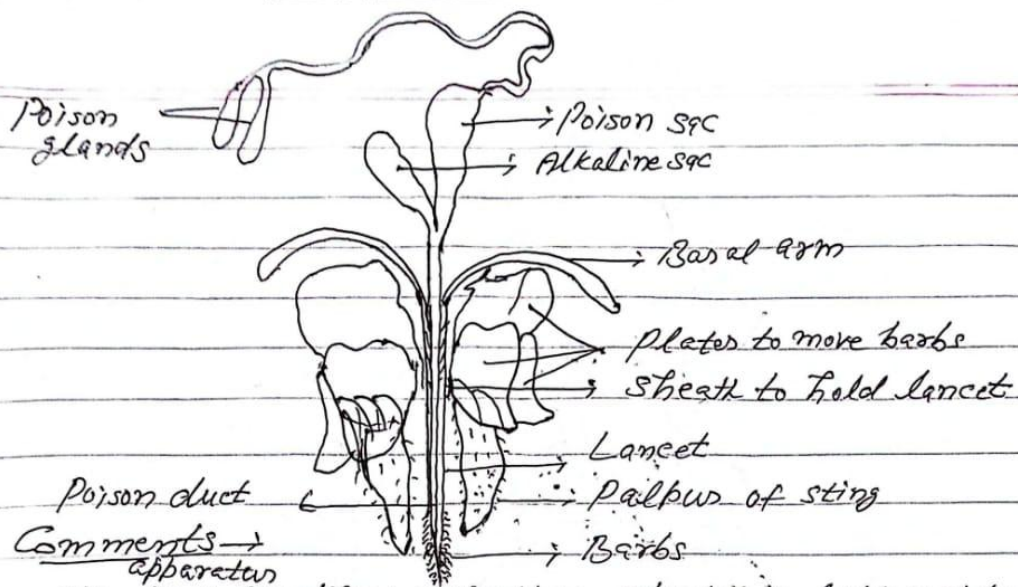
-Characters:

- It is strong and broad fish
- Rared in association with other major carps
- One of the major carp which gains weight very soon and develops faster than rohu
- It is surface feeder and feeds on plankton voraciously
- Dorsal surface is more elevated than ventral surface
- Colour of dorsal and ventral surfaces vary slightly
- Widened mouth is tilted upside and lower lip rather thick with continuous transverse folds
- Operculum is large
- Eyes are large and black
- Barbels absent
- Dorsal fin advances of pelvic fins
- Fins are black in colour and fin rays are strong
- Caudal fin well forked -Lateral line almost clear
- Large regular cycloid scales
- Maximum length about 180 cm
- Suitable for cultivation in confined waters
- Does not breed in ponds but spawning may take place under controlled conditions in special reservoirs
- Spawning period in N. India is June to Sept
- Larvae and fries are used for stocking in ponds and tanks
- Attains length 38-45 cm and weight 900 gm in one year and in second year weight becomes 4.5 Kg
- Annual production is about 1,100-2,200 Kg/ hectare.

Fin formula : D 18-19(3/15-16), P 19, V 9, A 8, C 19, LL 43, Ltr. 7 ½

Ex.3. Mounting of the sting apparatus.

(Sting Apparatus of Honey bee)



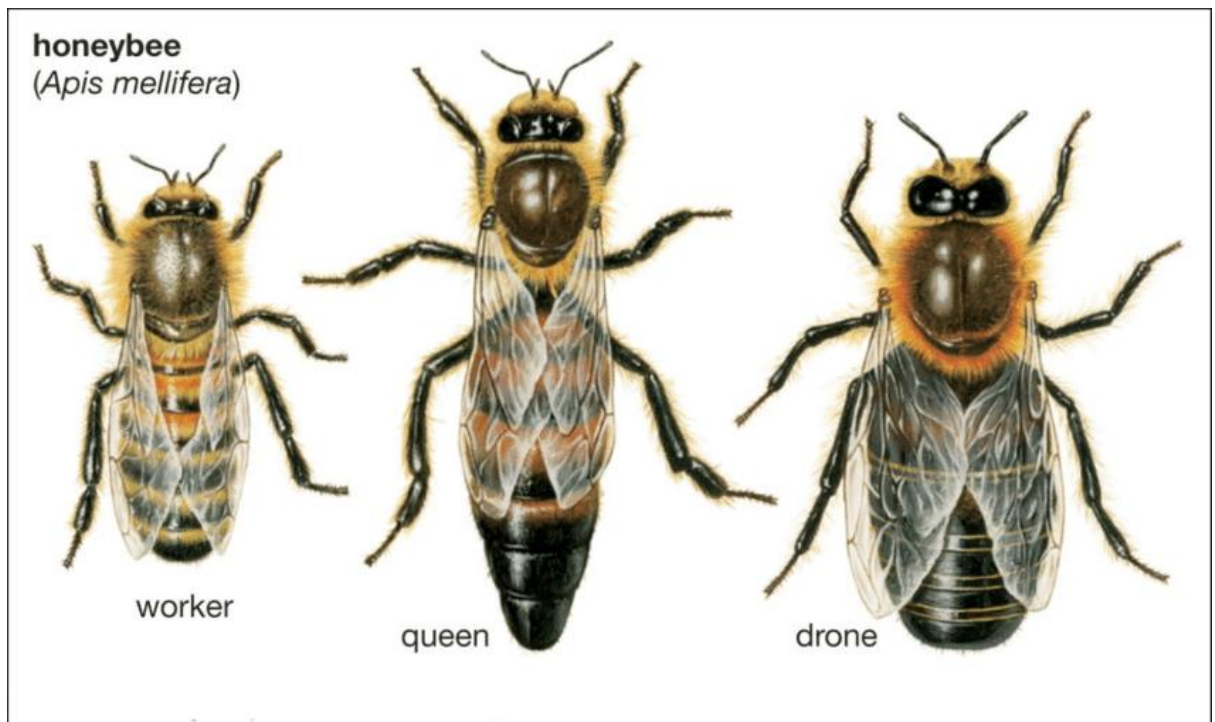
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apparatus

