RESPIRATORY SYSTEM

Gill respiration in cyclostomes and fishes.

Pulmonary respiration in tetropods.

Respiratory System

Gill Respiration in cyclostomes and fishes:

Introduction:

Every cell in a living organism consumes oxygen (O_2) during oxidation of substances resulting in the release of heat and energy and production of carbon dioxide (CO_2).

The system designed for exchange of gases (O_2 and CO_2) between the organism and its environment is termed respiratory system.

The body structures which are needed for gaseous exchange between the blood and the surrounding medium are known as respiratory organs.

Depending on the type of medium, vertebrates have two principle types of respiratory organs: gills for aquatic respiration (in water) and lungs for terrestrial respiration (in air). Gills and Lungs are derivatives of the embryonic pharynx.

Gills:

Gills or branchiae are the aquatic respiratory organs of fishes and amphibians. On the basis of their location, gills are of two general types: internal gills and external gills. In some animals, both internal & external gills are present.

(A) Internal (or) true gills:

Internal gills are characteristic of fishes. They are located in the gill slits and attached to

to the visceral arches.

Gill slits:

- Gill slits are one of the most fundamental traits of the chordata.
- In the embryo the pharyngeal cavity is connected to the outside by a series of lateral opening, known as pharyngeal clefts or simply gill slits. These persist in the adult state of protochordates, cyclostomes, fishes and certain amphibians. but become reduced, modified in higher vertebrates.
- The number of gill slit varies in different chordates eg: 140 — in amphioxus,
  6 – 14 pairs in cyclostomes.
  5 — pairs in most elasmobranches.
  6 – pairs in Hexanchus
  5 – pairs in most bony fishes &
  4 – pairs in teleosts.
- The gill slits are separated from one another by partitions called visceral or gill arches.

- Structure of a true gill.

- The true gills are developed on the walls of some gill cleft or gill arches.

- Typically, a gill is composed of two rows of numerous gill filaments or lamellae. These are derived from epithelium on either side of an interbranchial septum. Containing arteries

and supported by the branchial cartilage or bone of a gill arch.

- A single row of lamellae on one side of branchial septum forms only half the gill, called a demibranch (or) hemibranch.
- A septum with two attached demibranchs comprises a complete gill or holobranch.
- Gill filaments are richly supplied with blood capillaries and it is here that exchange of gases with water takes place.

Cyclostomes : cyclostomes are the living agnathans but they have no bony external skeleton. They might have lost the bony armour by mutations. Notochord persistent. Skeleton is cartilaginous.

- A single nostril is present (Monorhina).
- 6 to 14 pair of gills. Eg① petromyzon.

(Greek – petron, rock or stone + myzon, sucker)

- petromyzon had nostril infront of eyes.
- Gill slits 7 pairs, lying anteriorly
- Branchial basket well developed. Gill slits open into the respiratory tube.

Eg: ② Hagfish (Gr – myxa, slime + ots, like)

- Nostril terminal.
- Gill slits 6 to 14 pairs lying far posteriorly
- Branchial basket vestigial.
- Gill slits open directly into the pharynx. The gill slits open by a common pore on each side.

- Gills of elasmobranchs (e.g. dog fish) are generalized in structure and relationships.
- Gills of bony fishes are also basically similar but show the following differences:

(a) Operculum.

In bony fish, a bony flap, called operculum or gill cover, arises from the hyoid arch and covers the gills in a common opercular cavity which opens by a single slit-like crescentric external gill opening behind.

(b) Interbranchial Septum:

The median septum is best developed in elasmobranchs. It is reduced in some intermediate fishes like Chimaeras. It is virtually absent in teleosts.

© Spiracles.

In elasmobranchs and ganoids, the first gill slit, between mandibular and hyoid arches, bears a reduced pseudobranch and open to outside through a small opening, the spiracle. In chimaeras, lung fishes and teleosts, spiracles become either closed or lost in the adult.

(d) Reduction in number of demibranchs.

Number of gills greatly varies among fishes.

