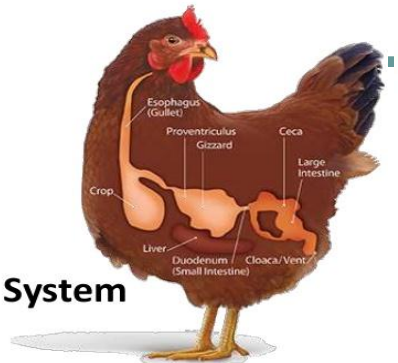
poultry physiology

Prepared by

Ahmed Hashem El-Anwar

Professor and Head of Physiology Department
Faculty of Veterinary Medicine
Beni Suef University



Avian Digestive System

Avian physiology

I - Hematology

The blood of chicken is about:-

8 % of body weight at the age of 1-2 weeks

6% in mature hen.

The blood is formed from plasma and cells. The cells are R.B.Cs, W.B.Cs and thrombocytes.

1- R.B.Cs

They are oval-shaped and nucleated.

The count is about 3.8 million / μL in adult male and 3.0 mill./ μL in adult female .

The life span of R.B.Cs. is

26 - 35 days for chicken,

42 days for duck

35-45 days for pigeon

Haematocrite value

Haematocrite value is:-

30 - 40 % in the male

30% in the female.

Testosterone and thyroxin hormones increase the number in males but not in female.

Estrogens have no effect on the number.

Hemoglobin

Hb of chicken reaches

9-13 gm/ dL blood.

Laying hens have a lower Hb content than non-layers.

2- W.B.Cs

W.B.Cs are larger in size

W.B.Cs count is about 15 - 35,000 /μL.

The W.B.Cs are heterophils, eosinophils, basophils, monocytes and lymphocytes.

Stress →↑ACTH →↑glucocorticoids →↑ Heterophils and ↓ lymphocytes.

Heterophils: Its ratio is 27.2%

They are called:-

- polymorphonuclear
- pseudoeosinophilic granulocyte or pseudoeosinophils.

They have many rod-shaped or spindle-shaped acidophilic bodies in the cytoplasm.

The nucleus is polymorphic with varying degrees of lobulation.

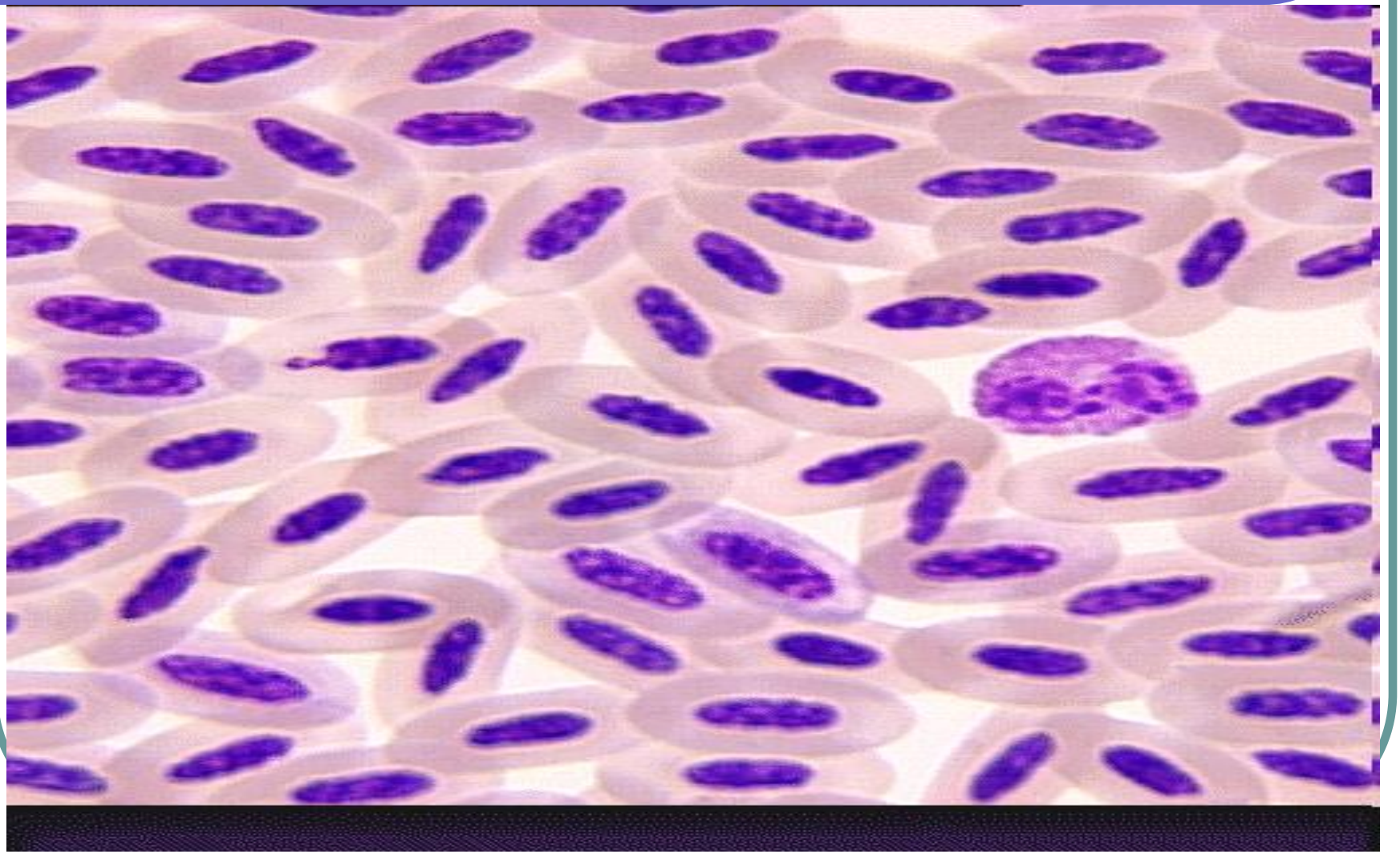
Eosinophils: 1.9 %

They have the same size as heterophils.

The granules are spherical and relatively large.

The nucleus is of a richer blue staining ability than that of heterophils.

Eosinophils



Basophils: 1.7%

They have the same size and shape as heterophils.

The nucleus is weakly basophilic in reaction and round or oval is shape and may be lobulated.

The granules are deeply basophilic and are abundant.

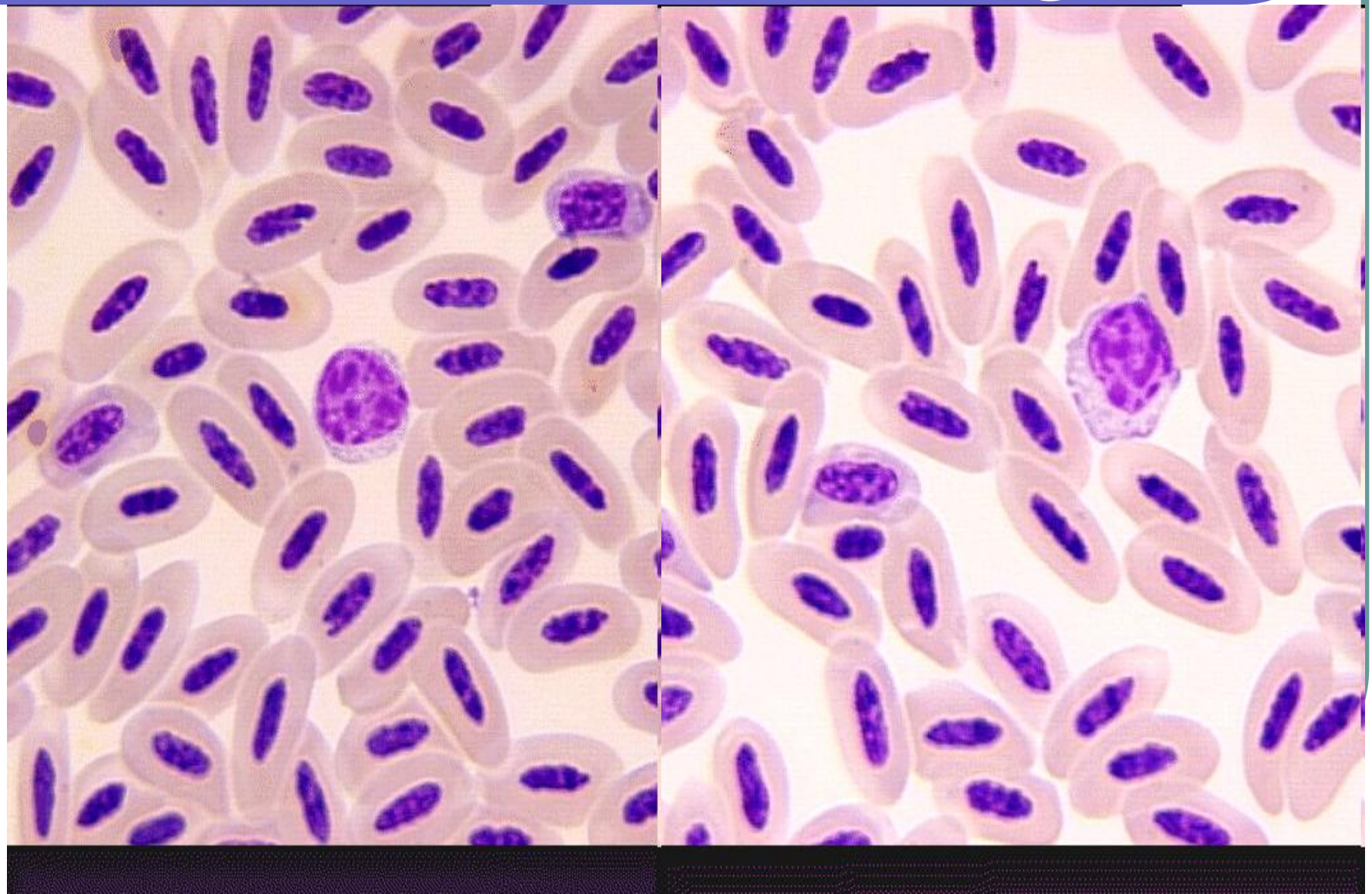
Lymphocytes: 59.1%

- They constitute the majority of W.B.Cs in the blood of fowl.
- Their shape and size are as in the blood of mammals.
- There are small and large lymphocytes.
- The nucleus may have indentation.
- They have a bacteriophage role besides antibody production.

Lymphocytes

Small

Large



Monocytes: 10.2%

They are sometimes difficult to differentiate between them and lymphocytes because there are transitional forms between them.

The nucleus is irregular.

They have a function in fat metabolism, which is of great importance during long starvation periods in migratory birds.

Thrombocytes: 25,000/ μL

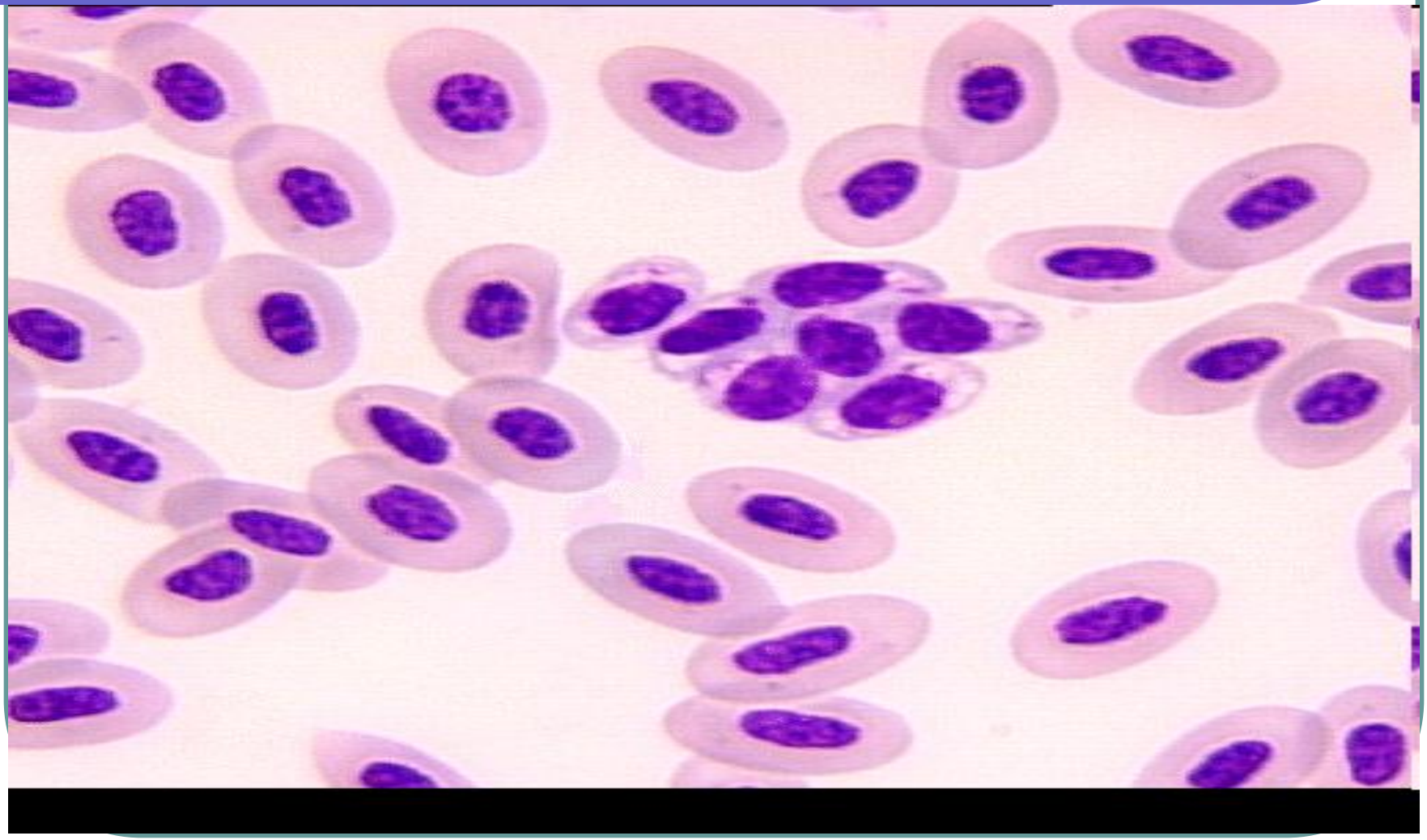
They are oval to round, with a round nucleus in the center of a clear cytoplasm.