- Sting is a modified ovipositor, situated in last 4-5 abdominal segments.
- It is used for injecting poison.
- It is composed of two grooved stylets or lancets.
- At the distal ends of lancets there are anteriorly pointed barbs or spines.
- Muscles and three pairs of chitinous plates operate the lancets.
- A pair of filiform poison glands secrete acidic fluid which is stored in a poison sac, situated at the base of sting.
- An alkaline gland is also associated with poison sac which secretes alkaline fluid.
- Both fluids are mixed and form poison or bee venom.
- Bee venom flows through poison duct which opens at the tip of lancets.
- After stinging, sting remains in the skin of victim due to anteriorly pointed barbs.

Ex.4. Castes of honey bees.

- There are three castes of honey bee which perform various functions:
- **-Queen:** It is fertile female produced from fertilized eggs.
- -Usually only one queen resides in a colony.
- -It is largest (15-20 mm long). Abdomen is long, cylindrical and tapering.
- -It has strong legs and short wings. Its sole function is egg laying for which it has sting-cum-ovipositor.
- -Its life span is 2-5 years. It feeds on royal jelly.
- Queen secretes a queen substance (9-oxo-2-decenoic acid) which inhibits sexual development of workers and regulates their building activities.
- **-Drones:** These are fertile male produced from unfertilized eggs.
- Their number varies from 12 to 300 and are medium in size.
- -Their thorax is wide and abdomen is short and blunt, without sting.
- -They are totally dependent on workers for food.
- -Their main function is to copulate with queen and die after mating.

- **-Workers:** These are sterile females developed from the fertilized eggs.
- They are the smallest in size but largest in number (90% of colony population).
- They feed on bee bread.
- They have life span of 6 weeks.
- Ovipositor is modified into sting.
- They perform all indoor and outdoor duties.
- They have wax glands to secrete wax required for hive formation.
- **-Division of Labour:** They perform all type of duties to maintain the colony. There is great division of labour found among workers.
- a) Fanners: Air conditioning of the comb.
- b) Scavengers: Cleaning of the hive.
- c) Nurse bee: Feeding of queen and larvae.
- d) Guards: Protecting the colony from outsiders.
- e) Directors: Watching the activities of workers.
- f) Scoute/Forager bees: Searching source of food and water.
- f) Board of Directors: Few old workers constitute the board of directors which keep eye on the functioning of directors.



Ex.5. Legs of worker honey bee.

Legs of Honey bee

There are three pairs of legs in honey bee which are covered with dense hairs. These are adapted variously.

A typical leg of honey bee consists the segments \rightarrow Cox, trochanter, femur, tibia and tarsus. Tarsus is five segmented. Proximal segment of it is metatarsus while distal one is pretarsus which bears a pulvillus and a pair of claws.

① Prothoracic leg: - ~~Femur~~ ^{Tibia} is provided with stiff hairs which form Eye brush and a movable plate like velum.

- Metatarsus bears a semicircular notch called antennal comb
- Antennal comb along with velum forms the antennal cleaner.
- Posterior face of metatarsus bears bristles which form pollen brush.

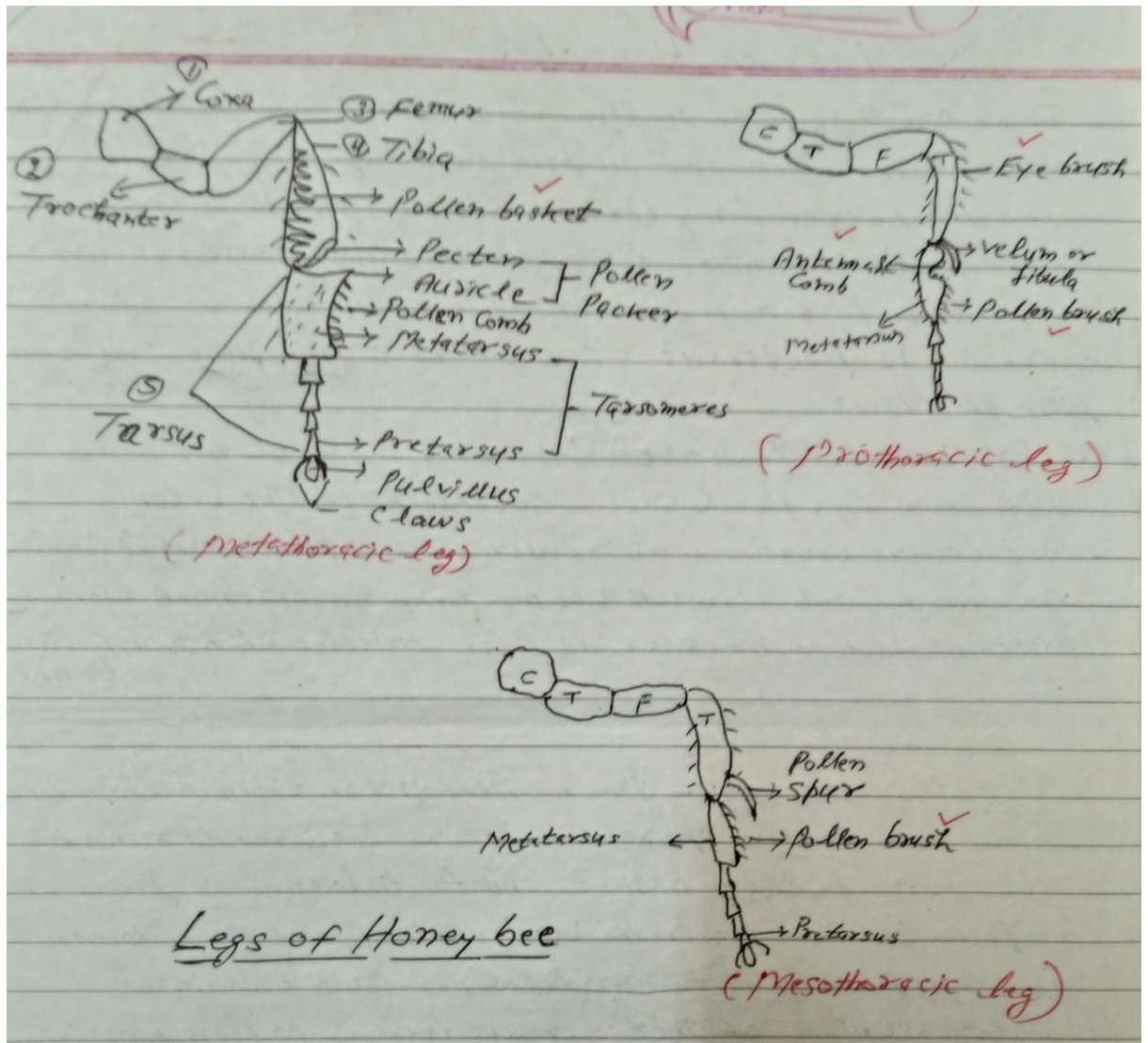
② Mesothoracic leg: - Inner distal end of tibia bears a spine like pollen spur. Both spurs are used to remove pollens from pollen basket and to dislodge wax from wax pockets situated on the ventral surface of the abdomen and transferring it to mandibles for comb building.