There a 7 pairs in Heptanchus,
6 pairs in Hexanchus, &

- 5 pairs in most elasmobranchs in addition to spiracle. However, the demibranch found on hyoid arch in elasmobranchs is lost in modern ganoids and teleosts which have only 4 holobranches.

- Additional demibranchs are lost in some lungfishes.

- The extreme case of reduction is found in the eel Amphipnous in which first and 4th branchial arches are without gills. while the second arch retains only a demibranch.

B External or larval gills:

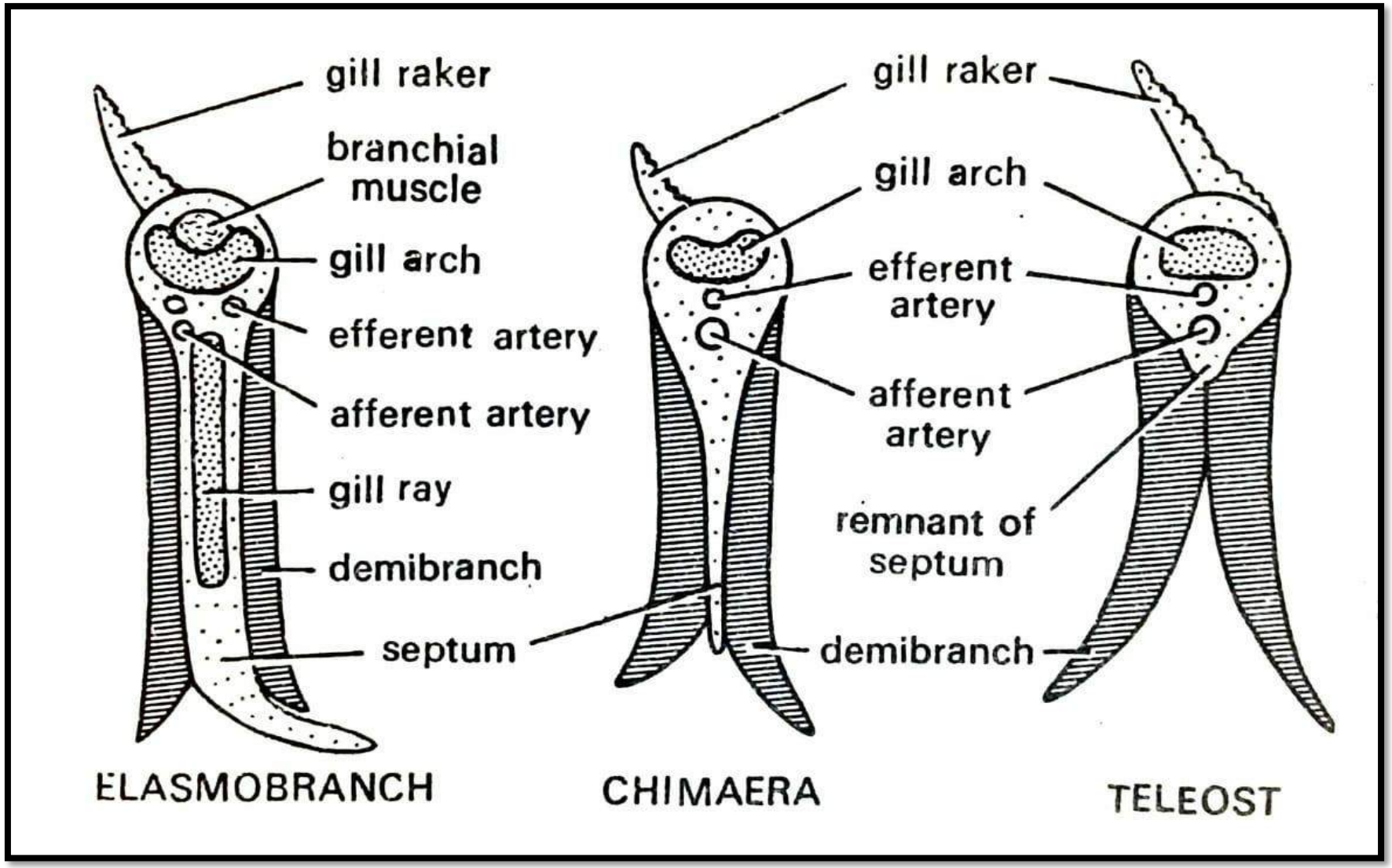
As against true gills, the external gills are formed as branching outgrowths from the exposed outer epithelium of gill arches and not from that of the pharyngeal pouches.