A constant feature is one or more brightly red stained granules present at the poles of the cell.

R.B.Cs / thrombocyte ratio is about 200.

It appears that thrombocytes are cells belonging to R.B.Cs series.

Thrombocytes



Question!!!!!

The absence of platelets from avian blood raises the question whether the nucleated thrombocytes could act as a source of thromboplastin in chicken, or activation of avian hemostats depends entirely on tissue thromboplastin.

Plasma: 60-70%

It constitutes about 60-70% of the whole blood volume.

Total plasma protein $\rightarrow$ 4 gm /dL.

A/G ratio $\rightarrow$ 0.71.

Laying hen has a relatively more globulin than non-layers suggesting that it is increased with estrogen.

Osmotic pressure is less than in mammals due to a lower albumin content than mammals.

Avian plasma lacks coagulation factors (IX) and (XII).

Some hematological features:

* Sedimentation Rate (ESR) → 1.5 - 4 mm/hr.
* Clot retraction is slower than in mammalian blood.
* Prothrombin time → below 12 seconds.
* Coagulation time → 2-10 minutes.

Some circulatory features:

- Cardiac output → 218 ml /Kg/ min.
- Heart rate:
  - Pigeon → 221
  - Geese → 200
  - Duck → 180
  - Fowl → 350 - 470.
- Blood pressure $\frac{130 - 190}{85 - 160}$ mm Hg.

Haemorrhagic syndrome:

- It is observed in growing chickens, and is characterized by sub/cut hemorrhages, frequently anemia and pale bone morrow.
- It is due to deficiency of Vit.K. due to its lack in the ration.
- It may also be due to the injudicious use of coccidiostatic drugs as sulfaquinoxaline which acts as antagonist of Vit.K.
- It may also be due to toxins of some molds as aflatoxins.

Lymphatic tissue

It is composed of

- Lymph vessels.
- Lymph nodes.
- Thymus.
- Spleen.
- Bursa fabricius.
- Caecal tonsils.
- Lymphatic hearts and ducts.

Spleen

N.B: The spleen is an organ associated with the circulatory system and present near the gizzard in the abdominal cavity for formation of blood cells and acts as a reservoir for blood cells.

Thymus:

- It is an elongated and lobulated gland lies on each side of the trachea below the crop along the course of the jugular vein and vagus nerve.
- There are 7-lobes on each side.
- It increases in size until sexual maturity then undergoes regression of the cortex leaving medullary type of tissue with few lymphocytes at the onset of sexual maturity.
- It is enlarged by thyroxin and atrophied by glucocorticoids.

Thymus gland

The thymus gland has a C.T. capsule, which extends inward to form septa dividing the gland into lobules containing small lymphocyte-like cells called " Thymocytes"

Thymus gland

The thymus has an influence upon growth, egg production, thyroid, adrenals and gonads.

It is responsible for the production of lymphocytes (T-Lymphocytes) and formation of antibodies.

It secretes some hormones like:

a-Lymphocytosis stimulating hormone.

b-Thymosine.

c-Erythrocyte inhibiting factor.

d-Calcitonine.

e-Insulin-like growth stimulating factor.

f-Sterilizing factor that inhibits gametogenesis.

Bursa of Fabricius:

- It is an oval or round sac connected by a short stalk to the dorsal region of the cloaca at its junction with the colon.
- It is fully developed in immature birds and regressed at the onset of sexual maturity due to its sensitivity to steroid hormones, which cause its involution.
- It is the central lymphoid organ responsible for immun-oglobulin synthesis (B-Lymphocytes).
- It secrets an erythropoietin - like hormone. So bursectomized chickens have sever anemia.
- Also it secretes a hormone which stimulates maturation of the stem cells of the spleen and peripheral lymphoid tissues.

Caecal tonsils:

- They are enlargements of lymphoid tissue in the blind extremities of caecal wall and at the coadal end (the ileo - caeco - colic junction).
- They are important sources of antibodies.

Lymphatic hearts and vessels:

Both lymph vessels and valves are fewer than in mammals.

Lymph hearts are found in some birds like goose, ostrich and ank; these hearts lie at the level of the first coccygeal vertebra.

A pair of posterior lymph hearts is present in the chick embryo and disappears after hatching.

Fowl is the only type of birds in which lymphoid tissue is associated with the lymphatic vessels.

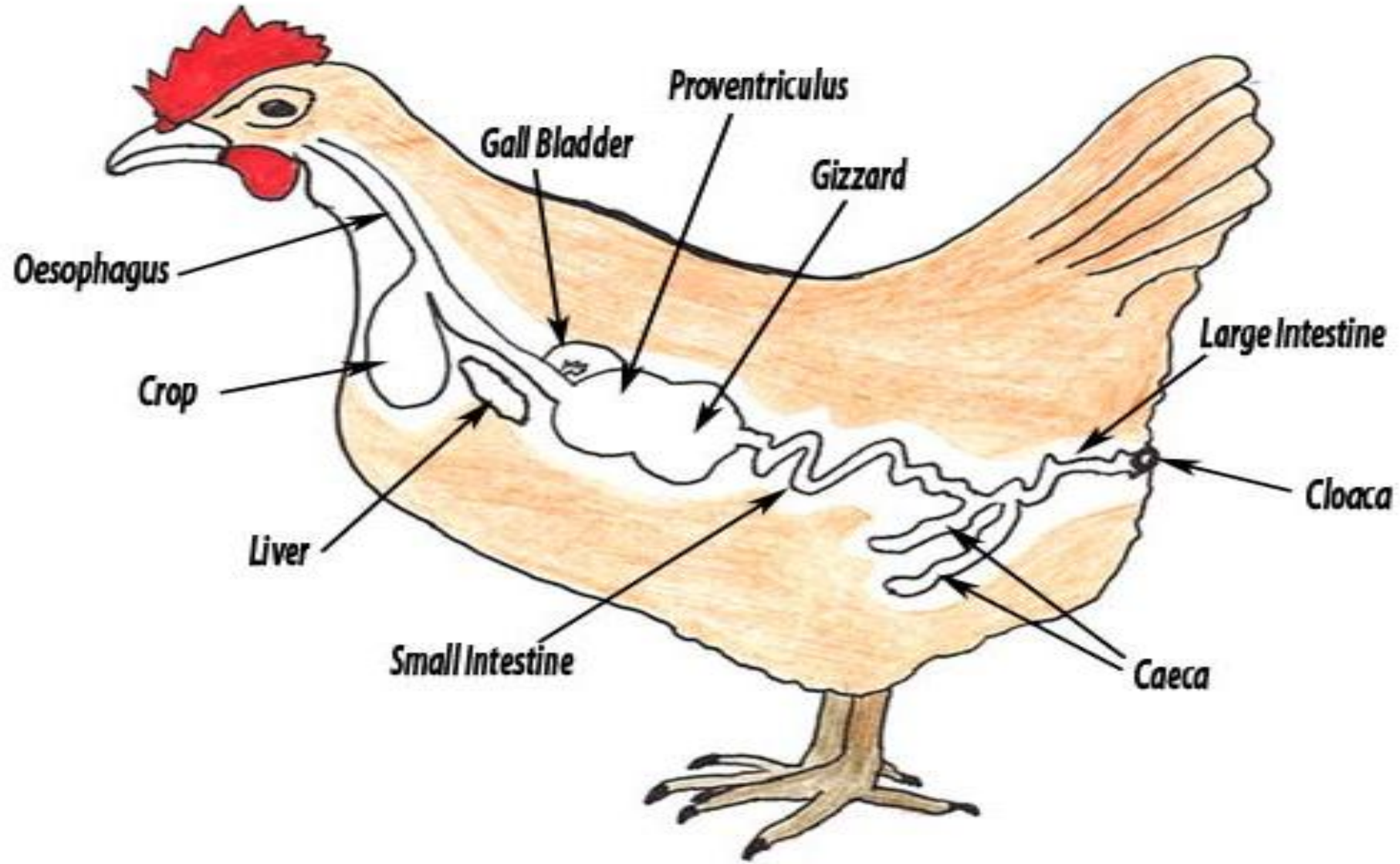
Digestive System

The digestive system of birds includes the alimentary canal and the accessory organs.

The alimentary canal includes the mouth, gullet (esophagus), crop, glandular stomach (proventriculus), gizzard, small intestine, caeca (2 in number), rectum, cloaca and anus.

The accessory organs include the beak, tongue, liver, and pancreas besides the salivary glands.

The Digestive System of a Chicken



The mouth

1-There are no lips and teeth, but instead there is a horny mandible on each jaw forming the beak, which is used for grasping, tearing and scooping of food.

2-The tongue is pointed and has barb - like projections at its rear to enable feed particles to be forced back toward the entrance of the gullet. There is no swallowing in birds.

3-Taste buds are few in number (12-in young chick) and are found on the base of tongue and floor of the pharynx.

Pharynx

1-The hard palate is pierced by a median slit that communicates with the nasal cavity.

2-There is no soft palate in most birds.

3-There is no sharp demarcation between the pharynx and the mouth.

Salivary glands

1-They are scattered through the mouth and pharynx.

2-They secrete mucous saliva that contains salivary amylase (small amount).

Gullet and crop:

1-The gullet is an elastic tube leading from the pharynx at the floor of the mouth to the crop and from the crop to the proventriculus.

It is lubricated internally by mucous glands.

2-The crop is an enlargement of the gullet and serves as a storage pouch in which the food is stored, soaked and softened.

Digestion by ptyalin probably occurs in the crop.

3-The crop is rudimentary in insect-eating birds and absent in carnivorous birds like falcon.

Proventriculus

It is a thickened tube leading to the gizzard. There is only one type of cells, oxynto - peptic cells, that produce both HCl and pepsinogen granules. Because of its small size, the food does not remain except for a very short time, but most of peptic digestion occurs in the gizzard.

The gizzard

1-It is an oval shaped structure having two openings on its upper side, one of which leads from the proventriculus while the other leads to the duodenum.

2-It is a very important organ serving to grind the feed and in some respects takes the place of teeth. With its thick development of musculature, it grinds or crushes coarse feed particles and breaks down the cellulose walls of the grains.

3-The presence of grit in the gizzard increases the efficiency of the grinding process. The particles of the grit remain in the gizzard until reduced to a fine ash

4-In carnivorous birds, it is small, poorly developed and represents a small expansion of the proventriculus.