- Inner surface of metatarsus bears a pollen brush.

③ Metathoracic leg \rightarrow - Tibia bears a pollen basket on its outer concave surface which is partially covered by long bristles - distal end of tibia is composed of rows of spines which form the pecten - Proximal end of metatarsus bears a concave lip like structure, the auricle

- Pecten and auricle together form a pollen packer to convey and pack pollen into the pollen basket.

- Inner surface of the metatarsus bears many rows of stiff bristles forming the pollen comb which brushes off pollen from the body parts.



Ex.6. Life cycle of mulberry silkworm, *Bombyx mori*.

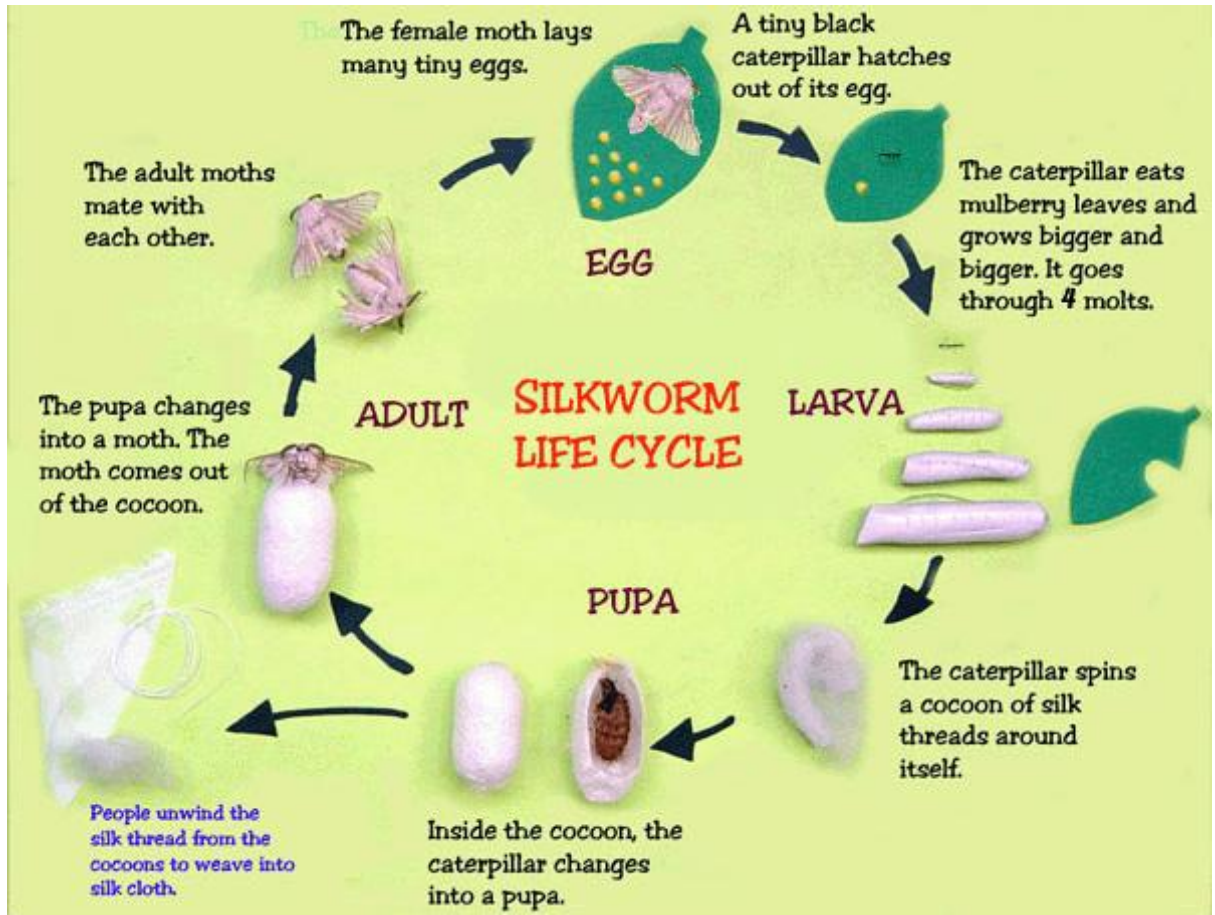
-Life cycle of silkworm is completed in about 50 days (complete metamorphosis).