- They are ectodermal in origin, and usually temporary organs found only in larval stages. hence also termed larval gills.
- They occurs in the larvae of lampreys. a few bony fishes including polypterus, lungfishes (e.g Lepidosiren). and all amphibians. larval external gills are absorbed at the time of metamorphosis. but in water-living perennibranchiate urodeles, both external gills and gill slits persist during adult life.
- In Amphioxus, gill are absorbed but gill

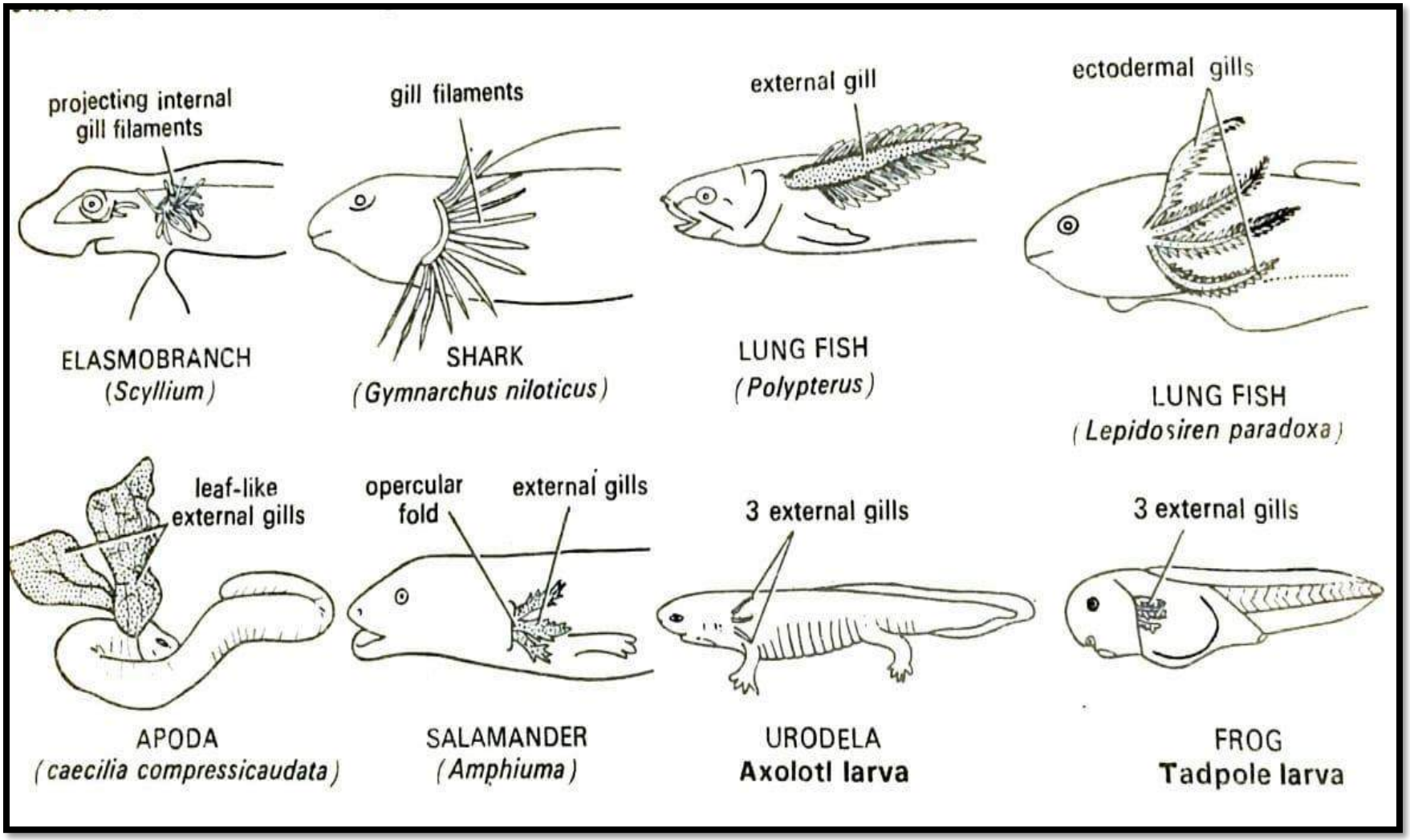
slits remain.