Digestive enzymes in birds

	Secretion	Enzymes	Substrate &functions	End product
Mouth	Saliva (by salivary glands)	Amylase in some birds , Most domestic bird lack it	A- starch & dextrin B- lubrication	Dextrin Glucose
Crop	mucus		Lubricate &soften food	
Proventriculus	A- gastric juice HCL by (chief cells) B- mucus	A- pepsin B- lipase in carnivores C- amylase	Protein Fat	Proteoses Poly peptides Fatty acids & glycerol Coating of stomach
Gizzard			Grit in gizzard increases the motility Grinding action increase digestibility of	Ground foods reduce particle size

	Secretion	Enzymes	Substrate & function	End product
Duodenum	Pancreatic juice	A- Trypsin & chymotrypsin	A-Protiens, proteoses& peptone	A-Peptone , peptids &amino acids
		B- carboxypeptidase	B-peptide	B-amino acids &peptides
		C-collagenase	C-collagen	C-peptides
		D- amylase(amylosin	D-starch, dextrin	D-maltose &dextrin
		E- lipase	E- lipids	E-fatty acids &glycerol
		F- cholesterol esterase	F- cholesterol	F- cholestrol estified with fatty acids
Liver	Bile		Lipids	Emulsifying effect of fat

	Secretion	Enzymes	Substrate & function	End product
Small intestine	Intestinal juice secreted by intestinal wall	A- peptidase B- sucrase (invertase) C- maltase D-lactase E- poly nucleotidase	A- peptides B- sucrose C- maltose D-lactose E- nucleic acids	A- amino acids & dipeptides B- glucose &fructose C- 2 glucose D- 4 glucose &galactose E- mono nucleotides
cecum		Limited microbial activity	Cellulosem polysaccharides, starch & sugars	VFA, vit. K and vit. B

Respiratory system

It is highly developed than that mammals

To meet with bird's requirements of oxygen during flight and to provide a greater capacity of heat regulation

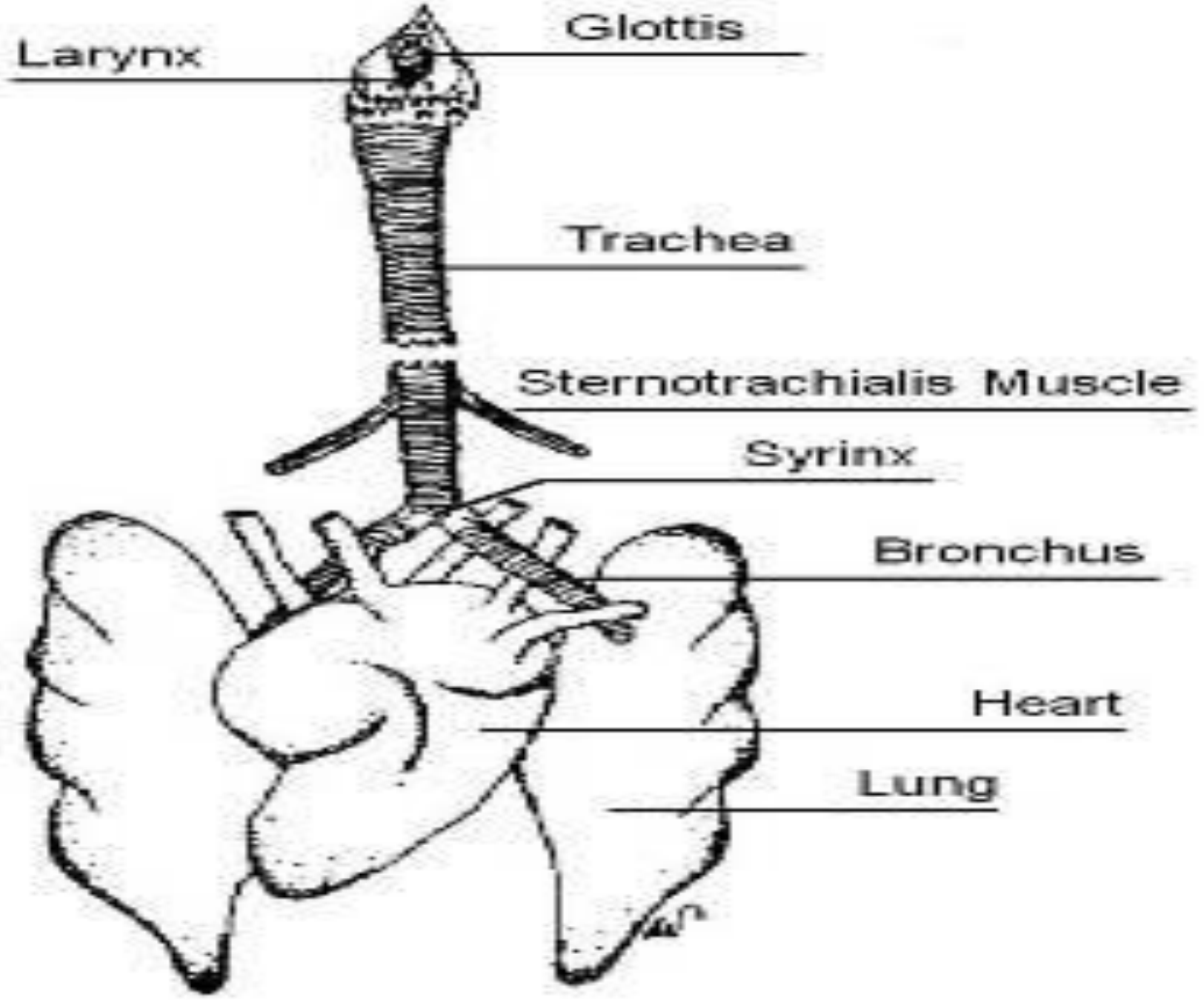
Chief function :

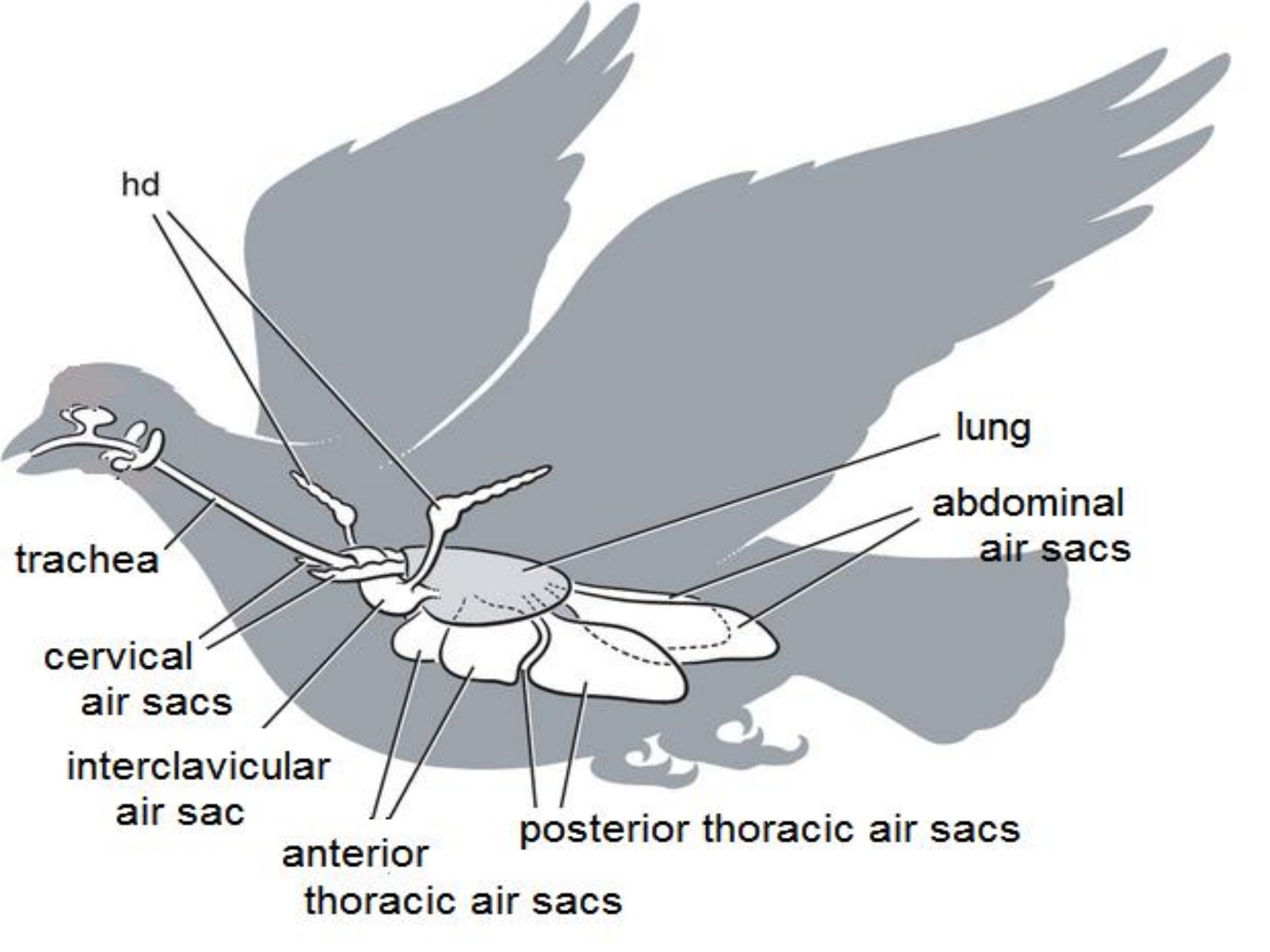
To supply living cells with oxygen and to get red of carbon dioxide

Respiratory system

It starts with nostrils , nasal chamber, mouth, 2 mesobronchi , air sacs and lungs.

Respiratory system of birds like that of mammals is able to accommodate to requirement of gas exchange, evaporating cooling and vocalization


Glottis
Larynx
Trachea
Sternotrachialis Muscle
Syrinx
Bronchus
Heart
Lung


hd
lung
abdominal
air sacs
trachea
cervical
air sacs
interclavicular
air sac
posterior thoracic air sacs
anterior
thoracic air sacs

Gas exchange

Gas exchange in mammals occur in alveoli.

In bird occur across shorter diffusion distance and relatively smaller surface area than that of mammals.

In minute air capillaries which open into tubular tertiary bronchi.

function nasal cavity

1- Olfaction.

2- Filtration.

3- Thermoregulation.

4-Water balance

During inhalation wall of nasal cavity are cooled by air passing over them and by evaporation from their surfaces

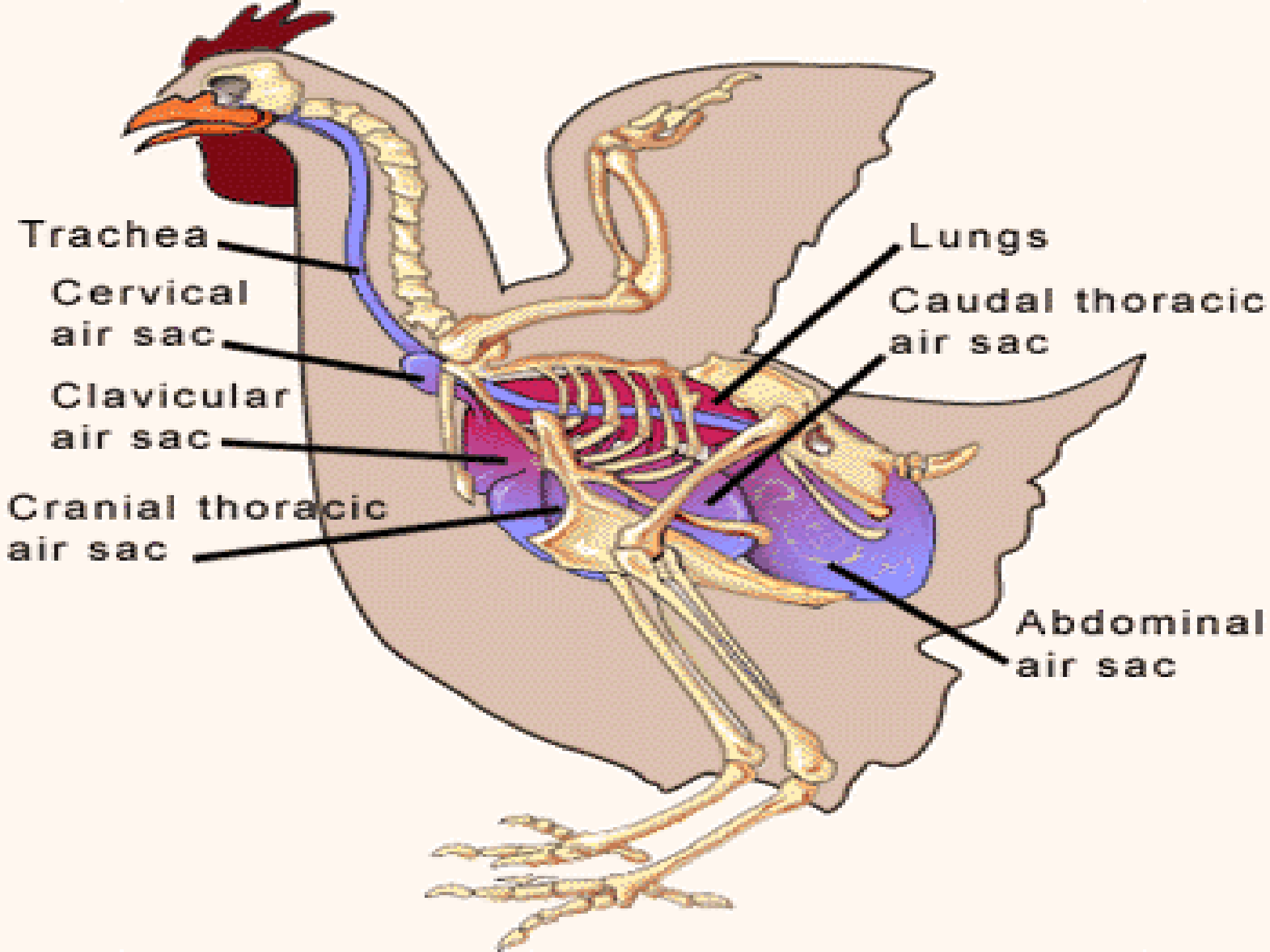
Part closest to nostrils being coolest and temperature gradient rises caudally.