-**Copulation:** Mating just after their emergence from cocoons. If both are not separated, then die. If separated then male dies soon after copulation, while female dies just after laying the eggs.

-**Fertilization:** It is internal.

-**Egg laying/Oviposition:** 300-500 eggs in clusters on the under surface of leaf at night.





-Egg: White and spherical in shape. Each egg is about 0.55 mg in weight. Anterior end bears micropyle while posterior end is flat called egg dimple which attaches with base. Eggs are covered by chorion and wax layers to prevent the water loss. Eggs are centrolecithal and become grey after embryo formation.

-Two types of eggs are produced:

-1. Diapause eggs: These are inactive and lay during winter by univoltine race.

-2. Non-diapause eggs: These are active and lay in summer by multivoltine race.

-Hatching: After 10 days of incubation, 1st instar larva hatches out.

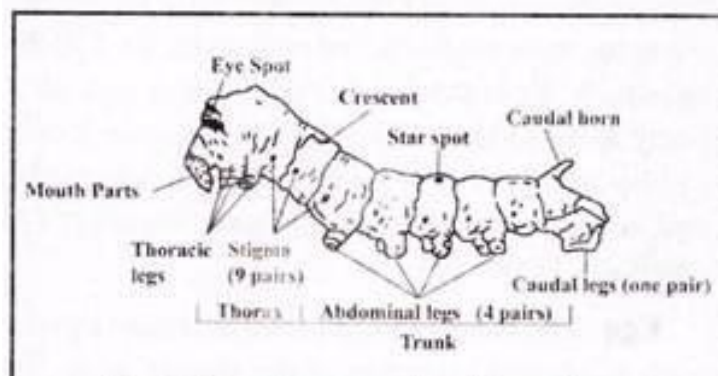
-Caterpillars/larvae: Initially, 1st instar larva is 3 mm long, 0.45 mg in weight and creamy white in colour. It moves in looping manner. Mouth parts are mandibulate type (biting and chewing). It feeds voraciously.

-After 4-5 days, it stops feeding and becomes inactive. Now 1st moulting takes place and it transforms into 2nd instar larva. It is bigger in size and resumes eating voraciously.

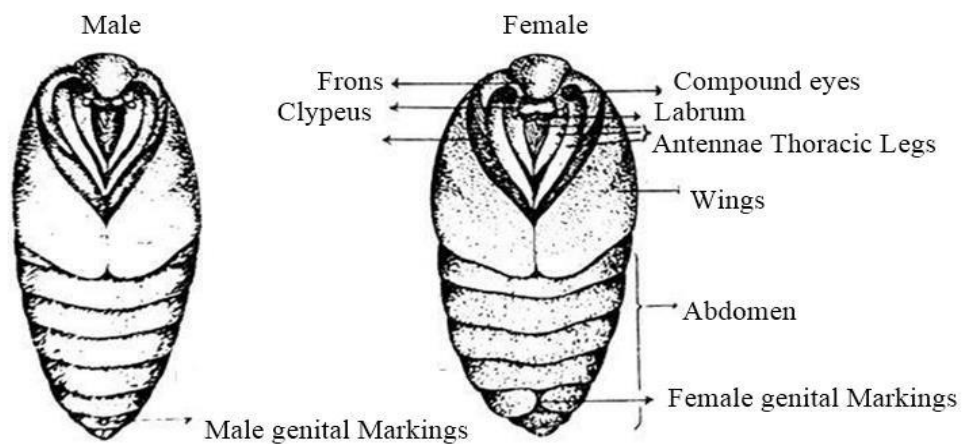
-After 7 days, 2nd moulting takes place and 3rd instar larva is generated.

-After 6 days, 3rd moulting takes place and 4th instar larva is produced.

-After 9 days 4th moulting takes place resulting in 5th instar larva. It is now 25-26 days old.



