PRACTICAL SYSTEMATIC ZOOLOGY

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For

Premedical, Predental, Prepharmacy, Preveterinary and Science Students

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NAME . . . . . .

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Preface

During our experience in teaching zoology we felt that our students are in great need of a practical book including instructions and terms which they use in their practical course. During his first year, the university student taking zoology is met with new terminology which he will use in his future study. In this book all the terms are clearly and simply given. In addition, the use of a personal practical book provides the student with clear-cut key to the structures and arrangements he is expected to find in his practical work.

This book includes instructions concerning systematic zoology dealing with the gross and microscopic anatomy of representative types of the different phyla and classes. The animals described here include the local fauna with which the student of zoology should be aware. It is advisable for the student to examine carefully more than a specimen in order to observe all the parts mentioned. Parts or regions which the student cannot find in the laboratory are not included and are left to theoretical courses.

It is recommended to make clear enlarged drawings of the different specimens. When examining sections — in addition to drawing complete sectors of specimens provided — magnified portions should be drawn in order to show all the details.

The purpose of this practical book is to explain, clarify as well as direct the student's attention to the most important parts. It also enables the student to derive the greatest benefit from a period in the laboratory, which is always too short.

The Authors

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Phylum Chordata

CLASS MASTIGOPHORA
Subclass Phytomastigina

Euglena sp.
A Flagellate

Examine specimens of fresh and prepared **Euglena** and note the following structures :

1. Spindle - shaped body, blunt at the anterior end, and pointed posteriorly.
2. **Flagellum** originating at the blunt anterior end from a flask - shaped **reservoir.**
3. Body composed of :
   a) Outer rigid **pellicle** giving **Euglena** a definite shape.
   b) **Ectoplasm,** a clear outer thin layer of cytoplasm.
   c) **Endoplasm,** inner granular cytoplasm.
   d) **Contractile vacuole** — a spherical structure near the anterior end.
   e) **Stigma** (**eye-spot**) — a red spot near the reservoir.
   f) **Nucleus,** large oval structure with a prominent **endosome.**
   g) **Chromatophores** are oval bodies carrying chlorophyll.
   h) **Paramylum bodies** of various shapes and represent masses of starch-like material.

Make a drawing of **Euglena** *showing the above mentioned structures.*

CLASS MASTIGOPHORA
Subclass Zoomastigina

Trypanosoma sp.

Examine a prepared film of a vertebrate blood infected by **Trypanosoma** and note :

The parasite which is found between the blood corpuscles consists of :

1. Slender, spindle - shaped body' pointed at the anterior end.
2. **Undulating membrane** extending laterally along the whole length of the parasite and ends anteriorly by the **flagellum.**
3. **Nucleus** — small and oval, found in the middle.
4. **Blepharoplast** and **basal granule** at the posterior end.

Make a drawing of **Trypanosoma.**

CLASS MASTIGOPHORA
Subclass Zoomastigina

Protopalina

Examine the contents of the toad's rectum by using a slide and cover. Among the various organisms you will find **Protopalina** which is characterised by :

1. Shape of body; elongated, dorsoventrally flattened.
2. **Pellicle,** outer flexible elastic membrane.
3. **Ectoplasm,** a thin clear layer under the pellicle.
4. **Endoplasm,** the inner granular cytoplasm.
5. **Nuclei** — two equal in size.

Note that the body is covered by long **cilia.** There are no contractile vacuoles or oral groove.

Make a drawing of **Protopalina.**

CLASS CILIATA (INFUSORIA)

Paramœcium sp.

Examine fresh and stained preparations of **Paramaecium** to note the following structures :

1. Shape of body — slipper - shaped with a blunt anterior end and somewhat pointed posterior end.
2. **Oral groove** running obliquely backwards to open into the **cytosome** (cell mouth).
3. **Pellicle** is a thin outer elastic membrane in the form of hexagonal areas.
4. **Cilia** covering the entire pellicle and arranged in longitudinal rows; posterior cilia are long.
5. **Ectoplasm** is a thin clear layer under the pellicle.
6. **Endoplasm** is the inner granular cytoplasm which contains :
   a) **Nuclei** — a large bean — shaped **macronucleus,** and a small **micronucleus** fitted in a depression of the macronucleus.
   b) **Food vacuoles** of various sizes, with food in various stages of digestion.
   c) **Contractile vacuoles**; two - one anterior and the other posterior.

   Note in fresh preparations the mode of movement.

Draw **Paramœcium** *to show all the details mentioned.*

Phylum Protozoa

CLASS CILIATA

Nyctotherus

Examine the contents of the rectum of the toad, and note the **Nyctotherus** which is characterised by :

1. Shape of body — large oval bean-shaped body, dorsoventrally flattened.
2. **Oral groove** — found at the right side and leading to cytosome.
3. **Pellicle** is the outer elastic membrane.
4. **Ectoplasm** — is a clear thin layer of cytoplasm underneath the pellicle.
5. **Endoplasm** — is the inner granular cytoplasm.
6. **Nuclei** — a large **macronucleus** and a small **micronucleus.**
7. **Contractile vacuoles** — one **anterior** and the other **posterior.**
8. **Food vacuoles** containing food at various stages of digestion.

Make an enlarged drawing to show the **Nyctotherus** *examined.*

Phylum Protozoa

CLASS SARCODINA (RHIZOPODA)

Amaeba sp.

Examine fresh (from pond water rich in decaying organic matter) and prepared specimens of **Amaeba.** By using the high power look for the following structures :

1. **Shape** : small irregular mass of protoplasm provided with broad projections called **pseudopodia** (sing. pseudopodium) by which it moves slowly.
2. **Ectoplasm** — a thin outer non-granular layer of cytoplasm surrounded by a flexible **cell membrane.**
3. **Endoplasm** — including the inner granular cytoplasm.
4. **Nucleus** is a small round finely granulated structure, better seen in stained preparations, and contains the **endosome.**
5. **Contractile vacuoles,** may be one or more, spherical transparent vesicles found near the nucleus.
6. **Food vacuoles** which are numerous and contain food material at different stages of digestion.

Make drawings of fresh and prepared **Amaebae.**

Phylum Protozoa

CLASS SARCODINA

Foraminifera

Examine the shells (tests) of the different foraminiferas provided and note the following structures :

The **shell** which is made of calcium carbonate, silica or chitin, is composed either of one or many **chambers.** Notice the **openings** in the shell through which **pseudopodia** extend.

Make clear drawings of the different foraminiferas you examined.

Examples : **Globigerina**; **Rotalia**; **Ammodiscus.**

CLASS SPOROZOA

Monocystis

It lives as a parasite in the seminal vesicles of earthworms. The different stages of the life cycle can be seen when examining pieces of the infected seminal vesicles, either fresh or prepared. The following stages can be seen :

1. **Mature trophozoite** consisting of an outer **pellicle, ectoplasm** and inner granular **endoplasm** containing the **nucleus.** Notice that it is surrounded by **sperm tails.**
2. **Conjugated gametocytes** surrounded by a **cyst.**
3. **Gametes** formed by multiple fission of each **gametocyte.**
4. **Zygote** stage which is produced by fusion of different **gametes.** Each zygote becomes a **sporoblast.**
5. **Pseudonavicellae** which are zygotes surrounded by shells, each containing 8 **spores.**

Make enlarged drawings of the different stages.

Subkingdom Metazoa

Phylum Coelenterata

CLASS HYDROZOA

Hydra

A fresh-water hydrozoan

Examine fresh and prepared specimens of **Hydra** to note the following structures:

1. Cylindrical body, 25-40 mm. long, with a free end (**oral**) and **aboral end** terminated by a **basal** or **pedal disc** for attachment.
2. The oral end contains a **mouth** located at the tip of a conical **hypostome,** which is encircled by 6-10 hollow **tentacles.**
3. A central **gastrovascular cavity** (or **enteron**).

Make full-page drawings of a living **Hydra** *and a whole mount of a prepared specimen.*

HISTOLOGY OF A TRANSVERSE SECTION

Study a cross (transverse) section of **Hydra** and notice the following structures :

1. **Epidermis** — an outer thin layer covered with a delicate **cuticle,** and contains :
   a) **Epitheliomuscular cells** — with outer polyhedral epithelial portions forming the outer body wall, and inner or basal parts in the form of long slender **fibrils** (**myonemes**). The boundaries between these cells are indistinct.
   b) **Interstitial cells** — small oval or round cells found between the bases of epitheliomuscular cells.
   c) **Cnidoblasts** or stinging cells. — oval - shaped cells containing the **nematocysts** Note that each nematocyst is made up of a **capsule** which encloses a coiled tube or **thread.**

   Nerve cells are not seen in ordinary preparations.

2. **Gastrodermis** — inner layer of cells formed of three main types of cells :
   a) **Epitheliomuscular** (**nutritive-muscular**) **cells** : similar to the outer cells, but the inner **muscular fibres** (bases) run circularly round the body. Note the numerous vacuoles, filled with food. The free edge is usually provided with one or two **flagella.**
   b) **Gland cells** — triangular in shape, club-shaped and full of granules.
   c) **Interstitial cells** — few round or oval cells, scattered among the bases of the epitheliomuscular cells.

   The gastrodermis lines a central **gastrovascular cavity** or **enteron.**

3. **Mesoglea,** a structureless layer between epidermis and gastrodermis.

Make a drawing of a cross section of **Hydra** *filling in a small sector with the cellular details, and labeling all structures.*

Phylum Coelenterata

CLASS SCYPHOZOA

Aurelia sp.

A Jelly fish

Examine the medusa of **Aurelia** to note the following :

a) Jelly-like umbrella of about 15 cm. diameter.

b) The convex surface is the **exumbrella,** while the **subumbrella** has a central mouth surrounded by four **oral lobes.**

c) **Tentacles** are numerous, small and are found at the margin.

d) **Mouth** leading to a central **gastric cavity** from which extend four **gastric pouches.**

Make a full page drawing of the medusa of **Aurelia.**

Phylum Coelenterata

CLASS ANTHOZOA (ACTINOZOA)

Sea Anemones

Examine the sea anemone to show the following structures :

a) **Shape** — cylindrical body with a **basal** (**pedal**) **disc** for attachment to substratum.

b) **Mouth** — at the center of a flat **oral disc.**

c) **Tentacles** — numerous arranged in whorls round the mouth.

Draw a lateral view of the sea anemone.

Stony Corals

Examine the exoskeleton of the different types of corals from the Red Sea. Make drawings of the different types you examine.

1. **Fungia** — solitary coral, a disc-shaped structure with a large number of **transverse septa.**

2. **Favia, Echinopora, Coeloria, Tubipora** (organ-pipe coral) and **Acropora** are colonial **stony corals.** Notice the cups in which polyps lived. In **Coeloria** or the **brain coral** the skeleton of polyps is continuous due to their incomplete fission.