Water balance

During exhalation warm air from lungs is cooled as it passes over the cold nasal wall.

This cooling causes condensation of water vapor and thus reduce water loss.

This is property of critical importance in water balance of birds in deserts habits and in migrating bird also it saves heat to be consumed for flying.


Trachea
Cervical air sac
Clavicular air sac
Cranial thoracic air sac
Lungs
Caudal thoracic air sac
Abdominal air sac

1-Upper respiratory tract

A- larynx

Is a vulvular structure , open and close glottis during respiratory cycle and prevent aspiration of foreign material into lower respiratory tract.

It is not the site of sound but it may modulate it.

No vocal cord but it located at top of trachea and leads directly to it.

B- Trachea

It is formed from a series of ossified tracheal cartilage both complete and incomplete overlapping each other. But in mammals incomplete rings

- Long and convoluted in female
- Short and straight in male

In geese and other bird trachea long and serves as a resonating tube to amplify the voice of these bird

2- lungs and air sacs

A- lungs :

They are dorsal in position small or quadrilateral in shape.

Total volume of lungs is less than that of mammals.

Two primary bronchi arise from trachea at its bifurcation one to right other to left.

Each primary bronchus runs full length of lung and give rise to two groups of secondary bronchi :-

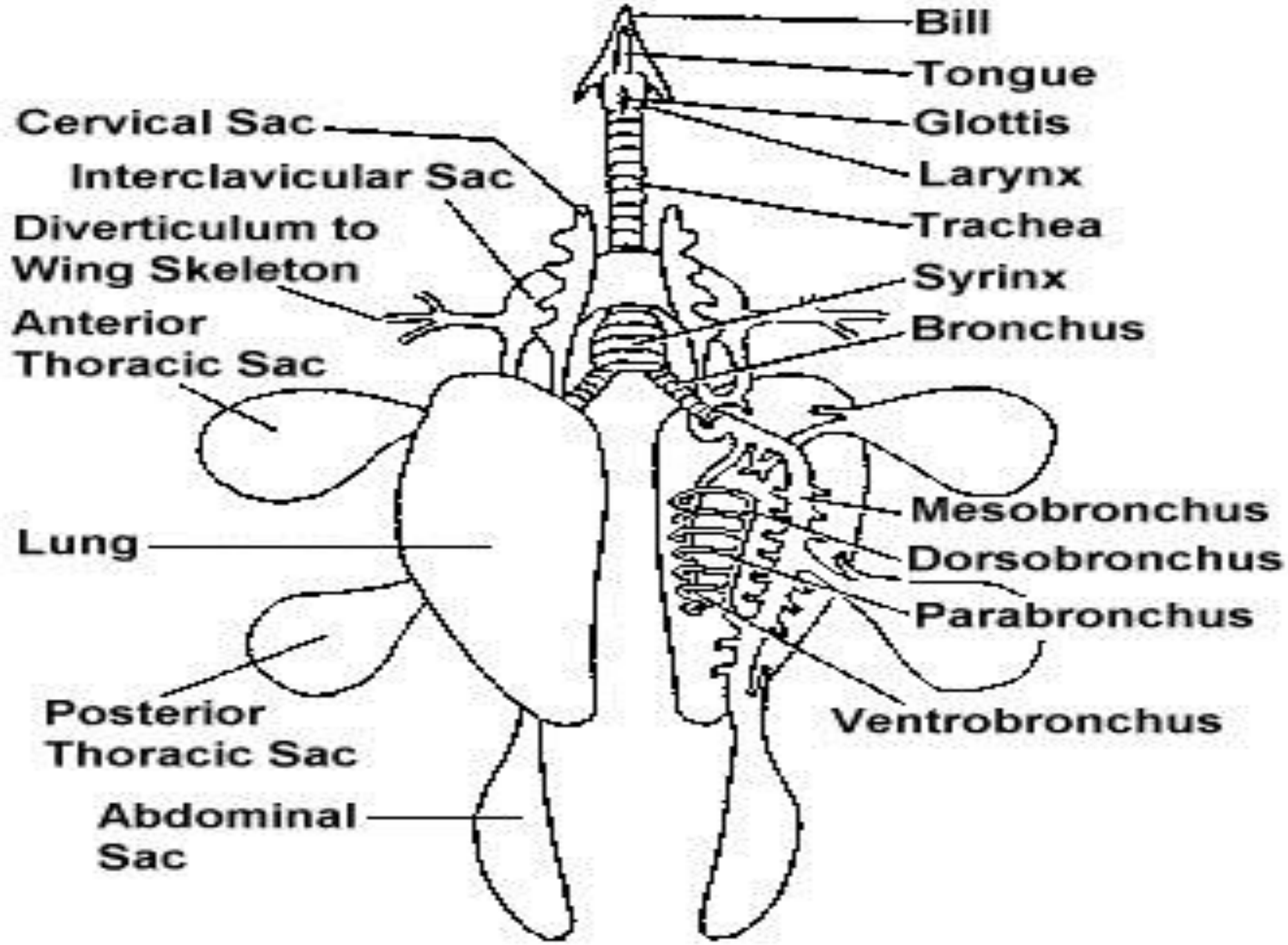
Medio ventral group and Medio dorsal group.

Two group of secondary bronchi joined together by tertiary bronchi called parabronchi

Parabronchi continuous form net work of air capillaries the functional respiratory exchange region

Two types of tertiary bronchi:-

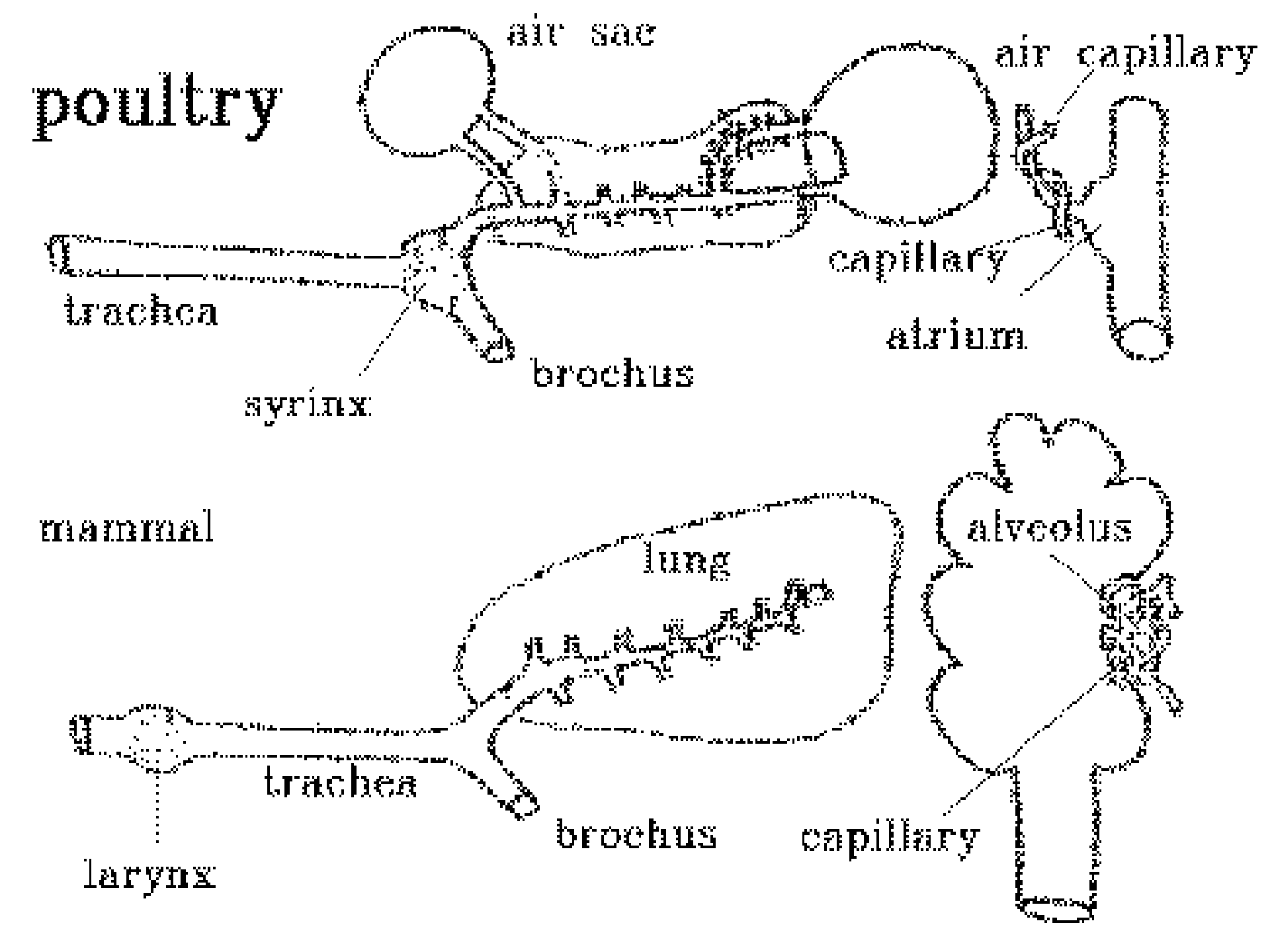
Paleopulmonic and neopulmonic.


Bill
Tongue
Glottis
Larynx
Trachea
Syrinx
Bronchus
Cervical Sac
Interclavicular Sac
Diverticulum to Wing Skeleton
Anterior Thoracic Sac
Lung
Posterior Thoracic Sac
Abdominal Sac
Mesobronchus
Dorsobronchus
Parabronchus
Ventrobronchus

Smooth muscle fiber of wall of bronchi is penetrated by many opening called atria

Extension from atria called infundibuli

Atrai 0.1- 0.2 mm in diameter leads to air capillaries where gaseous exchange occurs.


poultry
air sac
air capillary
capillary
trachea
atrium
brochus
syrinx
mammal
lung
alveolus
trachea
brochus
capillary
larynx

B- Air sacs

9 in number

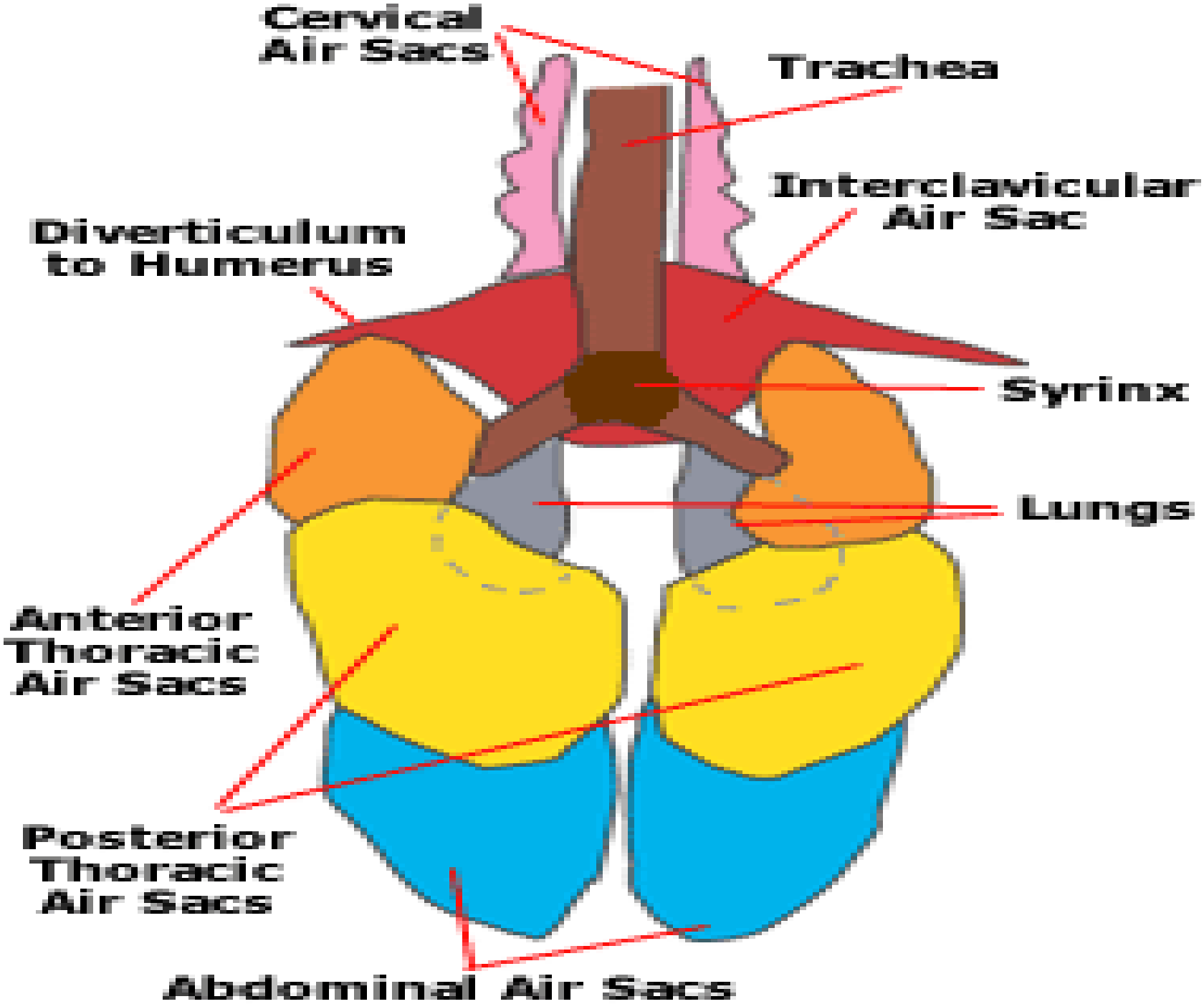
One unpaired (clavicular).