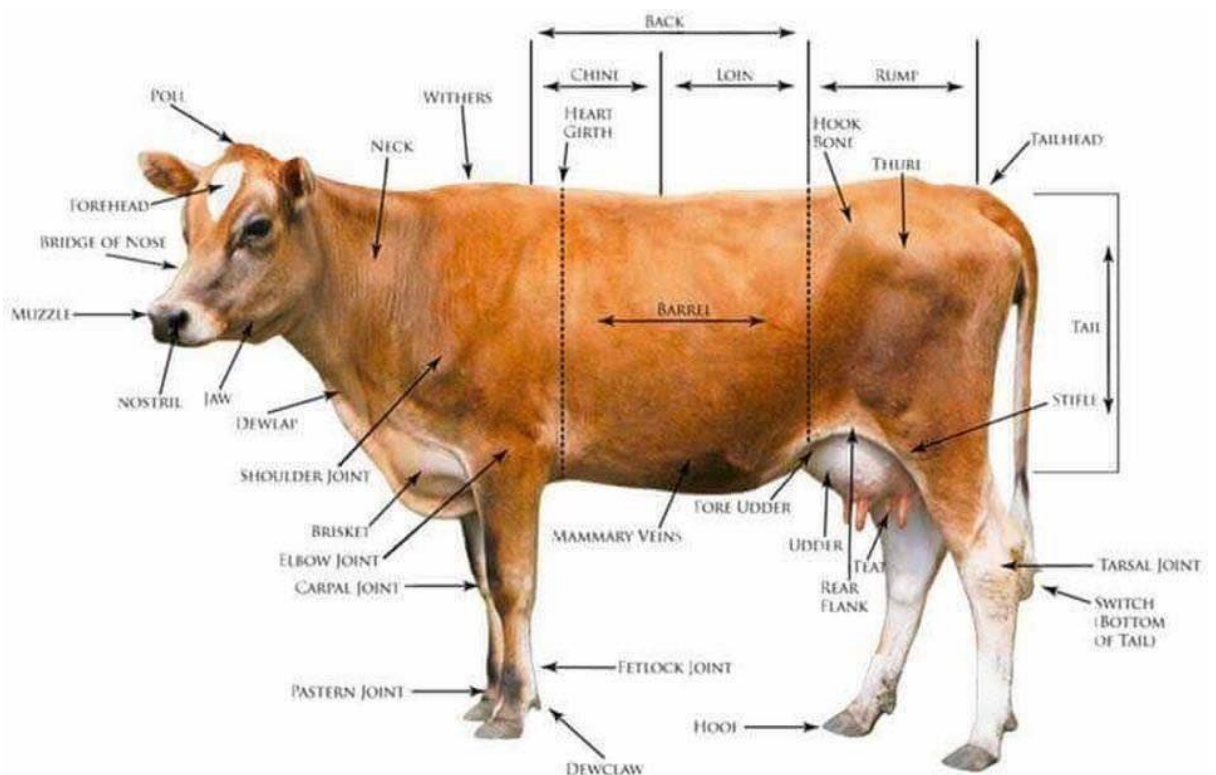
- -5th instar larva: It is about 8 cm long and 4-6 gm in weight. It has 13 segments.
- Head: It is hypognathous and bears biting and chewing type mouth parts, 1 pair compound eyes and 3 pairs ocelli. Antennae are 1 pair.
- Thorax: It appears unsegmented (fused 3 segments). It has 3 pairs jointed true legs and 1 pair lateral spiracles.
- Abdomen: It is 11 segmented. It bears 5 pairs unsegmented pseudolegs on 3rd, 4th, 5th, 6th and 11th segments. A dorsal horn is present 8th segment. First eight abdominal segments bear 8 pairs lateral spiracles. It contains well developed 1 pair silk gland.





- **-Pupa:** Within 15 days, 5th instar larva is converted into chrysalis/pupa covered with cocoon shell of silk, secreted by silk glands. Cocoon shell is formed within 3 days.
- **Head:** It has 1 pair compound eyes, 1 pair antennae and vestigial mouth parts.
- **Thorax:** It bears 2 pairs wings and 3 pairs legs which are enclosed in a chitinous case.
- **Abdomen:** It is 11 segmented but only 9 segments are visible. Spiracles are 7 pairs (6 pairs functional and 1 pair non-functional). In female, a fine vertical line is present on the ventral surface of 8th segment, while in male a rounded spot is present on the ventral surface of 9th segment.
- **-Imago:** During pupation, histolysis and histogenesis takes place and pupa finally metamorphoses into baby insect or imago. It secretes alkaline fluid to moisten one end of cocoon and emerges out. After that they copulate to repeat the life cycle.

Ex.7. External morphology and nomenclature of dairy animals (Cow/Buffalo).



HEAD

- ▮ **Poll:** The part immediately between and behind the horns.
- ▮ **Horns:** Paired bony processes that emerge from either side of the poll.
- ▮ **Ears:** The organ of hearing, situated just behind and below the horns.
- ▮ **Fore head:** From the poll down to the level of the eyes.

- ▮ **Face:** From the level of the eyes downward to the nostrils.

- ▮ **Bridge of nose:** Area of nasal bone.

- ▮ **Nostrils:** Two natural openings for breathing.

- ▮ **Temporal fossa:** Depression between the base of the horn and outer angle of the eye.

- ▮ **Muzzle:** The lower part including nostrils, mouth and a chin
- ▮ **Muffle:** Area between the nostrils, which is generally hair-less and black in colour.

- ▮ **Eyes:** An organ of sight.

- ▮ **Jaw:** Upper jaw is formed by maxilla and premaxilla, and lower jaw by mandible bone.

- ▮ **Cheeks:** Area of masseter muscle, the side of the face below the eye and above and to the side of the mouth.

- ▮ **Jowl:** Space between the branches of the lower jaw.

- ▮ **Throat:** The upper part of the esophagus just behind the jowl.

NECK

- ▮ **Crest:** Upper ridge of the neck, starting from poll.
- ▮ **Base of the neck:** The place where neck joins the body.
- ▮ **Apex of neck:** Attachment of the neck to the head.
- ▮ **Hollow of the neck:** Hollow area at the base of the neck.
- ▮ **Jugular groove:** Running down the lower part on each side of the neck from the angle of the jaw to just in front of the shoulder.
- ▮ **Dewlap:** A pendulous fold of the skin hanging down the lower part of the neck.

TRUNK (BODY)

- ▮ **Hump:** Fleshy protuberance on the top or shoulder of the animal.
- ▮ **Withers:** Just behind the hump.
- ▮ **Back:** Just behind the withers to the head of the last rib.

▮ **Loin:** The part of the body lying on each side of the spinal column between the hip bone and last rib.

▮ **Rump:** Region of sacrum, point of rump is the highest point formed by the sacral tuber.

▮ **Dock:** The part of the body of animals adjacent to the base of the tail.

▮ **Tail:** The posterior extremity of an animal.

▮ **Switch of tail:** Tuft of hair at the end of the tail.

▮ **Breast:** Lower part of the neck where it joins the body.

▮ **Brisket:** The part of the lower chest of the animal between the two fore legs.

▮ **Chest:** Ribs springing from the backbone above and attached to the breastbone below.

▮ **Girth:** Circumference around the chest, it is just behind the point of elbow.

(Abdomen):

▮ **Belly:** The area behind chest carrying alimentary canal and other organs.

▮ **Flank:** Hollow area between the ribs and hip or hook bone.

▮ **Fold of flank:** The flap of the skin on its lower border.