Phylum Platyhelminthes

CLASS TURBELLARIA

Cryptophallus sp.

A flat worm.

Examine a prepared specimen of **Cryptophallus** (which lives in the Red Sea). Note the flat body, with a central mouth leading to a **branched gut. Eyes** on the margin.

Draw **Cryptophallus.**

Phylum Platyhelminthes

CLASS TREMATODA

Fasciola gigantica

The sheep liver fluke

Fasciola lives inside the bile ducts of sheep, cattle, pigs, goats etc. and causes liver rot. It is about 2-4 cm. long.

Examine a piece of infected liver and notice the position of the fluke. Make a drawing. Take one of the flukes out of the bile duct, examine using a hand lens and draw it.

The **general structure** can be studied by examining a prepared slide of the whole fluke, using the low power of the microscope and binocular.

Make sketches of a whole specimen to indicate the following :

a) **Flat body,** with a triangular anterior end (**head**), and a blunt posterior end.

b) **Anterior** (**oral**) **sucker,** is cup-shaped around the mouth opening. **Posterior** (**ventral**) **sucker,** round, muscular and larger than the oral sucker. It lies at the junction of the triangular anterior portion with the broader part.

c) **Genital atrium,** lies between the anterior and ventral suckers. It contains the two genital openings (male & female).

d) **Excretory pore,** at the tip of the posterior end.

DIGESTIVE SYSTEM :

a) **Muscular pharynx** — ovoid mass lying behind mouth.

b) **Oesophagus** — is a short narrow tube leading to intestine.

c) **Intestine**— formed of two lateral branches (**intestinal caeca**), which run posteriorly giving numerous small caeca on their inner sides, and many large branched ones — called **diverticula** — on their outer sides. There is no anal opening.

EXCRETORY SYSTEM :

a) **Median excretory duct** extending along the middle line, to open posteriorly by the excretory pore.

b) **Small side canals** which connect the main duct. These canals branch among the various tissues and end into the **flame cells.**

REPRODUCTIVE SYSTEM :

The liver fluke is hermaphrodite i.e. has both male and female organs.

Male Genitalia :

a) two **testes** — formed of many tubules.

b) two **vasa deferentia** — which run forward and unite to form (c).

c) **vesicula seminalis** — a pear-shaped sac lying in front of the ventral sucker, and leads to (d).

d) **ejaculatory duct** — a convoluted tube which runs forward to end into a muscular copulatory organ, the **penis** (**cirrus**), which opens into the genital atrium. Notice that the penis is surrounded by the **cirrus sac.**

Female genitalia :

a) Single branched **ovary** lying in the anterior right side of the body and anterior to the testis.

b) **Oviduct** which meets a short median **vitelline duct,** at the **ootype** and these run forward as a single coiled uterus.

c) **Shell gland** surrounds the base of the uterus.

d) **Uterus** is a wide convoluted tube originating at the junction of the oviduct and the median vitelline duct. The uterus runs forward to open into the genital atrium.

e) **Vitelline system** consisting of :

(i) **Vitelline glands** — lying at both sides of the body.

(ii) **Longitudinal vitelline ducts** — two lateral ducts collecting yolk from the vitelline glands.

(iii) **Transverse yolk ducts** — each arises from the lateral longitudinal vitelline duct.

(iv) **Yolk reservoir** — triangular structure at the junction of the two transverse ducts.

(v) A short **median vitelline duct** runs forward from the yolk reservoir to join the oviduct.

Fasciola gigantica

HISTOLOGY OF A TRANSVERSE SECTION

Study a prepared transverse section of **Fasciola** at the posterior region. Use the low power objective to locate the more conspicuous organs such as intestine, excretory duct etc. Then use high power for details of structure.

Make a drawing to show the following structures :

1. **Cuticle** — is thick provided with **spicules.**
2. **Subcuticular gland cells** — sunk below the muscular layer.
3. **Muscular layer** — composed of **outer circular** and **inner longitudinal layers.**
4. **Intestinal caeca** — appear as sections of different sizes.
5. **Testes** — scattered in the parenchyma.
6. **Median excretory duct** — an empty central tube.
7. **Vitelline glands** — scattered on both sides of the body.
8. **Parenchyma** (**mesenchyma**) — loosely packed cells filling the spaces between the various organs and tissues.
9. **Dorso-ventral muscle fibres** — connecting the dorsal and ventral sides.
10. **Longitudinal lateral nerves** — at the sides.

Fasciola gigantica

STAGES OF THE LIFE HISTORY

a) **Egg** — is oval with a chitinous shell and an apical **operculum, egg cell** lying in the center surrounded by **yolk cells.**

b) **Miracidium** — with a double eye spot, covered with cilia and has an anterior **proboscis.**

c) **Cercaria** — with a rounded body and unforked tail.

Make drawings for these stages.

INTERMEDIATE HOST

Make drawings of the snails **Limnaea truncula**ta and **Limnaea cailliaudi.** Note that the opening of the shell is at the right side (i.e. right handed or dextral).

Phylum Platyhelminthes

CLASS TREMATODA

Schistosoma (*Bilharzia*)

Blood liver fluke

Schistosoma haematobium

Examine a prepared slide of the adult parasite and note the following :

a) Sexes are separate; males are found with the females.

b) The **female** is longer than the male with a cylindrical body; notice the **oral** and **ventral suckers.**

c) The **male** is broader than the female, flattened body with rolled sides to form the **gynaecophoric groove** where the female lies. Note **oral** and **ventral suckers.**

DIGESTIVE SYSTEM

a) **Mouth** leads to a **buccal cavity,** then a short narrow **oesophagus.**

b) **Intestine** is forked in front of the ventral sucker, the two branches unite at the posterior third forming a **caecum.**

Schistosoma mansoni

Examine a stained whole mount under low and high power magnifications. Note the differences between **S. mansoni** and **S. haematobium** which are mainly :

a) the two branches of the **intestine** unite at the anterior half of the body.

b) the male possesses 8-9 **testes.**

Make a clear labelled drawing of S. **mansoni.**

STAGES OF THE LIFE HISTORY

a) **Egg** is oval with a smooth **outer shell** provided with **a terminal spine** in *S. haematobium* and a **lateral spine** in *S. mansoni*. Eggs contain fully formed **miracidia** (sing. **miracidium**).

b) **Miracidium** is oval without eye spots, covered with **cilia**; and provided with an anterior **boring papilla.**

c) **Cercaria** with ovoid body, forked **tail, oral** and **ventral suckers,** forked **intestine.**

Make drawings of the different stages you examine.

INTERMEDIATE HOSTS

Examine the different snail hosts of **Schistosoma,** and make drawings of each :

a) *S. haematobium* — *Bullinus truncatus* with a left handed shell (opening at the left side).

b) *S. mansoni* — *Biomphalaria alexandrina* with a flat discoidal shell.

Phylum Platyhelminthes

CLASS CESTODA

Taenia saginata & *Taenia solium*

The tapeworms

Examine a preserved specimen of adult *T. saginata* and note the following structures :

a) **Head** is knoblike called **scolex** provided with **suckers.**

b) **Neck** is a narrow short part connecting scolex with body.

c) **Body** composed of **proglottides** which are similar parts arranged in a linear series, those just behind the neck are narrow and the youngest; the most posterior ones are the oldest being more broader and larger.

Make a full page drawing of the worm provided.

The Scolex

Examine stained whole mounts of the scolecies :

a) In *T. saginata* note the four large **suckers,** no hooks or mouth.

b) In *T. solium* — note in addition to the **four suckers,** an anterior **rostellum** provided with two rows of **chitinous hooks.**

Make magnified drawings to show the difference between the two scolecies.

MATURE PROGLOTTIS

Examine a prepared whole mount under the low power magnification. Identify as many of the following structures as possible.

a) **Lateral longitudinal nerve cord** on each side.

b) **Excretory canals**

(i) two **lateral longitudinal canals,** one on each side inner to the nerve cord.

(ii) **transverse excretory canal** lying at the posterior border of the proglottis.

c) **Female reproductive system** consisting of :

(i) **Ovaries** — a pair at the posterior border.

(ii) **Oviducts** — short and unite to form a median duct which joins the

(iii) **Vitelline duct** which leads to a posterior **vitelline gland.**

(iv) **Ootype** where the oviducts, vitelline duct and uterus meet.

(v) **Shell gland** (**Mehlis gland**) around the **ootype.**

(vi) **Seminal receptacle** (**receptaculum seminis**) which originates at the ootype and leads to a narrow,

(vii) **Vagina** which opens into the **genital atrium** by the **female genital opening.**

(viii) **Uterus** originating at the ootype as a wide blind tube projecting anteriorly.

d) **Male reproductive system** :

(i) **Testes** are numerous scattered spherical shaped, each connected to a fine duct.

(ii) The **vasa efferentia** which unite to form,

(iii) The **vas deferens** (**sperm duct**) is a convoluted tube ending into a **penis** (**cirrus**) which is surrounded by a **cirrus sac,** and opens into the **genital atrium** by the **male genital pore.**

Make a magnified drawing of a mature proglottis showing all the details mentioned.

GRAVID (RIPE) PROGLOTTIS

Examine a prepared stained whole mount of a gravid proglottis of both *T. saginata* and *T. solium* by using the low power.

Make clear drawings to show :

a) Shape of proglottis — longer than broad.

b) **Uterus** — much branched, full with eggs and formed of about 20-30 **side branches** in case of *T. saginata.*
In *T. solium* the number of side branches is 8-12 on each side.

c) Much reduced reproductive organs — i.e. **testes, ovary, vitelline gland** etc.

HISTOLOGY OF A TRANSVERSE SECTION

Examine a prepared tansverse section of a mature proglottis and note the following structures :

a) **Cuticle** is very thick secreted by **subcuticular gland cells.**

b) **Muscular layer** consisting of : an **outer circular, inner longitudinal muscle layers,** and **mesenchymal muscles** consisting of **longitudinal, circular** and **transverse fibres.** Strands of **vertical muscles** connect the dorsal and ventral sides.

c) Internal organs including median **uterus**; **ovary, lateral testes,** and **lateral nerve cords** and **excretory canals.**

d) **Parenchyma** (**mesenchyma**) filling the spaces between the various tissues.

Make a drawing of the cross section provided. Draw a magnified portion of the body wall.

STAGES OF THE LIFE HISTORY

a) **Egg** (**embryophore**) is a small, round with an outer **radially stripped shell,** and an inner **embryo** with 6 **hooklets** (**hexacanth embryo**).

b) **Cysticercus** (**bladder worm**), a large vesicle with invaginated **future head** (scolex).