Four paired (cervical, cranial thoracic , caudal thoracic and abdominal).

It occupy space in thoracic and abdominal cavities and may have diverticula into many bones causing them to be pneumatic.

Air sacs may completely surround heart, liver, kidneys, testis, ovaries and intestine.

It occupies about 80 % of total respiratory volume.


Cervical Air Sacs
Trachea
Interclavicular Air Sac
Diverticulum to Humerus
Syrinx
Lungs
Anterior Thoracic Air Sacs
Posterior Thoracic Air Sacs
Abdominal Air Sacs

Role of air sacs in respiration

1- Decrease specific gravity of body and this facilitates flying.

2- Increase pulmonary ventilation and exchanges of gases in lungs.

3- Help regulation of body temperature by cooling and warming inspired air.

4- Abdominal air sacs in contacts with testis and help lowering of temperature to facilitate spermatogenesis.

5- Air sacs humidify inspired air.

Pneumatic bones (aerated bones)

These are hollow bones connected to respiratory system of birds such as bones of skull, humerus, clavicle, keel, lumber and sacral vertebrae.

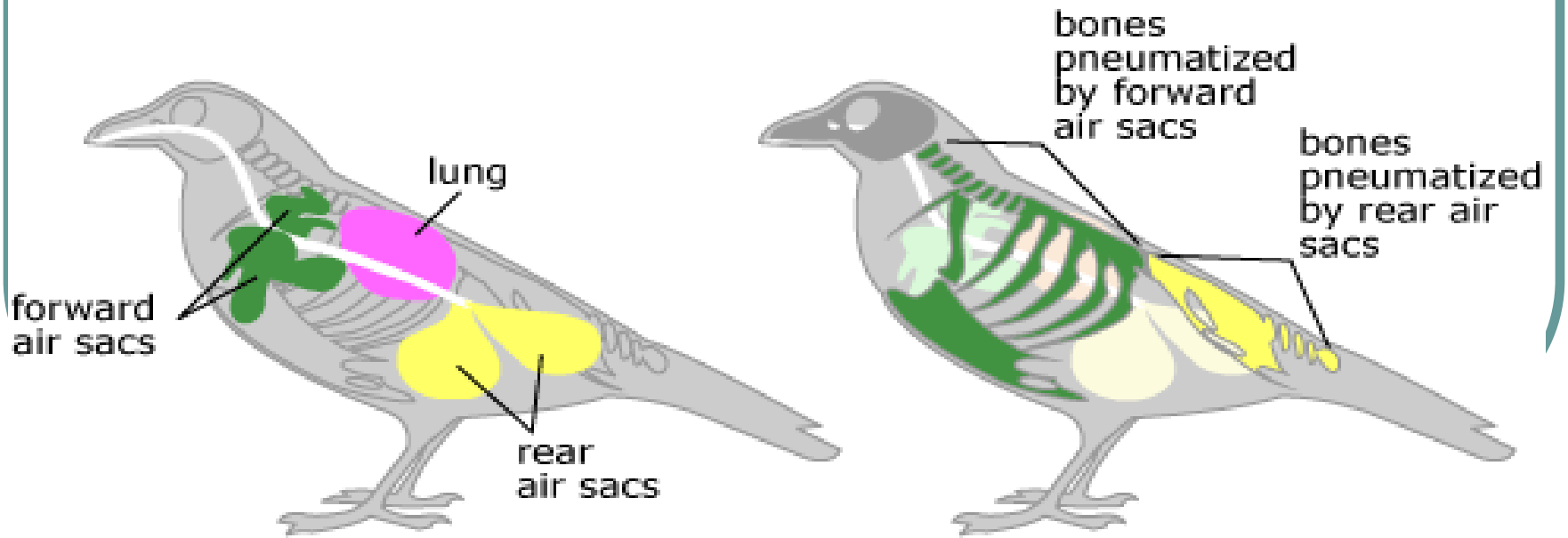
This connection is so intimate that a chick can breath through its cut humerus.

The clavicular air sacs sends diverticula into large pneumatic bones (sternum , pectoral and humerus).

Pneumatic bones

Paired air sacs supply sacrum, pelvis and legs

Large flying birds have well developed pneumatic bones while small flying birds have less developed pneumatic bones



Mechanism of respiration and air pathway in lungs and air sacs

Bird have no muscular diaphragm.

Thoracic and abdomen are continuous.

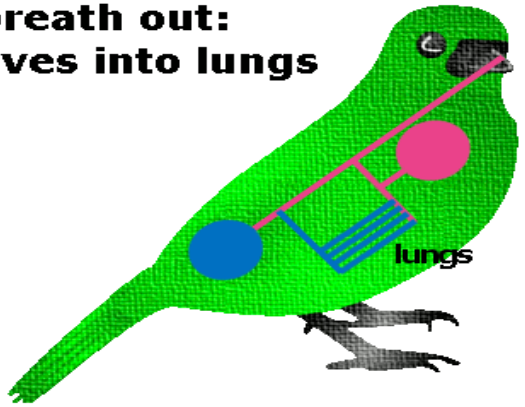
Bird depends on movement of thoracic cage and abdominal wall.

Force needed for gas exchange depends on action of respiratory muscle which increase volume of body cavity and produce sub atmospheric pressure with in sac.