- Gills assume various shapes being pectinate, bipinnate, dendritic, leaf-like, etc.
- Each gill consists of a narrow main central axis bearing a double row of filaments.
- Thoroughly vascularized by aortic arches, external gills are simply waved in water, and no respiratory water current passes through gill slits as in the case of true gills.

Types of gills in fishes in section



Larval external gills of fishes and amphibians



pulmonary respiration in tetrapods :

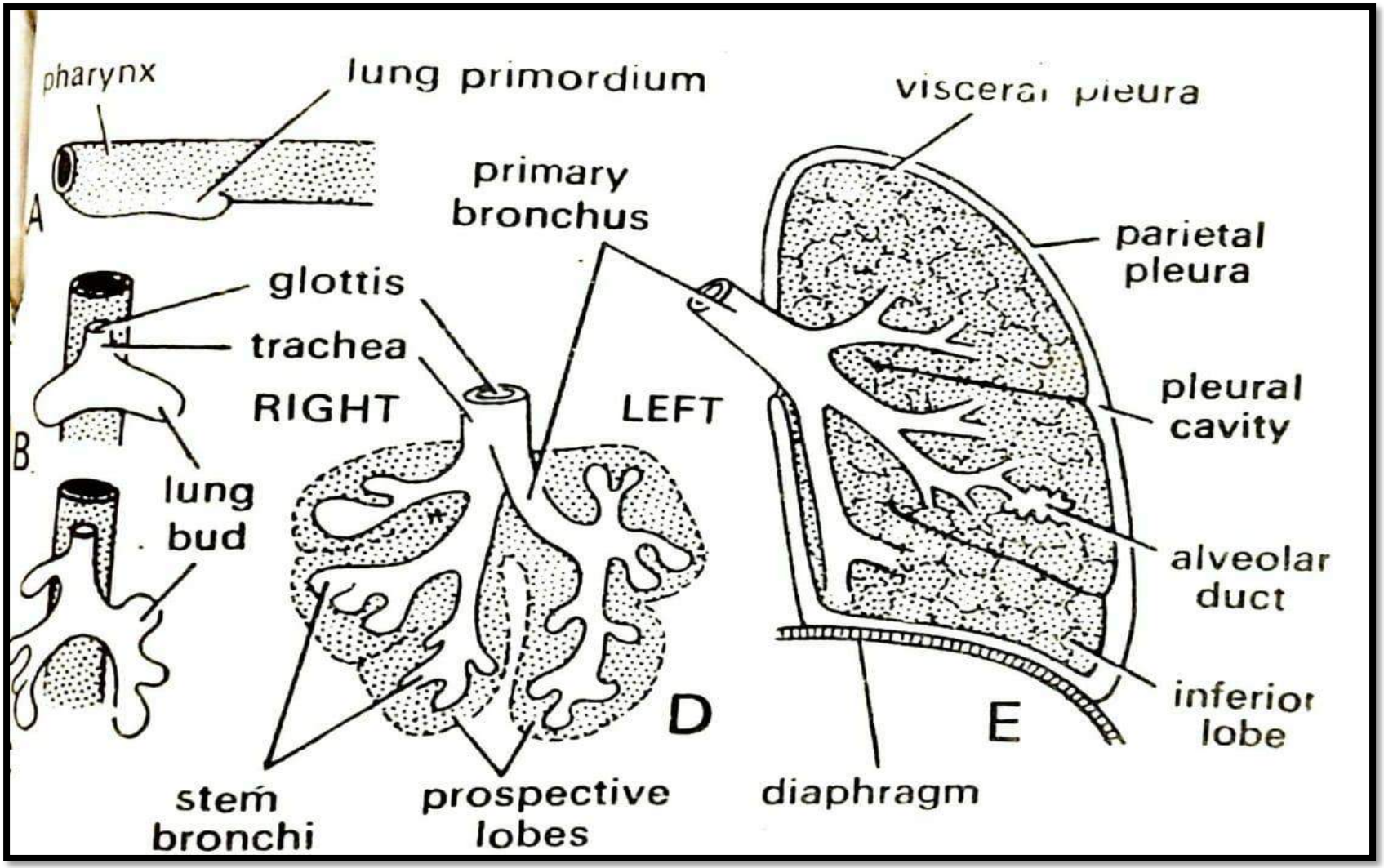
Lungs are the essential respiratory organs of land vertebrates or tetrapods and lung fishes. They are very elastic and dispensible.