Make clear drawings of the egg and cysticercus of **Taenia saginata.**

Phylum Aschelminthes

CLASS NEMATODA

Ascaris sp.

A roundworm

Examine preserved specimens of *Ascaris* and note :

a) **Males** — are distinguished from females by their smaller size and the bend at the posterior part of the body.

b) **Shape of body** — cylindrical tapering at both ends.

c) **Mouth** — at the anterior end surrounded by one **dorsal** and two **lateroventral lips.**

d) **Anus** — located near the posterior end; in the male it is a **cloacal opening** which receives both sexual and digestive products. A pair of **copulatory spicules** may project from the **cloaca.**

e) **Female genital opening** — is a minute ventral aperture situated near the anterior end.

f) **Longitudinal lines** — two white lines on the middorsal and midventral lines and are termed the **dorsal** and **ventral lines.** On each side a broader **lateral line** can be seen.

g) **Excretory pore** — a very minute ventral pore just behind the mouth.

Make drawings showing male and female **Ascaris.** *Draw enlarged portions of the anterior and posterior ends to show the various structures.*

INTERNAL ANATOMY

Dissect **Ascaris** by cutting a specimen along the midline of the dorsal surface. Open the specimen, carefully separate the different organs and study the following systems :

1. **Digestive system** consisting of :
   a) the **mouth** — which leads to a short muscular **oesophagus,** this part is called **stomodaeum** or **fore gut.**

b) **midgut** (**intestine**) — a long flattened ribbonlike muscular tubule.

c) **hindgut** (**proctodaeum, rectum**) — a short posterior region opening into the **anus** in the female, and into the **cloaca** in the male.

2. **Reproductive organs.**

Note their tubular thread-like coiled structure. In the **male,** the **reproductive organs** consist of :

a) single thread-like tube, **the testis,** found at the anterior half.

b) **vas deferens** which is a continuation of the posterior end of the testis.

c) **seminal vesicle** (**vesicula seminalis**) — a wide tube which opens by a short narrow muscular tube, the **ejaculatory duct,** into the **cloaca.**

d) **copulatory** (**penial**) **spicules** — surrounded by a spicule sheath and lying at the dorsal side of the ejaculatory duct.

3. **The female reproductive organs** consist of :

a) two thread-like coiled **ovaries-an anterior** and a **posterior ovary.**

b) **oviducts** — which lead from the ovaries into (c),

c) **uteri** — two wide straight tubes found at the anterior half. In some species of *Ascaris*, at the base of each uterus there is a spherical **seminal receptacle.**

d) **vagina** — a thin narrow tube formed by the union of the two uteri. The vagina opens by the **female genital pore.**

Make drawings of dissected male and female **Ascaris** *to show the internal organisation.*

HISTOLOGY OF A TRANSVERSE SECTION

Study a stained cross section at the region of the reproductive organs of the female and note the following structures :

Body wall formed of :

a) **cuticle** — thick and noncellular.

b) **epidermis** (**hypodermis**) — **syncytial** composed of a layer of protoplasm containing nuclei but no cell membranes

c) **longitudinal lines** — formed by inward projections of the epidermis. The **dorsal** and **ventral lines** are thin containing the **dorsal** and

ventral nerve cords. The **lateral lines** are broader, each containing a **lateral excretory canal** and two **lateral nerve cords.**

c) **longitudinal muscle layer** (no circular muscle layer) — divided into four **quadrants** by the longitudinal lines. Each **muscle fibre** consists of : an outer U-shaped **contractile** or **fibrillar zone,** and an **inner protoplasmic zone** containing the **nucleus.** This zone gives off **protoplasmic processes** which bend inward and run either to the dorsal or ventral nerve cords.

d) **intestine** — composed of a single layer of **columnar epithelium** lying on a **basement membrane** and lined by a **thin cuticle** (i.e. no cilia or muscle coats).

e) **ovary** — several cross sections of the ovary are observed, some packed with **undifferentiated cells,** others have a **central rachis** surrounded by the **genital epithelial cells.**

f) **oviducts** — one or two or more (depending on the level of the section), appearing as hollow large tubes lined by irregular layer of **simple epithelium.**

g) **uteri** — two wide tubes lined by thin epithelial layer and contain **ova.**

h) **body cavity** — surrounding the internal organs. It is called **pseudocoel** and is usually filled by a fluid and contains **fibres** and **giant cells.**

Make a drawing of a transverse section of female **Ascaris.** *Draw a magnified part of the body wall showing the different structures.*

In a **cross section of male Ascaris** note, in addition to the body wall and intestine, the following structures :

a) **testis** — cut in various regions and similar in structure to the ovary.

b) **vas deferens** — a wide tube with a cavity lined by **epithelial layer.**

c) **seminal vesicle** (appearing when the section passes at the posterior half) — a more wide tube containing **sperms** and lined by simple epithelial cells.

Draw a transverse section of male **Ascaris.**

EGGS

Examine *Ascaris* eggs under low and high power magnifications and note:

a) size and shape of egg — oval large eggs.

b) **outer mammillated shell** — yellowish brown in colour.

c) **inner egg shell** — smooth surrounding the embryo.

d) **embryo** in the form of zygote (unsegmented).

Draw the egg of **Ascaris.**

Phylum Aschelminthes

CLASS NEMATODA

Ancylostoma duodenale

The hookworm

Examine a demonstration of **Ancylostoma** (male and female) and note:

a) **The female** — 10-12 mm. long; the anterior end is bent dorsally; the posterior end is straight and ends into a sharply defined **spine.**

b) The **mouth** is provided with **cutting teeth,** and leads into the **buccal cavity** followed by a long **muscular oesophagus** which leads into the **intestine** (**midgut**) and a short **rectum** (**hind gut**).

c) the **ovaries** appear as thread-like structures.

The **male Ancylostoma** is shorter than the female and its posterior end is in the form of a broad **copulatory bursa** (**bursa copulatrix**) containing a number of rays.

Note an anterior single **testis** leading to the **vas deferens**; **vesicula seminalis** and **ejaculatory duct.**

Draw sketches of both female and male hookworm.

EGG

Examine the egg of **Ancylostoma** and compare it with other parasite-egg you studied. Note the following structures :

a) shape of egg — oval and small.

b) **shell** — thin transparent.

c) **embryo** — in 2,4 or 16 cell stage.

Draw the egg of **Ancylostoma.**

Phylum Aschelminthes

CLASS NEMATODA

Enterobius vermicularis

The pinworm

Study prepared stained whole mounts of both female and male pinworms and note :

1. the **female** is larger than the male being 12 mm. long. It is thread-like with elongated pointed **tail** end.
2. the **male** is much shorter with a broad bent **posterior end.**
3. the **egg** is oval with a thin **outer shell** and contains a young **embryo.**

Make drawings of female, male and egg of the pinworm.

Phylum Annelida

CLASS OLIGOCHAETA

Allolobophora caliginosa

The Common Earthworm

Examine living and preserved specimens of the earthworm, using a hand lens or binocular microscope for the study of minute structures. Note the following :

EXTERNAL ANATOMY

a) **Shape of body**— cylindrical tapering at both ends. Dorsal surface darker in colour. Body is segmented into a great number of **metameres** or **somites** separated by **intersegmental grooves.**

b) The **mouth** is in the first segment, **peristomium,** overhung by a fleshy lobe, the **prostomium** (not a segment); **anus** located on the last segment.

c) The **clitellum** is a saddle-like structure at segments 26-34, with two ridges, the **puberty crests,** on the ventral surface of segments 31-33. Note that the clitellum is an incomplete ring.

d) The **setae** (**chaetae**) are found on the ventral surface. There are four pairs on each segment which can be observed by a hand lens, or by passing the finger from the posterior to the anterior end.

e) The **genital openings** — two minute **female genital openings** on the ventral surface of segment no. 14. The two **male genital openings** which are slit-like are found on the ventral surface of segment no. 15, each opening is surrounded by a swollen lip.

The **spermathecal pores** are found in grooves between segments no. 9 and 10 and between 10 and 11, usually so contracted that it is not possible to observe them.

Make drawings of the dorsal and ventral views of the earthworm and label completely.

INTERNAL ANATOMY

Dissect either preserved or narcotised earthworms and study the following systems :

Digestive System

1. The **mouth** leads to the **buccal cavity** (in somites 1 and 2), which is followed by swollen **muscular pharynx** (in somites 3-5) that is connected to a thin walled **oesophagus** extending to somite 14.
2. The **crop** is a large thin-walled sac in somites 15 and 16, followed by a thick muscular **gizzard** in somites 17-19.
3. The **intestine** extends from the gizzard to the anus, with its dorsal wall folded inward forming the **typhlosole.** Note the yellow outer layer formed of **chloragogenous cells.**

Draw the digestive system and label fully.

Circulatory System

In the dissected specimen note the following main structures :

1. The **dorsal blood vessel** running along the dorsal side of the digestive tract.
2. The **ventral** (**subintestinal**) **blood vessel** extends along the ventral side of the digestive tract.
3. The **subneural blood vessel** lying ventral to the nerve cord.
4. The **pseudohearts** are 6 pairs surrounding the œsophagus in somites nos. 6-11 and connecting the dorsal and ventral blood vessels.

Make a drawing to show the above mentioned circulatory system.

Nervous System

In a dissected earthworm note the following structures after careful removal of the alimentary tract.

1. The **cerebral ganglia** (**brain**) — a bilobed mass located on the dorsal surface of the pharynx in somite 3.
2. The **circumpharyngeal connectives** surround the pharynx and connect the cerebral ganglia with the **subphnryngeal ganglia.**
3. The **subpharyngeal ganglia** lie just beneath the pharynx in somite no. 14.
4. The **ventral nerve cord** extends along the floor of the body cavity, with a swelling (a **ganglion**) in each somite.

Make a clear labelled drawing of the nervous system.

Reproductive System

The **male reproductive organs** consist of :

1. The **seminal vesicles** are 4 pairs, light coloured bodies on the ventral sides of somites 9-12.
2. The **testes** are two pairs located in somites 10 and 11.
3. The **sperm** (**seminal**) **funnels** are two pairs, each opening into the **vas efferens.** The two vasa efferentia of each side pass backwards to form the **vas deferens** which opens to the exterior on somite 15.

   (The testes and their ducts are too small to study).

The **female reproductive organs** consist of :

1. The **seminal receptacles** (**spermathecae**) are two pairs of small white spherical bodies in somites 10 and 11.
2. The **ovaries** include one pair of minute conical bodies attached to the septum between somites 12 and 13.
3. The **egg funnels** (**ovarian funnels**) include a pair in somite 13 which extend posteriorly to the **oviducts** which open in somite 14.

   (The ovaries and oviducts are too small for a satisfactory study).

Make a drawing of the reproductive organs you dissected.