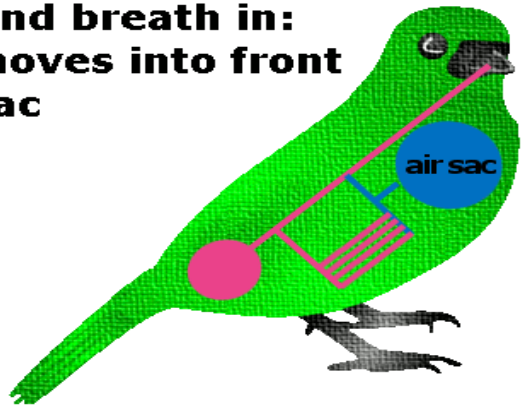
Breathing in birds

First breath in:
air (blue) moves
into the air sac

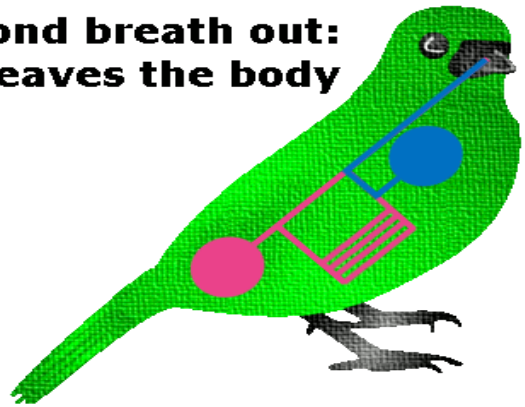
First breath out:
air moves into lungs

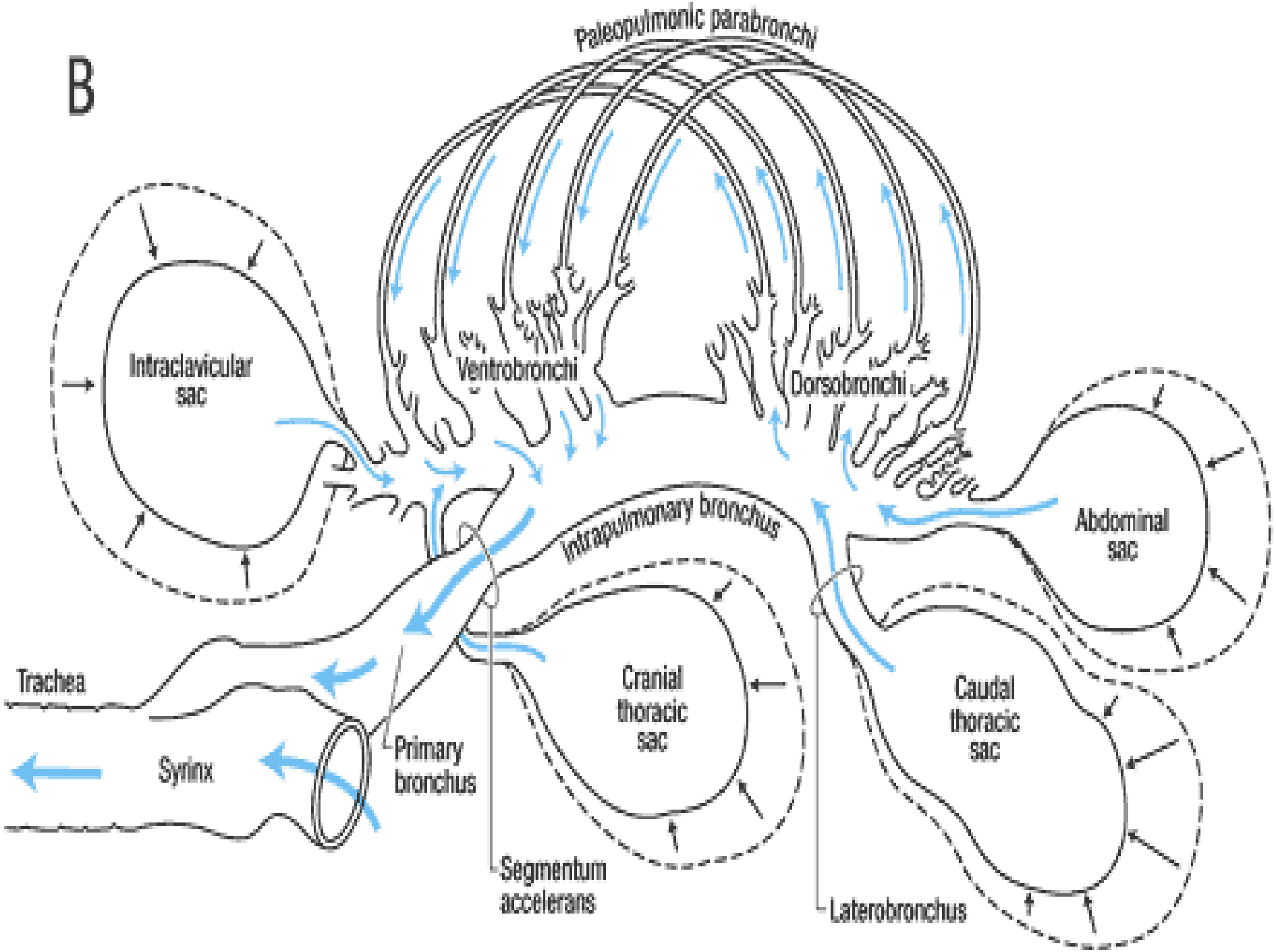


Second breath in:
air moves into front
air sac

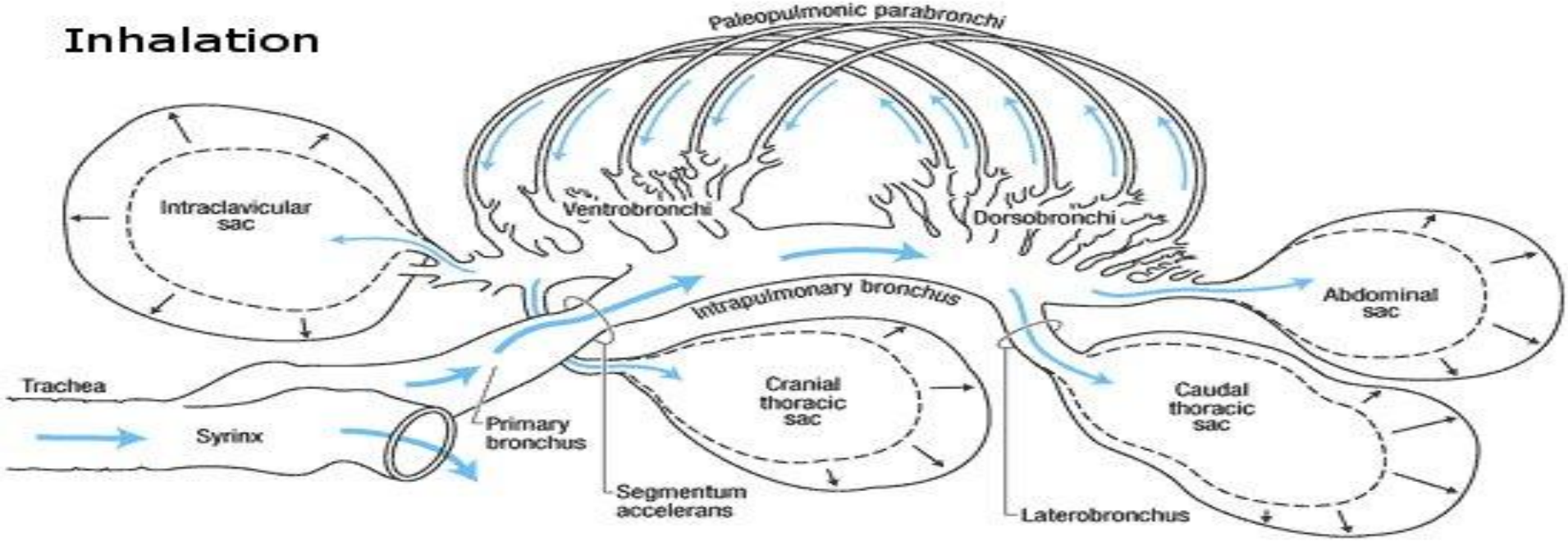


Second breath out:
air leaves the body

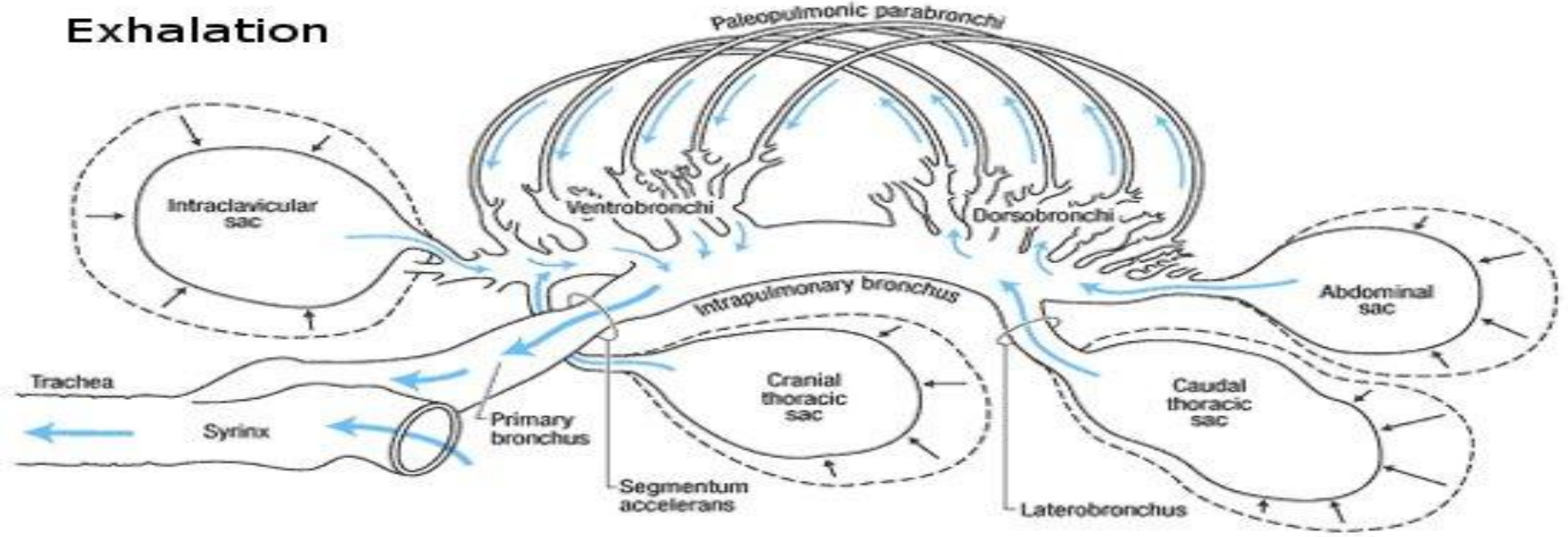



B
Paleopulmonic parabronchi
Intraclavicular sac
Ventrobronchi
Dorsobronchi
Intrapulmonary bronchus
Abdominal sac
Trachea
Cranial thoracic sac
Caudal thoracic sac
Syrinx
Primary bronchus
Segmentum accelerans
Laterobronchus