▮ **Body:** Comprises the chest, belly and flank.

▮ **Barrel:** Comprises belly and flank.

▮ **Anus:** The posterior opening of alimentary canal under the root of the tail.

POINTS PRESENT ONLY IN MALES

▮ **Sheath (Prepuce):** Flap of skin in the abdominal region.

▮ **Penis:** The male organ of copulation.

▮ **Scrotum:** Pouch of skin in which the testicles are lodged.

▮ **Testicles:** Male generative glands, which lie in the scrotum.

POINTS PRESENT ONLY IN FEMALES

▮ **Naval flap:** Loose skin below the abdomen.

▮ **Udder:** Mammary gland, the anterior part is called the fore udder and posterior as rear udder.

▮ **Teats:** Through which the milk is drawn.

▮ **Milk vein:** Vein on the udder.

▮ **Vulva:** External opening of the female genital organs situated below the anus.

▮ **Escutcheon:** A triangular pinkish area below the vulva extending on both sides up to pin bones.

▮ **Milk well:** The place from where the milk veins enter into the abdominal wall.

FORE LIMB

▮ **Shoulder joint:** The joint formed between the scapula and upper end of the humerus. It includes the point of shoulder and shoulder blade.

▮ **Elbow joint:** Formed by the dorsal end of humerus and proximal end of radius and ulna.

▮ **Arm:** The region of massive muscle lying over the humerus.

▮ **Fore Arm:** Region of radius and ulna between elbow and knee joint.

▮ **Axilla:** The cavity beneath the junction of the arm (region inside the elbow).

▮ **Knee-joint:** Formed by radius, carpal bones and metacarpal bones.

▮ **Fetlock joint:** Joint formed by the lower end of the metacarpal bone and the first phalanx with its sesamoides.

▮ **Shank, shin or fore cannon:** Portion of the limb below knee joint to fetlock joint.

▮ **Dew claws:** Two horny callosities behind the fetlock joint.

▮ **Pastern:** The region below fetlock and above coronet.

▮ **Coronet:** Region round the top of the hoof.

▮ **Hoof:** The outer horny covering of the foot, which is divided into two parts called claws.

▮ **Cleft of the hoof:** Space between the two claws.

HIND LIMB

▮ **Hindquarter:** Region bounded by rump and dock.

▮ **Buttocks:** The mass of muscles lying on either side of anus and extending downwards to the level of stifle to behind and flank in front.

▣ **Hook bones:** Bony prominence formed by the external angle of ileum.

▣ **Pin bones:** The projection of the quarter just below the root of the tail.

Thurl (Hip joint): Midway between hook bones and pin bones (formed by ischiatic tuber).

▣ **Thigh:** Region of femur bone, which runs from the hip joint to the stifle joint.

▣ **Stifle joint:** The joint formed by femur, patella and tibia.

▣ **Groin:** The inner aspect of thigh.

▣ **Hock:** Joint formed between the tibia, tarsal bones and metatarsal bones.

▣ **Point of hock:** The upper most extremity of hock formed by tuber calcis.

▣ **Hamstring:** The strong tendon running from the muscles of the back of the thigh to the point of hock.

BUFFALO

▣ Hump and dewlap are not present in buffaloes.

▣ Brisket is more developed in buffaloes as compared to cattle.

▣ Rest points are same as in cattle.

Ex.8. Determination of the specific gravity of milk by using a mercury lactometer. Adulteration tests in milk

Aim: To check water adulteration in milk by using lactometer

Principle: Water is the most common adulterant used which decreases nutritional value of milk and lowers the quality of milk. The milk adulterated with water has low density compare to pure milk, so that lactometer when dip in adulterated milk sinks more.

Requirement: Lactometer, pure and adulterated milk, beaker, etc.

-Methods to test the adulteration:

Lactometer:

-Lactometer is a cylindrical vessel made by blowing a glass tube. One side of glass tube looks like a bulb filled with mercury and another side is thin tube with scale. For milk testing, lactometer is dipped in milk which we are testing. In lactometer, the point up to which it sinks in the pure milk is marked after that put in water and marked at the point up to which it sinks in water. It sinks less in milk than water because as we know milk is denser than water. In the lactometer there are two portions i.e. 'M' and 'W' which is divided in three parts and marked as 3, 2 and 1. That indicates the level of the purity in milk.

-Procedure:

-Put the lactometer in milk.

If it sinks up to the mark 'M' which is mentioned in the lactometer that means milk is pure or if not that means milk is impure.

-If the milk is mixed in water then it would sink higher than the mark 'M'.

-If it stands at the mark 3 that means milk is 75% pure and respectively 2 for 50% purity and 1 means 25% purity.

-Result:

-Precautions:

1. Use the lactometer gently.
2. Prepare a milk sample adulterated with water.
3. Procure purest milk from the dairy.
4. Wash and dry the lactometer after the use.

Ex.9. Test for good quality eggs.

Object: Determination of quality of hen's egg

Principle : Grading of eggs is carried out by using external and internal characteristics of eggs. The main characteristics which are taken into considerations are shell quality, size of air cell, shape index, egg weight, yolk and albumen quality, immersion of egg in water, fluid volume, etc.

Requirements: Fresh and stored eggs, scale, measuring jar, beaker, etc.

Procedure: In this experiment, characteristics of eggs observed are: Shell quality, weight, volume of fluid, tendency towards water and shape index. Two fresh eggs of similar size and weight were procured. Egg quality of one fresh egg was observed immediately while the second egg was stored for 15 days at room temperature and after that, the stored egg was observed qualitatively. Methods used are as follows :

1. **Shell quality :** It was observed by the sound produced by the egg when tapped it gently by a wooden stick. Cracks and cleanliness of eggs were observed by naked eyes and hand lance.
2. **Weight:** Egg was weighed by physical balance.
3. **Tendency towards water:** It was observed by immersing the eggs in the water.
4. **Shape index :** It was calculated by using following formula :
$$\text{Shape Index} = \frac{\text{Maximum breadth}}{\text{Maximum length}} \times 100$$
5. **Fluid volume :** It was measured with the help of measuring jar.