Excretory System

Note the presence of a pair of coiled tubes, the **nephridia,** in every somite except the first three and the last one.

Examine a prepared stained preparation of a nephridium and note that it consists of :

a) **ciliated funnel** or **nephrostome.**

b) **convoluted tubule** — a thin coiled long tube.

c) **nephrostome** — the external opening of the nephridium.

Draw the nephridia to show their arrangement in a dissected specimen.
Make a drawing of a whole mount of a nephridium.

HISTOLOGY OF A TRANSVERSE SECTION

Study a prepared transverse section through the region of the intestine. By the use of a binocular or dissecting microscope notice the general shape and location of the various parts. Then by the use of the high power magnification study the cellular details which appear as follows :

1. The **body wall** consists of :

a) The **cuticle** is a thin noncellular layer.

b) The **epidermis** is formed of **simple columnar epithelial cells,** with **mucus-secreting cells** scattered among them, note their large elliptical shape. The epidermis lies on the **basement membrane.**

c) The **muscular layer** is composed of :

(i) The **outer circular muscle** layer is a thin layer running parallel to the circumference of the body.

(ii) The **inner longitudinal muscle layer** is a thick layer whose muscle fibres are arranged in a feather-like pattern and extend parallel to the length of the body.

(iii) The **chaetae** (**setae**) are four pairs found on the ventral and lateral sides. Each chaeta is surrounded by **chaetigerous follicle** (**sac**) to which **chaetigerous muscles** are connected. Setae are only seen in sections cut at their levels.

(iv) The **parietal peritoneum** (**somatic layer**) is formed of a thin layer of squamous epithelial cells lining the body cavity (**coelom**).

2. The **coelom** is the space between the internal organs, and is lined by **peritoneal epithelium.**

3. The **intestine** is composed of (layers from inwards) :

(i) **Ciliated columnar epithelium** lining the intestine, with some gland cells in between.

(ii) **Circular muscle layer** consisting of a thin layer of unstriated muscle fibres.

(iii) **Longitudinal muscle layer** which appears as a circle of dots.

(iv) **Chloragogue layer** (**chloragogenous yellow cells**) formed of a thick layer of cells representing **visceral** (**splanchnic**) **mesoderm.**

(v) **Typhlosole** is a deep fold in the dorsal wall of the intestine.

4. The **blood vessels** consist of :

(i) **Dorsal blood vessel** is located just dorsal to the typhlosole.

(ii) **Ventral blood vessel** is seen beneath the intestine to which it is connected by the ventral mesentery.

(iii) **Subneural blood vessel** which appears below the ventral nerve cord.

(iv) **Lateral neural blood vessels** are located on both sides of the nerve cord.

(v) **Typhlosolar blood vessel** is found inside the typhlosole.

5. The **nephridia** may appear inside the coelom in some sections.

6. **Ventral nerve cord** is located below the ventral blood vessel. Note the presence of three clear areas at its dorsal side. These represent the **giant fibres.**

Draw a transverse section of the intestinal region of the **earthworm.** *Make a fully labelled sector of the body wall in the region of a seta to show the different structures.*

Phylum Annelida

CLASS HIRUDINEA

Hirudo medicinalis

The Medical Leech

Study the external features of a preserved medical leech (*Hirudo*), make drawings of the dorsal and ventral sides to show :

1. The body is dorsoventrally flattened with a dark dorsal surface.
2. Suckers – **anterior sucker** surrounds the mouth; the **posterior sucker** is disc-like, located at the posterior end.
3. Segmentation – note the large number of **annuli** (sing. annulus); each real metamere corresponds to 3 to 5 annuli.
4. **Eye spots** are five pairs which appear on the dorsal surface of the anterior five segments.
5. Openings :
   a) The **mouth** is surrounded by the anterior sucker.
   b) The **anus** opens dorsally between segment 26 and the posterior sucker.
   c) The **male genital pore** is a single median ventral pore located on the 2nd annulus of somite 11.
   d) The **female genital pore** appears on the median ventral side of somite 12 (annulus 4).

HISTOLOGY OF A TRANSVERSE SECTION.

Study a stained transverse section in the middle region of **Hirudo.** By using the low power locate the different organs. Study the detailed structures by the high power and note the following :

1. **Body wall** composed of :
   a) **Cuticle** is a thin structureless layer.

b) **Epidermis** formed of **simple columnar epithelium,** with **mucus-secreting cells** in between.

c) **Dermis** made of connective tissue and containing muscle fibres and pigment cells.

d) **Muscular layer** consisting of :

(i) **Outer circular muscle layer** with oblique fibres.

(ii) **Inner longitudinal muscle layer** which is much thicker than the outer circular layer.

(iii) **Dorsoventral muscle fibres** which are in the form of bands connecting the dorsal and ventral body walls.

2. The **gut** is represented by a median **crop** and two **lateral caeca** (or **diverticula**). Note the epithelial lining of the crop and caeca.

3. **Blood spaces** and **vessels** include :

a) **Dorsal blood sinus** is located just above the crop.

b) **Ventral blood sinus** appears below the crop and surrounds the ventral nerve cord.

c) **Lateral blood vessels** with definite walls, and are seen on the sides of the diverticula.

4. **Nephridia** appear as sections on either side of the caeca.

5. **Nerve cord** is a ventral double cord running inside the ventral sinus.

6. **Testes** — a pair lying ventrally on both sides of the ventral sinus.

7. **Botryoidal tissue** which represents the tissues filling the spaces between the different organs, especially near the gut and blood spaces. It consists of large cells rich in pigment.

8. **Connective tissue** filling the spaces between gut and body wall.

Make a full page drawing of a transverse section of **Hirudo,** *filling in a small sector with the cellular details, and label all the structures.*

Phylum Arthropoda

CLASS INSECTA

Order Dictyoptera

Periplaneta americana

The Cockroach

EXTERNAL ANATOMY

Examine a narcotised cockroach to study the external anatomy. By the use of a hand lens note the following structures :

1. Division or segmentation of the body. It is divided into : **head, thorax** and **abdomen.** The head is connected to the thorax by a narrow **neck.** The external covering is the **exoskeleton.**

2. **The head** : is enclosed by a hard case, the **head capsule,** which is made up of several **sclerites** (plates): the **epicranium** (vertex) or top of head; **frons,** anterior; **genae** (cheeks) on the sides. The **clypeus** lies below the frons, and just above the **labrum** (upper lip). **Compound eyes** on the sides of the head; two oval **fenestrae** on both sides of epicranium; and one pair of **filiform antennae,** arising from **antennal sockets** and found between the compound eyes.

MOUTH PARTS

Carefully remove the various structures by using the forceps. Arrange them on a piece of paper in their natural arrangement. Examine the following structures :

a) **labrum** (upper lip) : a broad plate hinged to clypeus.

b) **mandibles** : a pair of strong toothed jaws lying beneath the labrum.

c) **maxillae** : a pair, one on either side; each consists of : a basal part formed of a **cadro** and **stipes**; the stipes bears an outer five-segmented **maxillary palp**; and two inner lobes, outer elongated **galea** and inner spiny **lacinia.**

d) **labium** (lower lip) : fused second maxillae consisting of : a basal **submentum,** a **mentum** and a small distal **prementum** bearing : a pair of three-segmented **labial palps**; and four inner lobes, two median **glossae** and two outer **paraglossae.** The **hypopharynx** lies beneath the labrum; it is a tongue-like organ, found in the center of the mouth.

3. **Thorax** : is divided into **prothorax, mesothorax** and **metathorax.** Each segment is covered by a dorsal **tergum,** a ventral **sternum** and a lateral **pleuron.** The tergum of the prothorax is large and covers the neck and head, and is known as **pronotum.**

   The **mesothorax** carries a pair of hard **fore wings** (**tegmina**), while the **metathorax** carries membranous **hind wings.**

   Each thoracic segment bears a pair of **walking legs**; each composed of a basal **coxa** (attached to the pleuron), **trochanter,** a long **femur, tibia** and five-segmented **tarsus** ending in two lateral **tarsal claws** and a median terminal fleshy pad or **pulvillus.**

   Remove and pin out the fore wing, hind wing and a walking leg.

4. **Abdomen** : composed of 11 segments separated by joints, the anterior 7 terga (dorsal sclerites) are clear, the 8th and 9th are covered by the 7th, while the 10th is large and notched. The 11th may be represented by the **podical plates** on both sides of the anus. The 10th tergum carries ventrally a pair of jointed **anal cerci** (sing. cercus).

   In the **male,** 9 sterna (ventral plates) are seen, the 9th bears a pair of **styles.**

   In the **female,** 7 sterna are seen, the 7th is elongated posteriorly to form a **boat-shaped structure.**

5. **Openings : mouth** surrounded by the mouth parts, **anus** at the posterior end dorsal to the genital aperture, **genital aperture** ventral to the anal opening. **Stigmata** (respiratory openings) : 10 pairs; two thoracic and 8 abdominal.

Make the following drawings labeling the various structures :

a) *dorsal view of adult male or female.*

b) *ventral view of the posterior region of a male and of a female.*

c) *front view of head.*

d) *a full page drawing of the mouth parts.*

e) *lateral view of a walking leg.*

INTERNAL ANATOMY

Dissect a freshly killed cockroach to expose the various systems. Using a hand lens, examine the different structures.

DIGESTIVE SYSTEM

a) **mouth** : surrounded by the mouth parts.

b) **fore gut** (**stomodoeum**) consisting of :

(i) **buccal cavity** : where the **salivary glands** (a pair) open by a **common duct.**

(ii) **oesophagus** : with a posterior dilation, the **crop.**

(iii) **gizzard** : with thick muscular walls.

c) **mid gut** (**mesenteron**) : short tube receiving 6-8 **pyloric caeca.**

d) **hind gut** (**proctodoeum**) : which begins where the **Malpighian tubules** enter the gut. The hind gut consists of :

(i) **small intestine** (**ileum**), a narrow muscular tube.

(ii) **large intestine** : consists of a wide **colon,** and a short globular **rectum** characterised by the presence of six **rectal glands** which appear externally as six longitudinal lines.

e) **anus** : at the posterior end, dorsal to the genital opening.

Draw the digestive system of the cockroach labeling all the parts.

CIRCULATORY SYSTEM

In your dissection, carefully separate the dorsal terga and pin them down while attached at the anterior end. Note the following structures :

a) **tubular heart** : lying in the mid-dorsal line just under the terga. It consists of 13 chambers, 3 thoracic and 10 abdominal. The heart continues anteriorly as the **dorsal aorta.**

b) **pericardial sinus** : surrounds the heart.

c) **alary muscles** : 12 pairs of intersegmental fan-shaped muscles arising from the terga, and partly inserted into the heart.

Draw and label the heart and alary muscles.