In tetrapod embryos, lung arise as a single midventral diverticulum from the floor of pharynx. It soon bifurcates into right and left lung buds.

The undivided common portion develops into wind pipe or trachea and larynx and opens into pharynx through glottis.

Each lung bud branches repeatedly and grows posteriorly into coelom, invested by mesoderm, Thus each lung has an inner

Stages in development of a vertebrate lungs in embryo.



endodermal lining derived from embryonic gut, an outer visceral peritoneum and in between the two a mesodermal mesenchyme containing lymph and blood vessels, nerve and smooth muscle fibres and connective tissue.

Larynx:

- Beginnings of larynx are seen in Amphibians. In its simplest condition (Necturus).
- In other amphibians, each lateral cartilage is divided into a dorsal arytenoid and a ventral cricoid.
- Sometimes both the cricoids fuse to form a cartilaginous ring (frog). In Anura lining of laryngotracheal chamber forms two muscular bands or vocal cords. which vibrate to produce various calls.

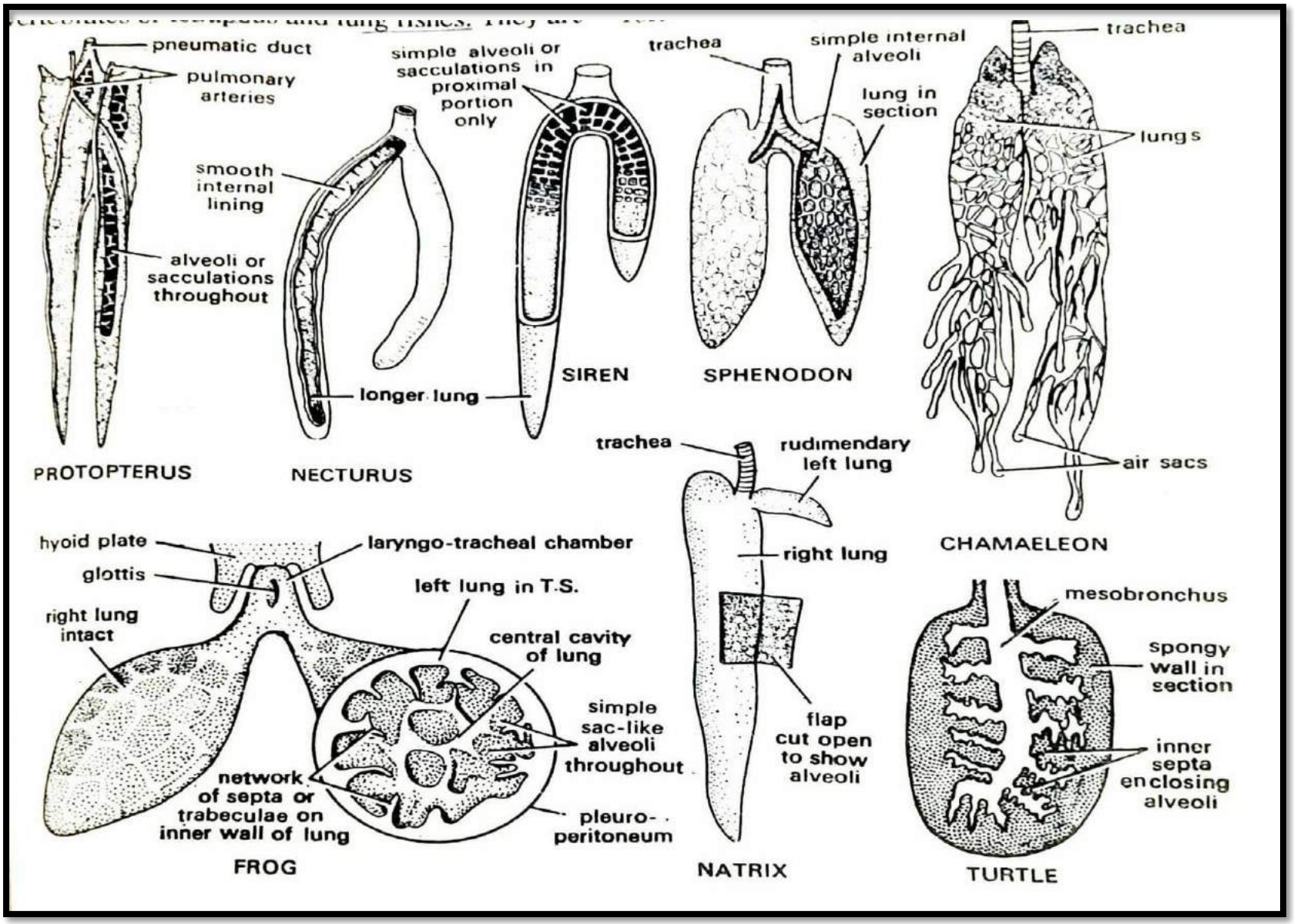
reptiles.

- It is small and rudimentary in birds another organ syrinx located the lower end of trachea, is responsible for sound production.
- Larynx reaches its greatest development in mammals. A flap-like muscular epiglottis is present in front of glottis and is characteristic of mammals.

Trachea:

- part of air duct between larynx and lungs is termed trachea.
- Lower end of trachea bifurcates forming two bronchi. lined with cilia. and each entering

Different types of vertebrate lungs



a lung.

- In Anura, trachea is extremely absent, merging with larynx to form a laryngo-tracheal Chamber.