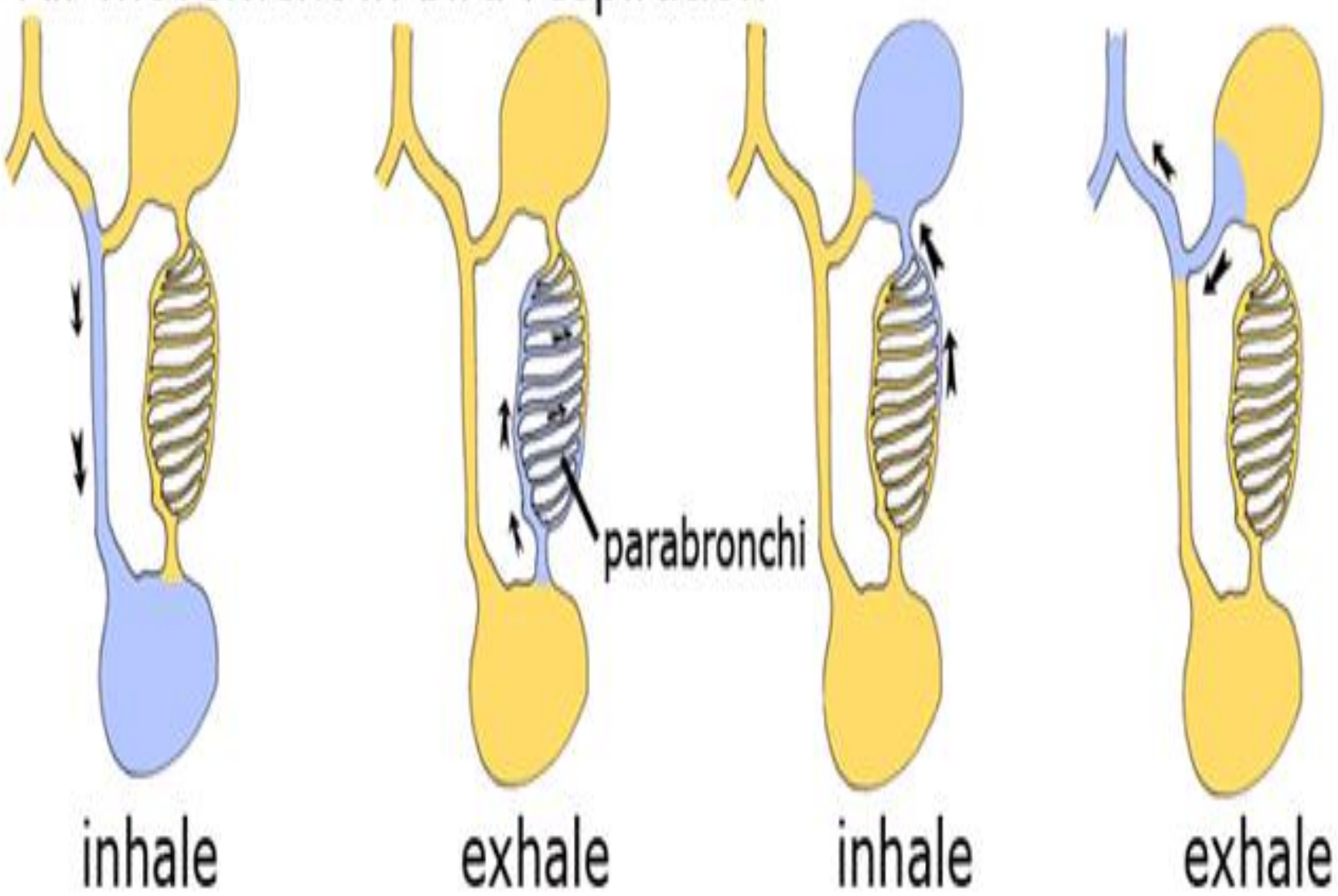
Inhalation

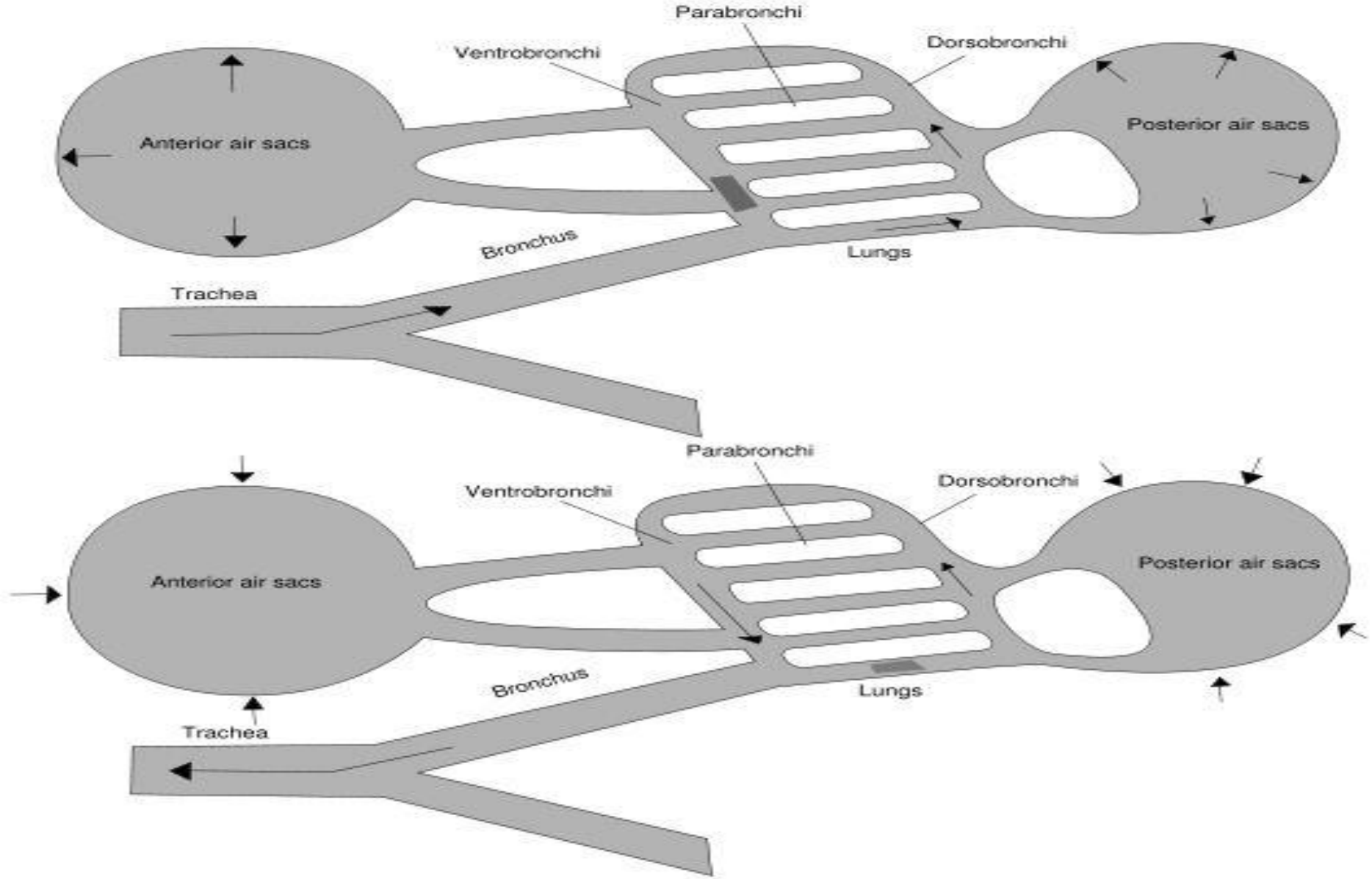


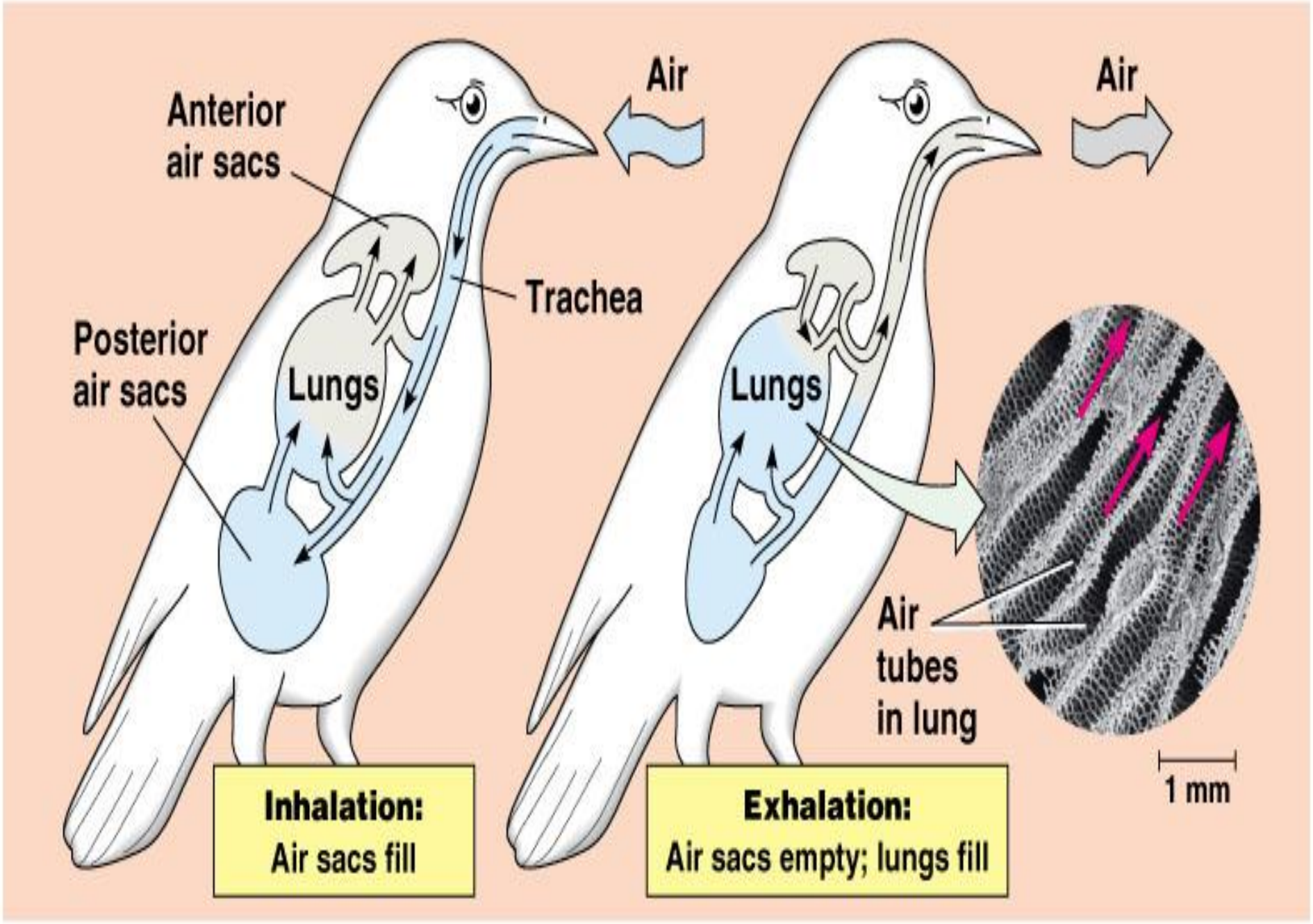
Exhalation



Air movement in bird respiration




Parabronchi
Ventrobronchi
Dorsobronchi
Anterior air sacs
Posterior air sacs
Bronchus
Lungs
Trachea
Parabronchi
Ventrobronchi
Dorsobronchi
Anterior air sacs
Posterior air sacs
Bronchus
Lungs
Trachea



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Air **flow through avian lungs during inspiration :**

Air move to cranial air sac goes through a large set of paleopulmonic before getting to sacs.

Air move to caudal air sac goes through a smaller set of neopulmonic before getting to sac

Air flow through avian lungs during expiration :

Gas pass from caudal air sac passes again through neopulmonic and then through palepulmonic

Gas from cranial air sacs moves to secondary bronchi and out of lungs through primary bronchi and trachea without passing through gas exchange surface.

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Ovary

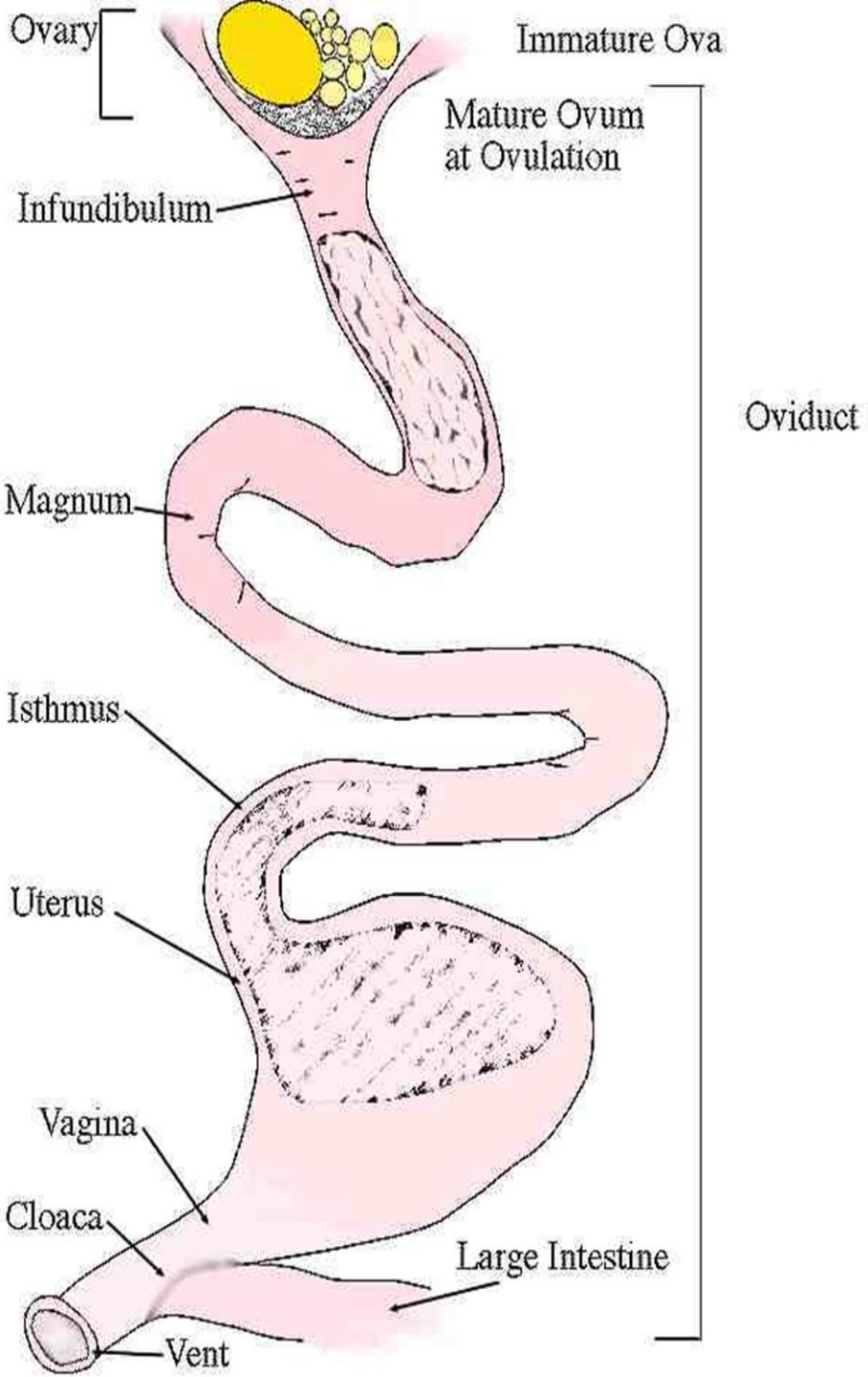
- present on left side of the body .
- During embryonic development a right gonads and oviduct also develop but gradually degenerate due to early estrogenic secretion produced from the left ovary as it develop first.

The inactive ovary appears as a small, whitish mass of irregular content while active one as a yellowish cluster of spheres of varying sizes

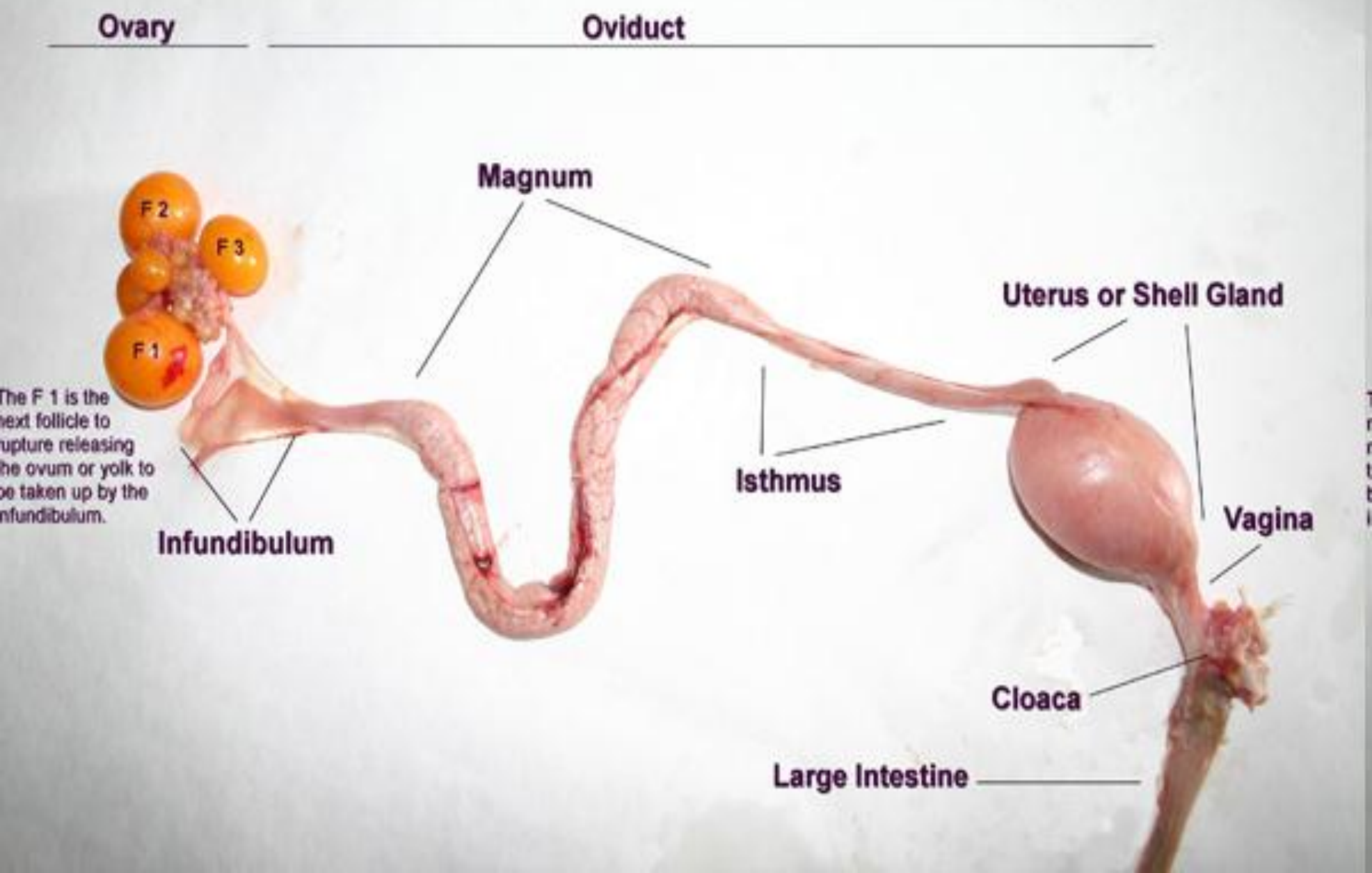
Each spheres is enclosed in a follicle

These spheres are ova and referred as yolk

Each yolk contain germinal disc from which embryo develops.



Reproductive Tract of the Laying Hen



As yellow-yolky follicle enlarges :

It produces increasing amounts of estrogen from theca cells. As follicular growth continues and ovulation approaches the estrogen decreases, While progesterone increases.

The increasing plasma estrogen coming from smaller yellow follicle intensify courtship behavior, stimulate development of oviduct and stimulates spongy bone formation.

As ovulation approaches, progesterone secreted from largest yolky follicles promotes nest-building

Ovulation:

It means the release of ovum from follicle which occurs through the rupture of stigma by the effect LH.

Progesterone is the stimulator for the secretion of LH which occurs after maturation of follicles so in birds progesterone do similar action to estrogen in mammals in stimulating LH that activates ovulation.

The post ovulatory follicle (POF)

- It is an enigmatic structure in birds . It begins to degenerate within one day after ovulation .
- Within 6-8 days after ovulation it degenerate. It is analogous to CL in mammals. The tissues of the POF play a role in oviposition.