NERVOUS SYSTEM : It is composed of :

a) **brain** (**supraoesophageal ganglia**) : in the head region.

b) **suboesophageal ganglion** : underneath the œsophagus.

c) **circumoesophageal connectives** (**commissures**) running around the œsophagus and connecting the brain with the subœsophageal ganglion.

d) **ventral nerve cord** : a double fused cord with 9 **ganglia,** 3 **thoracic** and 6 **abdominal.**

e) **lateral nerves** : arising from the ganglia.

Draw and label the nervous system you dissected.

REPRODUCTIVE SYSTEM

Male reproductive system, consists of :

a) a pair of **testes** : located in segments 4-6 (difficult to see).

b) a pair of **vasa deferentia** leading from the testes to the seminal vesicles which unite to form (c.)

c) **ejaculatory duct** : which opens below the anus and behind sternum no. 9.

d) **accessory glands** including : **a mushroom-shaped gland** formed of tufts of whitish caeca opening into the ejaculatory duct, underwhich an elongated **conglobate gland** passes. The testes and vas deferens are difficult to see.

Make a drawing of the male reproductive system showing the structures you see.

Female reproductive system

a) a pair of **ovaries,** each formed of about 8 **ovarioles** (ovarian tubes).

b) from each ovary, a short **oviduct** extends posteriorly.

c) **vagina** formed by the union of the two oviducts.

d) **colleterial glands** : a pair of branched tubules, opening into the vagina.

e) two small **seminal receptacles** (**spermathecae**) which open into the genital pouch where the vagina opens.

Make a drawing of the female reproductive system labeling the various structures.

Stages of the life history

Examine the various stages and make a sketch of each stage :

1. **Egg capsules** (**oothecae**) : chitinous elongated brown cases, with two rows of eggs inside each.
2. **Nymph** : smaller than adult, without wings or genital organs.
3. **Adult** : large, with wings and genital organs.

Make drawings of the different stages.

Phylum Arthropoda

CLASS INSECTA
Order Hemiptera

Cimex lectularis

The Bed Bug

Examine prepared whole mounts of the different stages of the bed bug, which is an example of **incomplete metamorphosis.**

1. **Adult male** consists of :
   a) **Head** : carries lateral **compound eyes,** a pair of **antennae** each is 4-segmented, **rostrum** (**proboscis**) 4-segmented and represents the lower lip (**labium**), two pairs of **mandibles** and **maxillae** in the form of needle-like stylets (may be seen).
   b) **Thorax** consists of : large **prothorax,** small triangular **mesothorax** bearing a pair of **vestigial fore wings,** and a large **metathorax.** Three pairs of **walking legs** each consisting of a basal **coxa, trochanter, femur, tibia** and 3-segmented **tarsus** ending in a pair of **claws.**
   c) **Abdomen** : consisting of 10 segments, the 1st. segment is fused with the 2nd. and the 10th segment is small surrounding the **anus.** Notice 8 pairs of **spiracles** on segments 2-8. The posterior end of the abdomen carries the **copulatory spicule** (**aedeagus**) which arises from the 9th segment.
2. In the **adult female,** the posterior end of the abdomen is rounded and broad. The female genital opening is slit-like and found on segments 8 and 9. It is surrounded by the **gonopods** (**gonapophyses**). Note the presence of a notch on the right side of segment no. 5, which is the **opening of Berlese's organ.**
3. **Nymph** : smaller than the adult, tarsus 2-segmented, wings and genital organs are absent.
4. **Egg** : oval and elongated.

Make full page drawings of male, female and nymph **Bed Bugs,** *labeling the various structures.*

Phylum Arthropoda

CLASS INSECTA
Order Anopleura

Pediculus humanus corporis

The body louse

Study prepared whole mounts of adult, numph and eggs of the body louse and note :

1. **Adult** : consisting of :
   a) **head** with a pair of lateral **reduced eyes** ; a pair of **antennae,** each 5-segmented.
   b) The **thorax** is formed of one piece; no wings; with three pairs of appendages, each consisting of : basal **coxa,** small **trochanter, femur, tibia** and one-segmented **tarsus** ending into a single **claw.** The latter and the tibia form a **chela-like structure** for clinging. One pair of **thoracic spiracles** is found between the bases of the first and second pairs of appendages.
   c) **Abdomen** : composed of 9 segments; the first is fused with the 2nd, the last (9th) is small and surrounds the anus. Note the presence of 6 pairs of **abdominal spiracles** found on well chitinised lateral **pleural plates** on segments 2-7.

      In the **male,** a well developed **copulatory spicule** (**aedeagus**) projects from the 6th segment posteriorly.

      In the **female,** note the highly chitinised **7th sternum,** the 8th segment being notched and bears ventrally a pair of triangular **gonopods** surrounding the **female genital opening.**

2. **Nymph** is smaller than the adult, without genital organs.

3. **Egg** is elongated in shape.

Draw and label adult, nymph and egg of the **body louse.**

Phylum Arthropoda

CLASS INSECTA
Order Diptera

A - Culex pipiens

The Mosquito

Examine prepared whole mounts of the different stages of **Culex** and note :

1. **Adult**; consisting of :

   (i) **Head** : small with a pair of large **compound eyes,** long 13-segmented **antennae** covered with dense long setae in the male (**plumose antennae**), and fewer and shorter setae in the female (**pilose antennae**).

   The **mouth parts** of the **female,** which are of the **piercing and sucking type,** are composed of :

   a) **labrum epipharynx** : elongated dorsal structure.

   b) **labium** (**lower lip**) : long dorsally-grooved, ending into a pair of **labellae.**

   c) **mandibles** and **maxillae** : 2 pairs of needle-like stylets.

   d) **hypopharynx** : a thin elongated seta.

   e) **maxillary palps** : a pair, short and 3-segmented.

   In the **male** note (in addition to the plumose antennae) the presence of **labrum epipharynx, labium** with **labellae** and well developed long 3-segmented **maxillary palps.** Mandibles and maxillae are absent.

   (ii) **Thorax** is composed of :

   a) **prothorax** : small and reduced.

   b) **mesothorax** : well developed and bears a pair of long wings.

   c) **metathorax** : carrying the **halters** (a pair of reduced hind wings).

d) 3 pairs of long **legs,** each consisting of : **coxa, trochanter, femur, tibia** and 5-jointed **tarsus** terminating with 2 **claws.**

e) **thoracic spiracles** : 2 pairs on meso-and metathorax.

(iii) **Abdomen** : long 10-segmented, the anterior 8 segments are visible, each carrying a pair of **abdominal spiracles.**

Make a full page drawing of adult **Culex,** *labeling the various structures.*

Draw separately the mouth parts of both male and female.

2. **Pupa** : comma-shaped consisting of :

a) large anterior portion representing **head** and **thorax**; and containing **eyes, antennae, rudiments of wings** and **appendages.** Dorsally, it is provided with a pair of slender cylindrical **respiratory trumpets.**

b) **abdomen** : is flexed below the anterior portion, 9-segmented and terminated by a pair of **tracheal gills** or **paddles.**

3. **Larva** : elongated with cylindrical body, and is composed of :

a) **head** : large with a pair of lateral **compound eyes,** a pair of one-segmented **antennae** and a pair of **feeding brushes.**

b) **thorax** : not differentiated into pro-, meso-and metathorax; with 3 pairs of **bristle tufts.**

c) **abdomen** : 9-segmented, segment no. 8 is short bearing a dorsal long cylindrical **respiratory siphon** with two spiracles at its tip. Segment no. 9 carries 4 **tracheal gills,** a dorsal tuft and a ventral brush.

4. **Eggs** : in groups forming a raft.

Draw and label the pupa, larva and egg of **Culex,** *an example of complete metamorphosis.*

B-Anopheles

Study prepared whole mounts of the different stages of **Anopheles,** compare with the corresponding ones of **Culex** and note the following differences :

1. **Adult** : similar to that of **Culex** except :
   a) **male** : maxillary palp long, its terminal segment is club-shaped.
   b) **female** : with long cylindrical 4-segmented maxillary palp.
2. **Pupa** : with a pair of funnel-like **respiratory siphons.**
3. **Larva** : with small antennae; food brush shorter than that of *Culex*; 8th. abdominal segment bearing a pair of **spiracles** (no siphon), anterior **comb of teeth** and lateral **protective chitinous plates.**
4. **Eggs** : single elongated with two lateral air chambers.

Make full labeled drawings of the various stages of **Anopheles.**

Phylum Arthropoda

CLASS INSECTA
Order Diptera

Musca domestica vicina

The Common House-Fly

Study a prepared whole mount of the **head of adult Musca** and note :

a) a pair of large **compound eyes.**

b) **epicranium** : with three **ocelli** located in an **ocellar triangle.**

c) **antennae** : a pair of **aristate antennae** situated in a depression.

d) the **mouth parts** are of the **spongy type** and composed of an elongated **proboscis** which consists of 3 regions :

(i) **rostrum** : broad, covered by the **clypeus** and bears a pair of one-segmented **maxillary palps** and a median **pharynx.**

(ii) **haustellum**; composed of :

a) **labium** : a ventral large structure.

b) **labrum-epipharynx** and **hypopharynx,** lying dorsal to the labium, in a special groove.

c) **prepharynx** : a small sclerite located in front of the pharynx.

d) **stipes** : two lateral chitinised rods, extending from the rostrum to the base of the labrum-epipharynx.

(iii) **labella** : composed of 2 broad structures, with **mouth** in between. Each **labellum** is provided with a series of **pseudotracheae.**

Make a full page drawing of the head of **Musca** *labeling the various structures.*

STAGES IN THE LIFE CYCLE

(example of **complete metamorphosis**)

1. **Egg** : small and oval.
2. **Larva** : is without appendages (apodous) and consists of :
   a) vestigial **bead** : with small **oral lobes** and **mandibular sclerites.**
   b) **thorax** : 3-segmented.
   c) **abdomen** : 8 segments being broader posteriorly, each segment carries **spiny locomotory pads.**
   d) **spiracles** : 2 pairs; **thoracic** on mesothorax, abdominal on the dorsal side of segment no. 8.
3. **Pupa** : surrounded by a barrel-like case or **puparium,** showing larval segmentation (12 segments) and provided with two posterior **spiracles.**

Draw the different stages labeling the various structures.