- In reptiles, its length varied. its depending upon that of the neck.
- In birds, trachea is usually elongated, and tracheal rings are complete and ossified.
- In mammals, trachea is variable.

Lungs proper:

- Swimming bladders of lung fishes are better lungs than those of most amphibians.
- In frogs and toads lung wall may be divided peripherally by a network of folds or trabeculae into air sacs or alveoli.

- Lungs of reptiles are more complicated. it also hang freely in the body cavity. In Chamaeleons, several long, thin-walled, sac-like diverticula arise from distal portion of lungs.
- In birds lungs are unique architecture and greatly modified due to their aerial mode of life. Lungs are small, compact, Sponge and only slightly capable of Contraction and expansion. They are placed outside Coelom in pleural cavities. They give out several thin-walled membranous air sacs that invade most parts of the body.

- Mammalian lungs are also highly developed spongy and very elastic. They lie protected in special chambers, called pleural cavities, which are separated from rest of perivisceral body cavity by a muscular diaphragm. In most mammals lungs are subdivided externally into lobes. eg: man - 3 lobes, 4 - lobes in rabbet.
- The mammalian lung consists like an elaborate branched respiratory tree. The bronchus divides repeatedly inside the lung ultimately resulting into a large number of terminal grape-like clusters of air-sacs or alveoli. Being terminal and blind, they always retain a certain amount of residual air after every expiration.
- In mammals, intercostal muscles, ribs, diaphragm, sternum and abdominal muscles, all aids in breathing.