Observations:

| Characteristics | First egg | Second egg | Standard quality |
|------------------------|---------------------|---------------------|-------------------------|
| Shell quality | Clean and no cracks | Clean and no cracks | Clean and no cracks |
| Weight | 65 gm | 60 gm | 50-70 gm |
| Tendency towards water | Submerged | Submerged | Should be submerged |
| Shape index | 80% | 80% | 70-75% |
| Fluid volume | 63 ml | 55 ml | 62-65 ml |

Results: On the basis of weight of eggs and fluid volume, it can be said that first egg is fresh and second egg is stored.

Precautions:

- 1. Handle the eggs carefully.
- 2. Measure the length and width accurately.

Ex.10. Test for fertilized and unfertilized eggs (Light test, Cracking test).

Aim: Candling of eggs to test the quality of eggs.

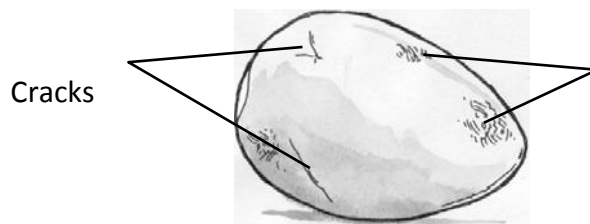
Principle: Candling is the process of using light to help determine the quality of an egg. Automated mass-scanning equipment is used by most egg packers to detect eggs with cracked shells and interior defects. Hand candling-holding a shell egg directly in front of a light source- is done to spot check and determine accuracy in grading.

Requirements: Fresh and days old egg incubated eggs, light source (torch, etc.).

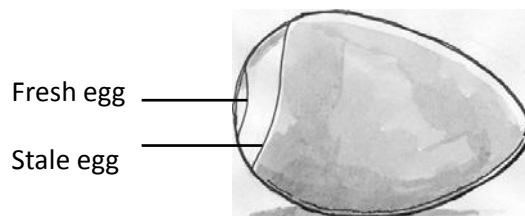
-Candling of eggs: Candling is a method of inspecting the egg during incubation. A bright light, usually a torch is used to allow light to penetrate the shell and display the contents.

-Uses of Candling:

1. To check the quality of the egg shell before incubation: Uneven shells (mottled) and cracked shells should be discarded at this stage. Irregular shaped eggs and those with mottled shells have a poor hatching rate. Cracked shells can introduce bacteria to the incubator which can infect the other eggs.



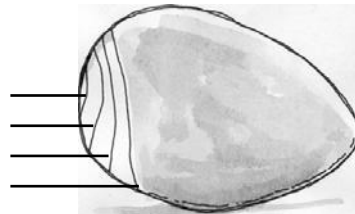
2. To check the freshness of eggs to be incubated: The air sac at the large end indicates the level of freshness of the egg. As the egg ages, the air sac grows larger. Many people 'float' eggs to test for freshness. As the eggs age and the air sac gets larger, the eggs tend to float in water.



3. To monitor humidity during the incubation period: Low Humidity causes an over-large air sac, and high humidity causes a small air sac.

4. To monitor the development of the embryo: Eggs that are clear by day 7 are infertile and should be discarded. By day 14, the embryo is well developed and shows as a dark mass occupying most of the shell. Movement can be noticed at this stage. By day 19, considerable activity can be seen and the beak can be seen in the air sac.

Fresh
Day 7
Day 14
Day 18



-Method of Candling

-Candling needs to be done in a darkened room.

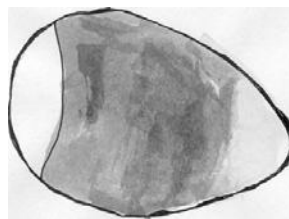
-Remove the eggs from the incubator gently with a minimum of rolling.

-A handy way to move the eggs is in an egg carton base with the pointed end down.

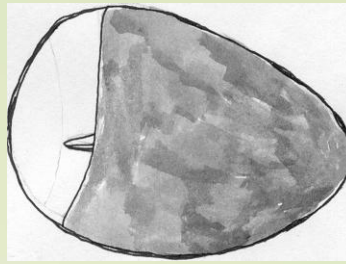
-Once in the darkened area, place the candling torch over the large (blunt) end of the egg and view the contents from the side. White or light coloured shells are easier to view.

-At approximately day 4 the first signs of activity should be noticed. This will show as a small dot with blood vessels radiating from it. Eggs containing live embryos have a warm pinkish tinge to them.

-As the embryos grow, they occupy more space inside the egg until about day 14 when almost all the egg is dark inside.



-In the advanced stages, towards day 18, considerable activity can be seen especially as a reaction to the candling torch light. Lack of activity, however, does not necessarily mean that the embryo is not alive and well. A failed embryo at this stage is usually noticeable by a change of colour from the warm pinkish tinge to a yellow tone, the dark mass tending to become solid and stuck to the shell.



Egg at 19 Days (beak in air sac)

Ex.11. External morphology of poultry birds.

CHICKEN

▮ The body of a fowl can be divided into four major parts for the study of its points. These are head, body, legs and wings.