Phylum Arthropoda

CLASS INSECTA
Order Siphonaptera (Aphaniptera)

Pulex irritans

The Human Flea

Examine a prepared whole mount of **adult Pulex** and note :

1. **Shape of body** : bilaterally compressed, composed of :

   a) **Head** : with a pair of simple **eyes** and a pair of short 3-segmented **antennae** lying in an **antennary groove.**

   The mouth parts, which can be seen in some preparations, consist of :

   (i) **maxillae** : a pair of triangular plates with a pair of 4-jointed **maxillary palps.**

   (ii) **labium** (lower lip) : tubular with a pair of 5-jointed **labial palps.**

   (iii) **epipharynx** : long.

   b) **Thorax** : consisting of distinct **pro-, meso-, and metathorax**; each carrying one pair of legs formed of : a large basal **coxa,** a small **trochanter, femur, tibia** and 5-segmented **tarsus** ending in a pair of **claws.** Note two **thoracic spiracles.**

   c) **Abdomen** : 10-segmented with **spiracles** on the anterior 8 segments.

In the **male,** the 9th segment carries the **pygidium**; note the presence of finger-like **claspers** and the spring-like **aedeagus** (modified posterior segments).

In the **female,** note a **pygidium** on the 9th segment and a **spermatheca** on the 7th segment.

Note that the posterior end of the female is round, while that of the male is directed upwards.

Make a full page drawing of a **male human flea,** *draw the posterior end of the* **female** *to show the difference.*

Phylum Chordata

SUBPHYLUM CEPHALOCHORDATA

Branchiostoma (Amphioxus) lanceolatus

The Lancet

Examine the whole mount provided of young **Amphioxus,** and draw it as shown from its lateral side. Notice that the body is elongated and tapers anteriorly into a **rostrum** and posteriorly into the **tail.**

Observe the following main structures :

1. **Notochord** : extends from the tip of the rostrum to the end of the tail.
2. **Neural tube** or **nerve cord** : dorsal to the notochord. Its anterior end dilates into a **brain vesicle.**
3. **Alimentary canal** : begins with the **oral hood,** surrounded by **oral cirri.** The oral hood encloses the **vestibule** which leads to the **mouth.** The mouth is found in a vertical **velum.** The mouth opens into a large **pharynx,** which is perforated by numerous **gill slits** separated by **gill bars.** The pharynx leads to the **intestine** which opens to the exterior through the **anus.** Around the pharynx and part of the intestine, there is a cavity known as **atrium** or **atrial cavity** formed by **atrial wall.** The atrium opens to the exterior by the **atriopore.**
4. **Myotomes** (muscles) : which are V-shaped blocks, separated from each other by **myosepta.**
5. **Dorsal, ventral** and **caudal fins.**
6. **Metapleural folds** : which are two folds of skin on both sides of the ventral aspect of the pharyngeal and part of the intestinal regions.

EXTERNAL ANATOMY

Examine the specimen of adult **Amphioxus** provided in a test-tube. Observe the following :

Rostrum, oral hood, oral cirri, myotomes, myosepta, atriopore, anus, tail region, fins, metapleural folds and 26 pairs of **gonads** on both sides of the pharynx.

TRANSVERSE SECTION OF PHARYNGEAL REGION

Study a T.S. of the pharyngeal region of **Amphioxus,** and observe the following :

1. Rounded **notochord.**
2. **Spinal cord** with a central canal, above the notochord.
3. **Pharynx** below the notochord, perforated by **gill slits.** The slits are separated from each other by **gill bars. Epibranchial groove** is found in the roof of the pharynx, and **endostyle** in its floor.
4. **Two lateral dorsal aortae** on both sides of the roof of the pharynx, and a **ventral aorta** inside an **endostylar coelom.**
5. Blocks of **myotomes** on both sides. They are separated by **myosepta** formed of connective tissue.
6. **Liver diverticulum** on the right side of the pharynx.
7. **Atrium** surrounding the pharynx. Observe **gonads** inside the atrium on both sides of the pharynx.
8. **Dorsal fin** supported by **fin rays.**
9. Two **metapleural folds** ventrally.
10. **Skin** which surrounds the body, and consists of simple columnar **epidermis** covered by **cuticle,** and a thin **dermis** of connective tissue below.

HISTOLOGY OF A TRANSVERSE SECTION OF THE TRUNK REGION OF AMPHIOXUS

Examine a transverse section of the trunk region to show : **notochord, spinal cord, myotomes, myosepta, intestine** surrounded by **coelom** which is lined by **somatic mesoderm** laterally and **splanchnic mesoderm** medially, **dorsal fin** with a single row of **fin rays, ventral fin** with two rows of **fin rays,** single median **dorsal aorta** and **subintestinal vein** with its branches.

HISTOLOGY OF A TRANSVERSE SECTION OF THE TAIL REGION

Study a tansverse section of the tail region and note : absence of alimentary canal, presence of **notochord, spinal cord, myotomes, myosepta, caudal artery, caudal vein, dorsal** and **ventral lobes of caudal fin** supported by **fin rays.**

Phylum Chordata

SUBPHYLUM CRANIATA (VERTEBRATA)

Superclass Pisces
CLASS CHONDRICHTHYES

Scyllium canicula

The Dogfish

EXTERNAL ANATOMY

Examine a specimen of dog-fish, and draw a lateral view to show the external features. The body is covered by placiod scales (spines). It is composed of :

a) **Head** : with two **lateral eyes, spiracles,** a ventral **mouth and nostrils.** Posterior to the spiracles, there are five pairs of gill slits.

b) **Trunk** : with median and paired fins. **Median fins** are **two dorsal** and one **ventral. Paired fins** are **pectoral** and **pelvic fins.**

c) **Tail** : which is laterally compressed, and carries the **caudal fin.**

Draw a diagram also of the ventral side of the anterior region of dog-fish to show :

1. Crescent-shaped **mouth** with two **jaws** provided with **teeth.**
2. **Nostrils** anterior to the mouth, and connected to it by two **oro-nasal grooves.**
3. Large **pectoral fins.**
4. Smaller triangular **pelvic fins,** with **claspers** on their median sides in case of male.

INTERNAL ANATOMY

Examine the dissected specimen of dog-fish provided, and note the structure of the gill and of the abdominal regions :

a) **In the gill region** : the **mouth** leads to a **pharynx** in which a **spiracle** opens as well as five **gill pouches** on each side. The lining of gill pouches is in the form of **gill lamellae.** Between the gill pouches, there are **gill arches.**

Examine the chambers of the **heart.** They are from posterior to anterior : **sinus venosus, atrium, ventricle** (ventral to atrium) and **conus arteriosus.** From the conus arteriosus, a **ventral aorta** extends anteriorly below the pharynx and gives off laterally **afferent branchial vessels.**

b) **In the abdominal region** : examine the general viscera :

1. **Digestive system** : the **pharynx** opens into the **oesophagus** which leads to the **stomach.** The stomach consists of **cardiac** and **pyloric portions.** Following the stomach, there is the **intestine** consisting of **duodenum, ileum** and **rectum** which opens into the **cloaca.** A small **rectal gland** opens into the rectum. The digestive glands are a large **liver** — composed of two lobes with **gall-bladder** — and a **pancreas.**
   Note also the presence of a **spleen.**
2. **Urogenital system** : consists of **two kidneys,** two **testes** (or **ovaries**) and their **ducts.**

PLACOID SCALES

Study an **isolated placoid scale** stained and mounted on slide, and note that it consists of :

A flattened **basal plate,** and a pointed **spine.** In the centre, there is a **palp cavity.**

HISTOLOGY OF A TRANSVERSE SECTION OF THE TRUNK REGION

Examine a T.S. of the trunk region of dog-fish, and note the following structures :

1. **Notochord** surrounded by **centrum.**
2. **Spinal cord** above the notochord, enclosed by a **neural arch** with a **neural spine.**
3. **Intestine** with **spiral valve,** and other parts of the alimentary canal. There are also the **liver, spleen** and **pancreas.**
4. Two **kidneys.**
5. **Dorsal aorta, two posterior cardinal veins** and **two lateral abdominal veins.**
6. **Epaxial** and **hypaxial muscles** separated by a **horizontal septum** of connective tissue. A **lateral line canal** is present lateral to the horizontal septum.
7. **Dorsal fin** may appear in the section.

HISTOLOGY OF A TRANSVERSE SECTION OF THE TAIL REGION

Study a T.S. of the tail region of dog-fish, and note the presence of :

1. **Notochord** surrounded by **centrum.**
2. **Spinal cord** dorsal to notochord, surrounded by **neural arch** with a **neural spine.**
3. **Caudal artery** and **caudal vein** below the notochord, enclosed by **haemal arch** with a **haemal spine.**
4. **Epaxial** and **hypaxial muscles** separated by horizontal septum.
5. **Lateral line canal.**
6. **Dorsal** and **ventral lobes of caudal fin** supported by **fin rays.**

Phylum Chordata

SUBPHYLUM CRANIATA (VERTEBRATA)

Superclass Pisces

CLASS OSTEICHTHYES

Tilapia nilotica

The Nile Bolti

EXTERNAL ANATOMY

Draw a lateral view of the specimen of **Bolti** provided to show the **external features.** Note that the body is bilaterally compressed. The body is covered by bony **scales.** There are **dorsal** and **ventral lateral lines** on each side. The body is composed of **head, trunk** and **tail.**

a) **Head** : with **mouth, eyes** and **nostrils.** The eyes have no eyelids. The gills are covered by an **operculum** supported with **opercular bones.**

b) **Trunk** : covered by **bony scales.** It carries median and paired fins. Median fins are the **dorsal and ventral** or **anal fins.** Paired fins are the **pectoral** and **pelvic fins.** There are **dorsal** and **ventral lateral lines** on each side of the trunk. Between the trunk and tail, there is the **anus,** followed by the **urogenital papilla** on the top of which there are the **genital** and **urinary apertures** in the female, or a **urogenital opening** only in the male.

c) **Tail** with a symmetrical **caudal fin.**

INTERNAL ANATOMY

Dissect the specimen of **Bolti** provided, to show the gill and the abdominal regions with the general viscera :

a) **Gill region** : cut the operculum and observe the reddish **gill lamellae,** which are highly vascular and carried on **gill arches** provided with **gill rakers.**

Expose the **heart** which lies medially below the gills. It consists of four chambers which are from posterior to anterior : **sinus venosus, auricle, ventricle** and **conus arteriosus** which extends anteriorly below the gills as the **ventral aorta.**

b) **Abdominal region** : just posterior to the urogenital papilla, cut through the muscles dorsally until the ventral lateral line. Then continue cutting deeply towards the head region. Remove these hypaxial muscles and study the exposed viscera :

1. **Digestive system** : begins with **oesophagus** behind the **pharynx,** then **stomach** which consists of a **cardiac caecum** and **a pyloric part.** The stomach leads to the coiled **intestine** which opens to the exterior through the **anus.** Observe the **liver** which consists of a small **right lobe** and a large **left lobe.** The liver has a **gall-bladder.** A **spleen** is also present.

2. **Urogenital system** : **two kidneys** are present adhering to the ventral side of the vertebral column. From each kidney, a **ureter** is given. The two ureters unite into a **common duct** which dilates into a **urinary bladder.** In the female, the common ureter opens separately by a **urinary aperture.** There are **two** ovaries full of eggs. From each ovary an **oviduct** arises. The two oviducts unite into a **common oviduct,** which opens by a **genital aperture** between the anus and the urinary aperture.

   In the male, there are **two testes.** From each testis, a **vas deferens** arises. The two vasa deferentia unite into a **common duct,** which in turn unites with the common ureter to open together through a **urogenital opening.**

3. **Air-bladder** : dorsal to the alimentary canal.

SCALES

Draw the stained preparation of **cycloid scales** mounted on slide. The scale is thin and more or less rounded. The **anterior edge** is the side of attachment and is ridged. The **posterior edge** is the free one and is smooth. The scale contains concentric **lines of growth.**

TRANSVERSE SECTION OF THE PHARYNGEAL REGION

Study a T.S. of the gill (**pharyngeal**) **region** of a teleost fish, and note the following :

a) **Brain** : with its different parts.

b) **Pharynx** : with gills. Each gill consists of a **gill arch** carrying two rows of **gill filaments** and **gill rakers,** and of **afferent** and **efferent branchial arteries.** The gills are covered by an **operculum** supported with **opercular bones.** The edge of the operculum carries a **branchiostegal membrane** strengthened by **branchiostegal rays.**

c) **Blood vessels** :

1. **Circulus cephalicus** formed by the union of the two lateral dorsal aortae above the pharynx.
2. **Inferior jugular veins.**
3. **Anterior cardinal veins.**
4. **Ventral aorta** below the pharynx.

SUBPHYLUM CRANIATA (VERTEBRATA)
Superclass Tetrapoda
CLASS REPTILIA
Order Squamata
Suborder Lacertilia

Chalcides
The Lizard

EXTERNAL ANATOMY

Study the **external features** of a lizard as **Chalcides** or **Scincus,** and note that the body is composed of a **head, neck, trunk** and **tail.** The body is covered by **horny scales.**

Head : note the **mouth, nostrils, eyes** and **tympanic depressions** which represent external ears and lead to tympanic membranes.

Trunk : carries two pairs of **limbs**; anterior and posterior limbs. Each limb has five **digits** ending with **horny claws.** Between the hind limbs, there is the **cloacal opening.**

Tail : is elongated.

INTERNAL ANATOMY

Examine the dissected specimen of the lizard provided, and note the following structures :

1. **Digestive system** : the **mouth** opens into **pharynx** which leads to a long **oesophagus,** followed by the **stomach** which opens into the **intestine.** The intestine is differntiated into a U-shaped **duodenum,** a coiled **ileum** and a large **rectum** which opens into the **cloaca.** Between the ileum and rectum, there is a short **caecum.**

   The **liver** is large and consists of two lobes and has a **gall bladder.** The **pancreas** is found between the stomach and duodenum.

   The **spleen** (not a part of the digestive system) is small and lies near the stomach.

2. **Respiratory system** : a long **trachea** is supported by incomplete **cartilaginous rings.** The tachea divides into two **bronchi** which enter the **lungs.**

3. **Circulatory system** : examine the chambers of the **heart.** It consists of **two auricles** and **a ventricle,** as well as a **sinus venosus** opening into the right auricle.

4. **Urogenital system** : the **two kidneys** lie posteriorly and the **two ureters** open into the **cloaca.** The **urinary bladder** opens in the ventral wall of the **cloaca.**

   In the male, there are **two testes.** From each testis, **vasa efferentia** are given to form an **epididymis.** From the epididymis, a **vas deferens** extends posteriorly to open into the cloaca.

   In the female, there are **two ovaries.** Two **oviducts** extend posteriorly and open into the cloaca.

SUBPHYLUM CRANIATA (VERTEBRATA)
Superclass Tetrapoda
CLASS AVES

Columba livia
The Pigeon

EXTERNAL ANATOMY

Study the **external features** of the pigeon, and note that the body is covered by **feathers** which are characteristic to birds. The body consists of **head, neck, trunk** and **reduced tail.**

Head : **mouth** is surrounded by **horny beaks, nostrils** in the base of the upper beak, two **eyes** and **external auditory depressions** behind the eyes.

Neck : is long and flexible.

Trunk : carries the **limbs.** The **fore limbs** are modified into **wings.** In the **hind limbs,** the feet carry no feathers, but they are covered by **horny scales.** The **digits** carry **horny claws.**

Tail : is short, and the **cloacal opening** is found between it and the abdomen.

Study the **types of feathers** provided which are :

a) **Contour feathers** : these cover the body. The feather consists of a **quill** and a **vane.** The quill is the proximal part inserted in the skin. It is hollow and has two openings, an **inferior** and a **superior umbilicus.** The vane is composed of a **rachis** or **shaft** carrying oblique **barbs** on both sides, which in turn carry **barbules** firmly held together by hooks. The rachis and quill may be termed together the **axis** of the feather.

b) **Down feathers** (**nest feathers**) : found below the contour feathers and in the young bird. The feather consists of a **quill** carrying **barbs** with **barbules** in a circle at its top.

c) **Filoplume feathers** : the feather consists of a long **axis** with few **barbs** at its terminal part.

INTERNAL ANATOMY

Dissect the pigeon, cutting through the abdominal wall and on both sides of the sternum to remove it. Study the general viscera to show :

DIGESTIVE SYSTEM: the **mouth** leads to **pharynx,** then to elongated **oesophagus** with **crop.** The œsophagus opens into the **stomach,** which consists of a small **proventriculus** and a large **gizzard.** The stomach is followed by the **intestine** which consists of U-shaped **duodenum,** coiled **ileum** and **rectum.** Between the ileum and rectum, there are two small **rectal caeca.** The rectum opens in the **cloaca,** which is composed of three chambers.

Liver : consists of **two lobes** without a **gall-bladder.**

Pancreas : found between the two limbs of the duodenum.

Spleen : close to the right side of the proventriculus.

RESPIRATORY SYSTEM: the **trachea** lies ventral to the œsophagus. Two **lungs** are found in the thoracic region.

CIRCULATORY SYSTEM

Heart : consists of **two auricles** and **two ventricles.** Connected to the heart are the following blood vessels :

1. Three **venae cavae** opening into the right auricle, **two anterior** and **one posterior.**
2. Four **pulmonary veins** opening into the left auricle.
3. **Aortic arch** : arises from the left ventricle. It curves to the right side, and then extends posteriorly taking a median position as tbe **dorsal aorta.**
4. **Pulmonary arch** : comes out from the right ventricle.

UROGENITAL SYSTEM : **two kidneys** are present, each consisting of three lobes. A **ureter** runs along its ventral side, and extends posteriorly to open into the **cloaca.**

In the male, there are **two testes.** The testis is oval and a **vas deferens** is given from its inner side. The vas deferens extends posteriorly to open into the cloaca.

In the female, there is the **left ovary** only. Near it, there is the funnel-shaped opening of the **left oviduct,** since the right oviduct is also absent. The left oviduct is convoluted and opens into the cloaca.

SKELETAL SYSTEM

Study the skeleton of the limbs and their girdles :

1. **SKELETON OF THE WING** — it consists of three portions : skeleton of upper arm, fore arm and hand :

Upper arm : its bone is the **humerus** with a proximal **head** which fits into the glenoid cavity of the pectoral girdle. Beside the head, there is a **deltoid ridge.**

Fore arm : its bones are the **ulna** and **radius.**

Hand : proximal **carpals** are two pieces, **radiale** and **ulnare.** Distal carpals are fused with metacarpals forming **carpometacarpus.** The **digits** are three; the first and third, each consists of one **phalanx**; while the second digit consists of two **phalanges.**

2. **SKELETON OF THE HIND LIMB (LEG)** : consists of three regions also : thigh, shank and foot. The bone of the thigh is the **femur** with its **head**, which fits into the **acetabulum** of the pelvic girdle. The bone of the shank is the **tibia,** but here it fuses with the proximal tarsals of the foot to form a **tibiotarsus.** There is also a small **fibula.**

In the **foot,** the distal tarsals fuse with the metatarsals to form a **tarsometatarus.** The **digits** are four in number, each ending with a **horny claw.** The phalanges are 2, 3, 4, & 5.

3. **SKELETON OF THE PECTORAL GIRDLE** (& **STERNUM**) — Three bones constitute the pectoral girdle: a strong **coracoid,** a sword-shaped **scapula** and a thin **clavicle.** These bones contribute in the formation of a **glenoid cavity** for the reception of the head of the humerus. The two clavicles fuse ventrally to form a **furcula.** The two coracoids of both sides articulate with the sternum. The **sternum** is large and curved. It has a strong median **keel** or **carina,** which projects ventrally. To the sternum are attached also the sternal portions of the **ribs,** the vertebral portions of which attach to the vertebral column.

4. **SKELETON OF THE PELVIC GRIDLE** (& **HIND REGION**) — Half of the pelvic girdle is composed also of three bones : **ilium, ischium** and **pubis.** The **ilium** is large and broad, and articulates with the vertebral column. The **ischium** is broad and lies ventral to the posterior part of the ilium. The **pubis** is a thin slender bone, extending posteriorly ventral to the ischium. The three bones contribute in the formation of the **acetabulum** for the reception of the head of the femur.

The last thoracic vertebra; the lumbar, the sacral and certain caudal vertebrae fuse together forming a **synsacrum** to which the ilium articulates. Behind the synsacrum, there are **six free caudal vertebrae,** followed by fused ones forming the so-called **pygostlyle.**

Phylum Chordata

SUBPHYLUM CRANIATA (VERTEBRATA)
Superclass Tetrapoda
CLASS MAMMALIA

Oryctolagus cuniculus
The Rabbit

EXTERNAL ANATOMY

Study the **external features** of the rabbit. Observe that the body is covered by **hairs** which are characteristic to mammals. The body consists of **head, neck, trunk** and **tail.** In the head, observe the **mouth** with apparent **incisors** (since the **upper lip** is cleft), the **nostrils**, the **eyes** and the **ear pinnae** which surround the external ears. Sensitive hairs **or vibrissae** are found on the anterior region of the head.

The trunk carries the two pairs of **limbs**, the anterior with five **digits** and the posterior with four only ending with **claws.**

The tail is short. Between the trunk and tail, there is the **anus** and the **urogenital opening** in front of it. In the male, the urogenital opening lies on the tip of a **penis.** There are two **scrotal sacs** containing the testes outside the body cavity. In the female, the opening is called **vulva,** and a **clitoris** is present just in front of it. In the female there are paired **teats** on the ventral side of the thorax and abdomen.