HEAD

- ▮ Comb: The fleshy part on the head, which is a colourless and featherless body.
- ▮ Face: The area in front of, behind and around the eyes.
- ▮ Eye: The organ of sight.
- ▮ Eye ring: The name given to the bony ring at the union of cornea and sclera of the eyeball peculiar to the birds.
- ▮ Ear: In birds it does not form any external appendage to the head and an opening surrounded by a fringe of feather leads into a canal.
- ▮ Ear lobe or Deaf ear: A colourless and featherless fold of skin attached on either side of the head below ears.
- ▮ Cap: Feathers above the eyes forming a cap.
- ▮ Nostrils: Two narrow oval openings on the base of the upper part of the beak, their margins being guarded by small feathers.
- ▮ Mouth: In birds it is characterized by the absence of lips and cheeks. The jaws are replaced by ▮ BEAK which is a dense horny structure. The teeth are absent in fowl.
- ▮ Tongue: It is shaped like an arrow.

▮ **Wattles:** Two fleshy coloured, featherless fleshy fold of skin hanging below the beak.

▮ **Throat:** The area between the wattles.

▮ **Beard:** Bunch of feathers beneath the throat found in certain breeds.

▮ **Crest:** A tuft of feathers on the head of fowl in certain breeds.

BODY

▮ **Neck hackles:** The feathers around the neck.

▮ **Cape:** The bottom of the neck hackles.

▮ **Back:** The area of the thoracic vertebrae.

▮ **Saddle:** The part behind the back reaching up to the tail (corresponding to cushion in female fowl).

▮ **Saddle hackles:** The long slender feathers, which droop from the saddle of the cock (CUSHION FEATHERS in female).

▮ **Parson's nose:** The portion of the body to which tail is fixed at the end of the body.

▮ **Oil gland:** Under the tail in the muscles in which the feathers are attached, glands are situated which secrete oily secretion used by the birds occasionally to dress up its feathers for giving a glossy appearance.

▮ **Main tail feathers:** Stiff and straight feathers. Sometimes the two top ones are slightly curved.

▮ **Sickles:** The top pair of curved feathers on a cock's tail. Sometimes one or two pairs falling below are termed Lesser Sickles.

▮ **Tail coverts or Hangers:** The soft covered sickles like feathers at the base of the cock's tail.

▮ **Breast:** The parts of the body from the point of breast bone up to the throat.

▮ **Brisket:** Region between the legs.

▮ **Chest:** The area surrounded by the ribs and covered by wings.

▮ **Abdomen:** The part beneath the vent and down to the loose end of breast bone.

▮ **Keel:** The posterior end of the breast bone

▮ **Cloaca:** The last tubular structure of the large intestine opening on the exterior.

▮ **Vent:** The opening of the cloaca, which is common for the digestive, urinary

and genital systems.

▮ **Fluff:** The fine under coat feathers covering abdomen and upper part between pubic bones and legs.

▮ **Pubic bones:** The bones projecting backwards below the vent and can be felt easily.

LEGS

▮ **Thigh:** Formed by the bulge of gastrocnemius muscle on tibia.

▮ **Hock:** Joint between the thigh and the shank.

▮ **Shank:** Formed by metatarsal bone and is covered by the scales.

▮ **Spur:** Bony protuberance on the inside of the cock's shank not developed in female fowl.

▮ **Toes:** Four in number and formed by phalanges having toe nails on their ends.

▮ **Scale:** The name given to the horny covering of the shank and toes.

▮ **Web of the foot:** The skin between the toes of the fowl.

▮ **Pads:** The cushions on the planter side of the toes for absorption of the shock.

WING

▮ **Wing:** The organ of flight.

▮ **Shoulder:** The region where wings join with body.

▮ **Flight feathers:** They consist of **PRIMARIES**, the first ten big feathers in a fowl wing; **SECONDARIES**, the second lot of stiff feathers from the outside of the wing which are fourteen in number in an average fowl and nearer to the body; and **AXIAL**, a short feather situated in between primaries and secondaries.

▮ **Wing bar:** Any dark line of colour or marking across the middle of the wing caused by lower wing coverts.

▮ **Wing way:** The three cornered part of the folded wing above the bar.

▮ **Wing butts:** The end or corners of the wing. The upper end is called **SHOULDER BUTT** and the lower end as **LOWER BUTT**.

▮ **Wing coverts:** These are the broad feathers covering the roots of secondary feathers.

POINTS OF A FEATHER

▮ **Axis:** A typical feather consists of a straight structure called **AXIS** to which other parts called **VANE** is systematically arranged.

▮ **Quill:** Lower part of the axis, which is round, transparent and hollow.

▮ **Shaft:** The term applied to the axis other than quill to which vane is attached. It is solid, four sided, tapering and elastic with a longitudinal groove running along that surface which looks towards the body when the feather is in position.

▮ **Barbs:** These are narrow slender lamellae springing from the vane and sloping obliquely outwards and the tip of the feather. **Barbules:** It is a part of the barb, which grow from that side of barb, which looks towards the tip of the feather. They have fine hooklets, which hook on to the BARBICEL the growth on the opposite side of barbules on the barbs of the proximal row.

▮ **Accessory Plume:** It is small variable tuft found in mature feathers at the junction of quill and vane. The vane consists of two rows of narrow slender lamellae or barbs springing from the axis of the vane (shaft) and sloping obliquely outwards and towards the tip of the feather.

Definition and classification of feather:

▮ **Feather:** These are epidermic structures partly embedded in follicles of the skin and forming the covering of a bird.

▮ **Plumage:** The whole feathers of a bird.

▮ **Down:** Initial hairy covering of the baby chicks.

▮ **Fluff:** The downy part of the feather, soft fur or down-feathery stuff given off by blanket.

▮ **Coverts:** Covered, concealed or secret feathers on the wings and tail.

▮ **Hangers:** The short sickle like feathers at the base of the cock's tail also termed coverts.

▮ **Hackles:** These are narrow lance shaped feathers on the neck of fowl and the saddle of a cock. All cocks have pointed hackles e.g. neck hackles, saddle hackle.

Ex.12. Project report on visit to dairy farm and visit to Poultry farm.

Ex.13. Group discussion or Seminar presentation on one or two related topics from the list.