INTERNAL ANATOMY

☞ Dissect the specimen provided. At first, cut through the skin in the midventral line, then through the muscles, cutting through the ribs. Study the general viscera :

a) **Digestive system : oesophagus** is elongated passing through the **neck** and **thorax**, and reaching the abdominal cavity passing through the **diaphragm.** The œsophagus opens into the **stomach** which consists of **cardiac** and **pyloric portions.** The pyloric portion leads to the **duodenum.** The duodenum opens into an elongated **small intestine** which is coiled and held together by mesentery. The ileum opens into the **large intestine,** which begins by the **caecum** that is large and constricted. At the junction with the caecum, the ileum dilates into a **sacculus rotundus.** The caecum ends into the narrow **vermiform appendix.** The **colon** follows the caecum. It is sacculated and opens into the narrow **rectum,** which generally contains **faecal pellets.** The rectum opens to the exterior through the **anus.**

The **liver** is large and lies directly behind the diaphragm. The liver consists of **five lobes** and has a **gall-bladder.**

The **pancreas** lies between the two limbs of the duodenum.

The **spleen** is elongated and adheres to the cardiac portion of the stomach at its posterior convex side.

b) **Respiratory system** : the **trachea** begins with the **larynx** and is supported by **tracheal rings.** In the thoracic cavity, there are two **lungs.**

c) **Circulatory system** : the **heart** consists — as in birds — of **two auricles** and **two ventricles.** Connected to the heart, there are the following blood vessels :

1. **three venae cavae,** two anterior and one posterior opening into the right auricle.
2. two **pulmonary veins** open into the left auricle.
3. **aortic arch** comes out of the left ventricle, curves to the left side, and then extends posteriorly taking a median position as the **dorsal aorta.**
4. **pulmonary arch,** leaves the right ventricle to the lungs.

d) **Urogenital system**

Cut through the sysmphysis pubis of the pelvie girdle. There are **two kidneys** which are bean-shaped. The right kidney lies more anterior than the left one. Close to the kidney, note the **adrenal gland.** From the inner concave side of the kidney, the **ureter** emerges. It extends posteriorly to open into the dorsal side of the **urinary bladder.**

In the **male,** there are two outer **testes** enclosed by **scrotal sacs.** On the inner side of the testis, there is the **epididymis** which is a very long twisted tubule composed of **caput epididymis** and **cauda epididymis.** The cauda epididymis leads to the **vas deferens,** which enters the abdominal cavity. It curves over the ureter and opens into a tube dorsal to the **urinary bladder,** known as **uterus masculinus.** The latter unites with the neck of the urinary bladder, and the two form the **urethra** which extends into the **penis** and through which the urine and sperms pass to the exterior.

In the **female,** there are two small **ovaries** posterior to the kidneys. Two **oviducts** open opposite the ovaries into the abdominal cavity by a funnel-shaped opening. The oviduct begins by the **Fallopian tube,** then it extends posteriorly to form the **uterus.** The two uteri unite together into the **vagina** dorsal to the **urinary bladder.** The vagina unites with the hind part of the neck of the urinary bladder to form the **vestibule.** The latter opens to the exterior by the **vulva.** The **clitoris** lies just anterior to the vulva.

SKELETAL SYSTEM

A. — AXIAL SKELETON

1. THE SKULL

Draw a **dorsal view** of the skull to show: The mid-dorsal bones from front backwards are two-**nasals,** two **frontals,** two **parietals,** a single **interparietal** and a single **supraoccipital** forming the roof of the **foramen magnum.** The frontal sends a **supraorbital process** over the eye.

The **upper jaw** is formed of **premaxillae, maxillae** and **jugals.** The jugal is fused with a **zygomatic process of the maxilla.** Lateral to the parietal, there is the **squamosal** bone which sends anteriorly a **zygomatic process.** This latter process articulates with the jugal to form a **zygomatic arch** below the eye.

Postero-ventral to the squamosal, there is the **tympanic bulla** which lodges the ossicles of the middle ear. The tympanic bulla has an **external auditory meatus** or the opening of the external ear. Just behind the tympanic bulla, there is the **periotic bone.**

THE SKULL (Cont.)

Draw a **ventral view** of the **skull** and note :

On either side, there are **premaxilla** carrying two **incisors, maxilla** carrying **three molars** and **three premolars, jugal, squamosal** as well as a **zygomatic arch.** The palate consists of a single median **vomer,** two **palatines** and two smaller **pterygoids** behind them. The palatines as well as the maxillae send median **palatal processes** which unite in the mid-ventral line forming a **secondary palate** characteristic of mammals (and some reptiles, eg. crocodiles). The secondary palate hides the vomer bone which lies dorsal to it, leaving the posterior end of the vomer appearing in the ventral aspect of the skull.

The **sphenoid bones** seen in the ventral aspect are a single median **basisphenoid** lying between the pterygoids, a median smaller rod-like **presphenoid** between the posterior ends of the palatines and two **alisphenoids** lateral to the basisphenoid. Behind the basisphenoid, there is a single median **basioccipital** bone which forms the floor of the **foramen magnum.** On both sides of the foramen magnum, there are two **exoccipital** bones. Two convex prominences develop mostly by the exoccipitals, known as **occipital condyles,** for articulation with the atlas vertebra.

On both sides of the basioccipital, the two **tympanic bullae** are seen.

THE SKULL. (Cont.)

Draw a **lateral view** of the **skull** and note: **premaxilla** with **incisors, maxilla** with **molars** and **premolars, jugal, squamosal** and **zygomatic arch.** The bones of the roof are seen: **nasal, frontal, parietal, interparietal** and **supraoccipital.** The premaxilla sends a **nasal process** which ascends posteriorly above the maxilla, between it and the nasal bone. In the orbital region, the frontal sends a downgrowth which forms, with an **orbitosphenoid** bone below, a side wall for the brain in this region. In front of the orbitosphenoid, between it and the maxilla, there is the **lachrymal** bone.

Note the **tympanic bulla** with **external auditory meatus** and the **periotic bone.**

Parts of the palatal bones can be seen below: the **basioccipital, basisphenoid, pterygoid** and **palatine.**

Draw a **lateral view** of a **ramus** of the **lower jaw.** Note that it consists of a single bone, the **dentary.** The dentary sends a posterior **angular process**; and a dorsal extension with a **coronoid process**, and a **condyle** by which the ramus articulates with the skull.

The dentary carries the teeth of the lower jaw. These are one **incisor, three molars** and **two premolars.** The canines are absent and their place, found between incisor and premolars, is known as **diastema.**

The two rami of the lower jaw articulate together anteriorly by a suture.

2. VERTEBRAL COLUMN (BACKBONE)

It is composed of five regions: **cervical, thoracic, lumbar, sacral** and **caudal** regions.

1. **CERVICAL VERTEBRAE** : they are **seven** in number. The first and second differ from each other and from the following cervical vertebrae.

The first is the **ATLAS** and it articulates with the skull anteriorly. Draw **anterior** and **posterior** views of the atlas vertebra. In the **anterior view,** note the following :

Two condylar facets for articulation with the occipital condyles of the skull. A **neural arch** with a **neural spine** enclosing the **vertebral canal,** which is divided by a **horizontal ligament** into a wide upper part for the spinal cord to pass through, and a narrower lower part for the reception of the **odontoid process** of the axis vertebra. **Transverse process** and **vertebrarterial foramen.**

In the **posterior view** of the atlas, note the following :

The same structures except two facets, instead of the anterior condylar facets, for articulation with the axis vertebra behind.

AXIS or **second cervical vertebra** — Draw a **lateral view** to show:

Centrum, neural arch, neural spine, odontoid process and **two lateral facets** anteriorly for articulation with the atlas, **two postzygapophyses** posteriorly for articulation with the following normal cervical vertebra, short pointed spine-like **transverse process and vertebrarterial foramen.**

NORMAL CERVICAL VERTEBRA — draw **anterior and lateral views** of one of the following five cervical vertebrae to show :

Centrum, neural arch, neural spine, bifurcated transverse process, vertebrarterial foramen and prezygapophyses for articulation with the postzygapophyses of the preceding vertebra.

2. **THORACIC VERTEBRA** : draw antenior and **lateral views** to show :

Centrum, neural arch, elongated **neural spine, transverse process** carrying a **tubercular facet** for articulation with the tuberculum of the rib, **two demi-facets** on the centrum for articulation with the capitulum of the rib, **pre-** and **postzygapophyses.**

RIB : draw the rib, and note that it consists of a curved **shaft** with two processes at its proximal end which articulate with the vertebral column. One of these processes is rounded and known as **capitulum,** while the other is short and pointed and known as **tuberculum.**

3. **LUMBAR VERTEBRA** : draw **anterior** and **lateral views** to show :

Centrum, neural arch, neural spine, metapophyses carrying **prezygapophyses,** median ventral **hypapophysis,** two elongated **transverse processes** directed ventrally and laterally, **postzygapophyses,** and **anapophyses** below the postzygapophyses.

4. **SACRAL VERTEBRA** : draw a **dorsal view** to show : **centrum** broad anteriorly and narrow posteriorly, **neural arch, neural spine, prezygapophyses, postzygapophyses** and broad **transverse processes** for articulation with the ilia of the pelvic girdle.

B. — APPENDICULAR SKELETON

1. BONES OF THE LIMBS

a) FORE LIMB

Humerus — draw **anterior** and **posterior** views to show : **Shaft, head, greater** and **lesser tuberosities** on the sides of the head, **trochlea** on the other end of the shaft and **supratrochlear fossa** with a **supratrochlear foramen.**

Radius and Ulna : ulna is larger with an **olecranon process,** which fits into the supratrochlear fossa of the humerus bone forming the **elbow joint.**

b) HIND LIMB

Femur — draw an **anterior view** to show : **shaft, head** at the proximal end, **condyles** at the distal end with **intercondylar notch, greater trochanter** beside the head, **third trochanter** below it, and **lesser trochanter** opposite the third one.

Tibia and Fibula — draw an **anterior view** to show : large **tibia** and small **fibula** fused with it, **surfaces of articulation** on both ends and **bony patella** on the proximal end.

2. BONES OF THE GIRDLES

a) **Half-pectoral Girdle** : draw a **dorsal view** and note : broad **scapula** with a **coracoid process.** The two form together a **glenoid cavity** for the reception of the head of the humerus. The scapula carries a **dorsal spine** which has a lateral **acromion process.** The latter process projects ventrally and gives a posterior **metacromion process.**

b) **Half-pelvic Girdle** — consists of three bones: **ilium, ischium** and **pubis.** Ilium is broad, elongated and directed anteriorly. Posteriorly, the ischium lies dorsal to the pubis. Between the ischium and pubis, there is a wide **obturator foramen.** The ilium, ischium and pubis contribute in the formation of a concavity known as **acetabulum** for the reception of the head of the femur bone.

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