The oviduct

Only left oviduct normally develops ,Increased the size of oviduct when the bird is coming into breeding condition

About 80 cm coiled tube and consists of:-

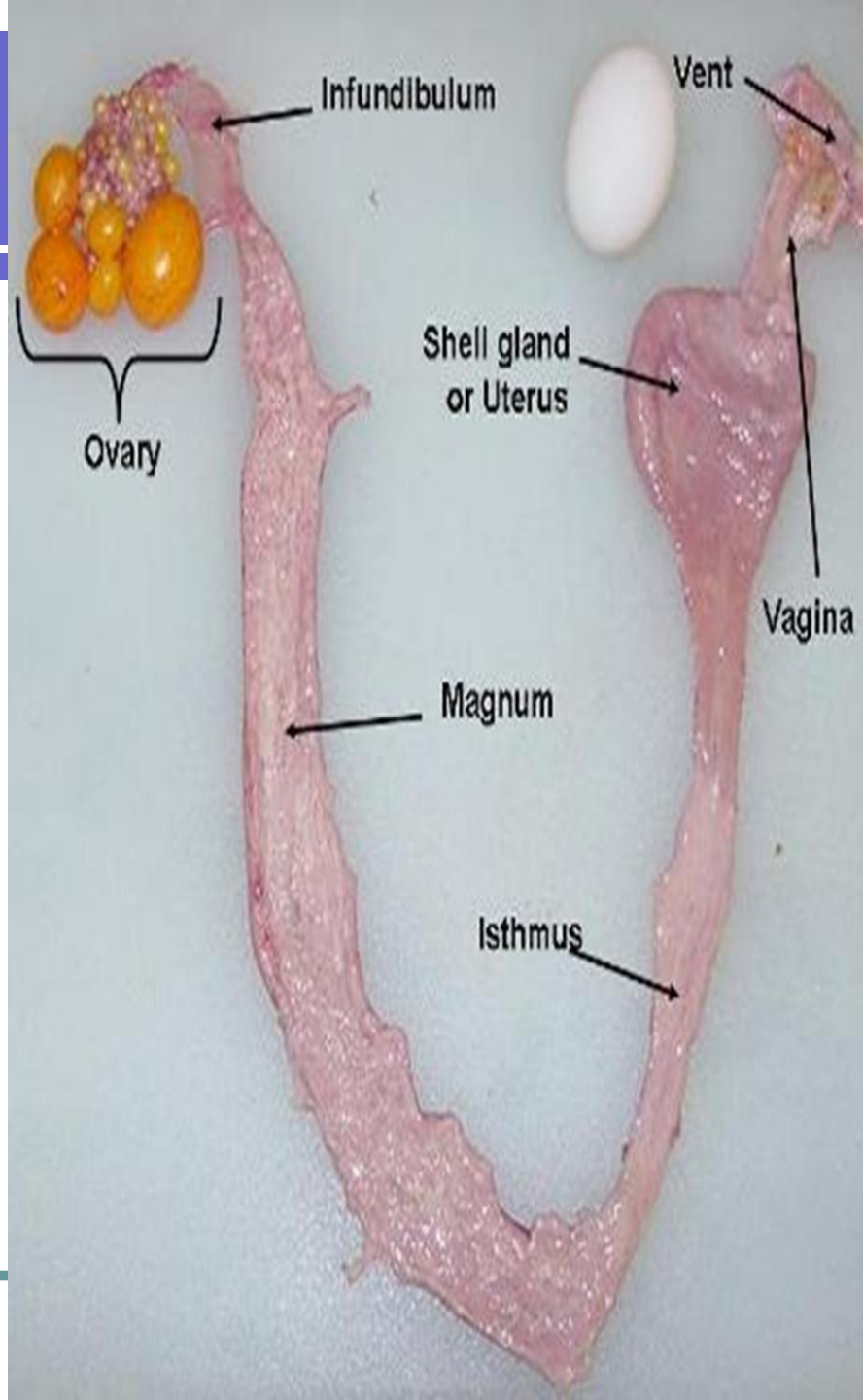
1- Infundibulum.

2-Magnum.

3-Isthmus.

4-Uterus.

5-Vagina leads to cloaca.



1- infundibulum 15-30min

Funnel- shaped called ampulla followed by chalaziferous region.

Function :

1-Fimbriae grasp the shed ovum.

2-It is the site of fertilization.

3-Formation of chalaza which connects the oocyte with two poles of eggs.

4-Formation of chalazeferous layer (inner thick albumin).

2-The magnum (2-3hr)

Albumin secreting part.

(54% of egg white).

3-The isthmus (75 min.)

It is responsible for formation of shell membranes

4- The uterus (Shell gland) (20 hrs)

It is a similar diameter to isthmus, but after a short course expands to form a pouch in which the egg is retained during the shell formation. The egg imbibes 15gm of water, exchanges electrolytes,Caco3, protein, pigment and cuticle. During the first 6 hours after the egg enters the shell gland, 8ml of water containing electrolytes accumulates in the egg giving the final mass of albumin (plumping).

Egg coloring begins 3-5 hrs before laying due to protoporphyrin pigment by uterine epithelium.

5- The vagina

Short S shape and plays no part in the formation of hard-shelled egg (few minutes) .

Its wall contains mucus-secreting cells, which secrete mucus to seal the pores of the shell to prevent bacterial invasion.

Sperm nest

The vaginal glands functions as a storage organ for sperms (sperm nest).
The sperm clump together to form compact mass oriented to each other with the heads to the blind ends.

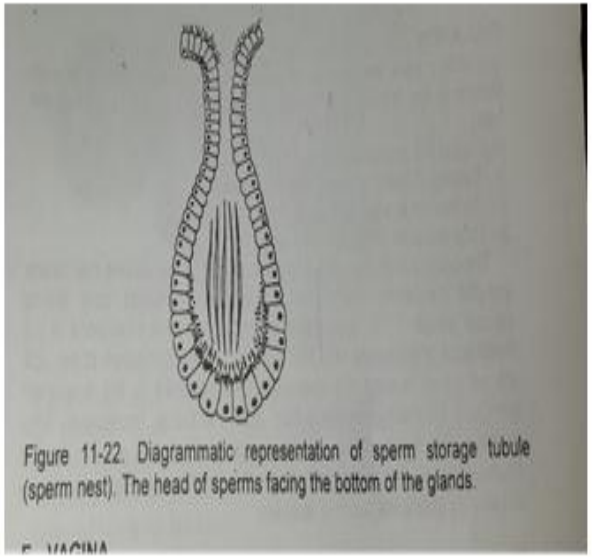


Figure 11-22. Diagrammatic representation of sperm storage tubule (sperm nest). The head of sperms facing the bottom of the glands.

Oviposition (bearing down reflex)

- Expulsion of the egg from the shell gland to the exterior through the cloaca. The contractility of the oviduct during passage of the egg through it as the ovum descent in the infundibulum, magnum & isthmus, the frequency and intensity of contraction are weak but when entering the shell gland the contraction increases. During the last few minutes before oviposition , the force of contraction of the shell gland become very high leading to expulsion of the egg .
- It is facilitated by contraction of the muscular wall of the shell gland beside the contraction of the body wall muscle that increases the intra-abdominal pressure leading to oviposition.
- It is attributed to PGF2. While PGE2 is secreted to relax the vaginal sphincter:
- Arginine vasotocin (post. Pit.) facilitate contraction of the body wall muscle that helps in egg expulsion (neuro humoral)

Structure of fully formed eggs :

From inside to outside :

1-Egg yolk (yellow and white yolk).

2-Germinal disk.

3-Vitelline membrane.

4-Inner thick white and chlaza.

5-Inner thin white.

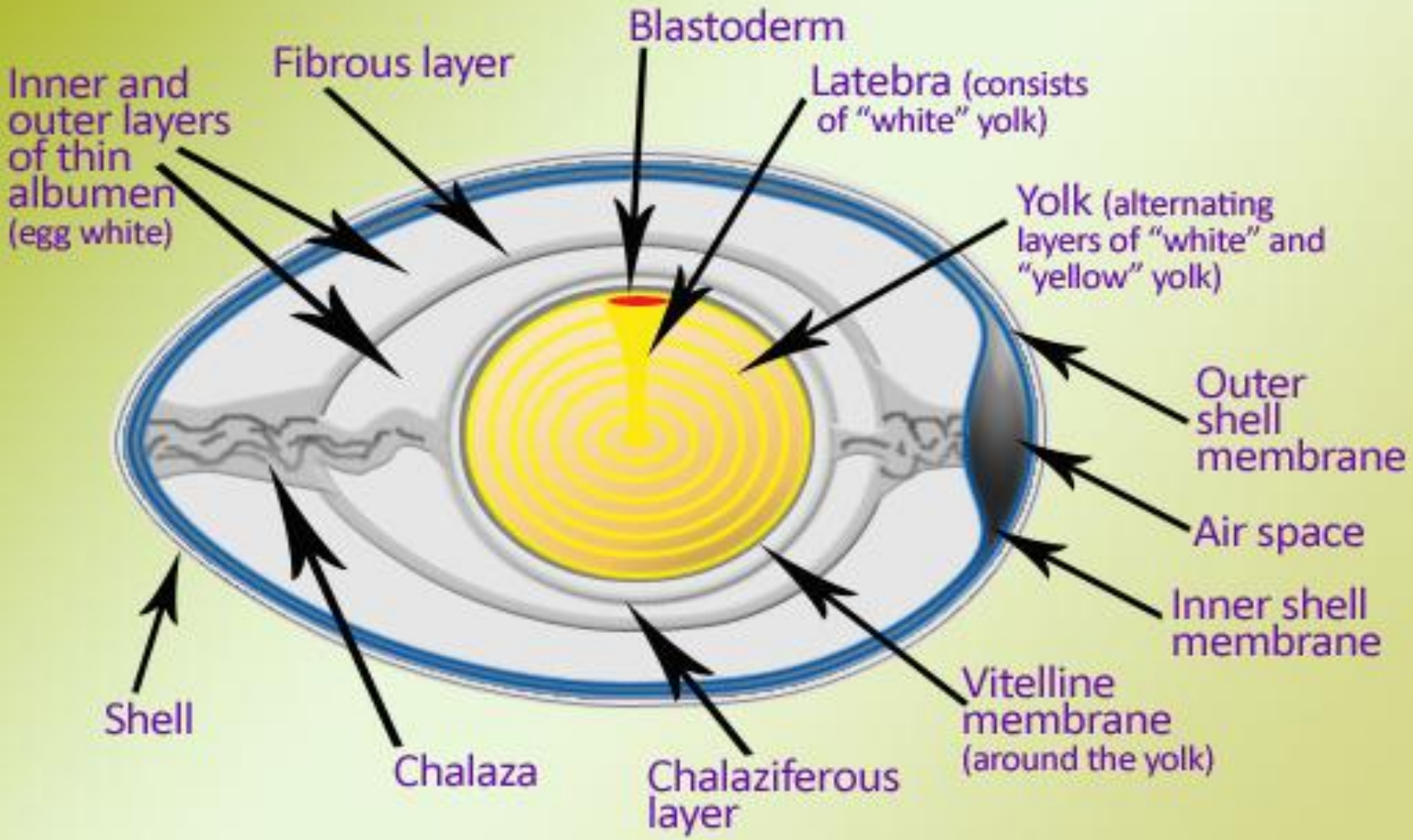
5-Outer thick white.

7-Outer thin white.

8-Shell membranes (inner and outer) and air cell in between.

9-Egg shell.

CHICKEN EGG ANATOMY



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Synthesis of the egg contents
1- yolk or egg yellow:

50% water and 50% (protein and lipid) at ratio of (1:2).

The synthesis of yolk protein occurs in the liver under effect of estrogen.

The yolk contains blastodisc (germ spot) enclosed in a vitelline membrane

The yolk has two types :

1-Light (white) rings : due to low level of carotene in the blood and is formed during night or not eating

2- Dark (yellow) rings : formed during the day due to high level of carotene .

2- Egg albumin (white egg)

It consists of proteins and water (1:8)

The major source of albumin is oviduct (magnum) which contains water soluble oviduct protein (WSOP) sufficient for 2 eggs. The oviduct is unable to store albumin for any length of time. The bulk of protein required for one egg is produced on that day .

The secretion of albumin is under the effect of estrogen which stimulate the synthesis of many enzymes system and synthesis of RNA.

3- Shell membranes :

In isthmus . Contains 20% water and 80 % sulfur contains protein and carbohydrate .

These membranes are made up of many interacting fibers (keratin) which permeable for both water and air .

The membrane normally adhere to each other except at the broad end of the egg where they are separated to form (air cell) which quite small when egg is first laid and then increases in size as the egg cools and as later evaporation of water through the membranes and shell.

4- The egg shell

The egg shell occur in the uterus.

98% ca carbonate and 2 % protein and mucopolysaccharides as an organic matrix covered by a thin organic cuticle that seals the pores and useful in reducing moisture losses and in preventing bacterial penetration of the egg shell.

The egg remains in the uterus during which the egg shell is formed and (plumping) of the egg occurs.

Calcification ($CaCO_3$) ,the source of CO_3 is HCO_3^- formed by shell gland mucosa in the presence of carbonic anhydrase or metabolism of the cells .

So, the process of shell formation produces acidosis accompanied by hyperventilation .during summer, very rapid rate of respiration (panting) to evaporate saliva leading to decrease CO_2 producing thin shelled eggs.

Calcium is obtained from blood which withdrawn from food or bone. The bone marrow activities of many of the bones are invaded by a new system of secondary bone(medullary bone)

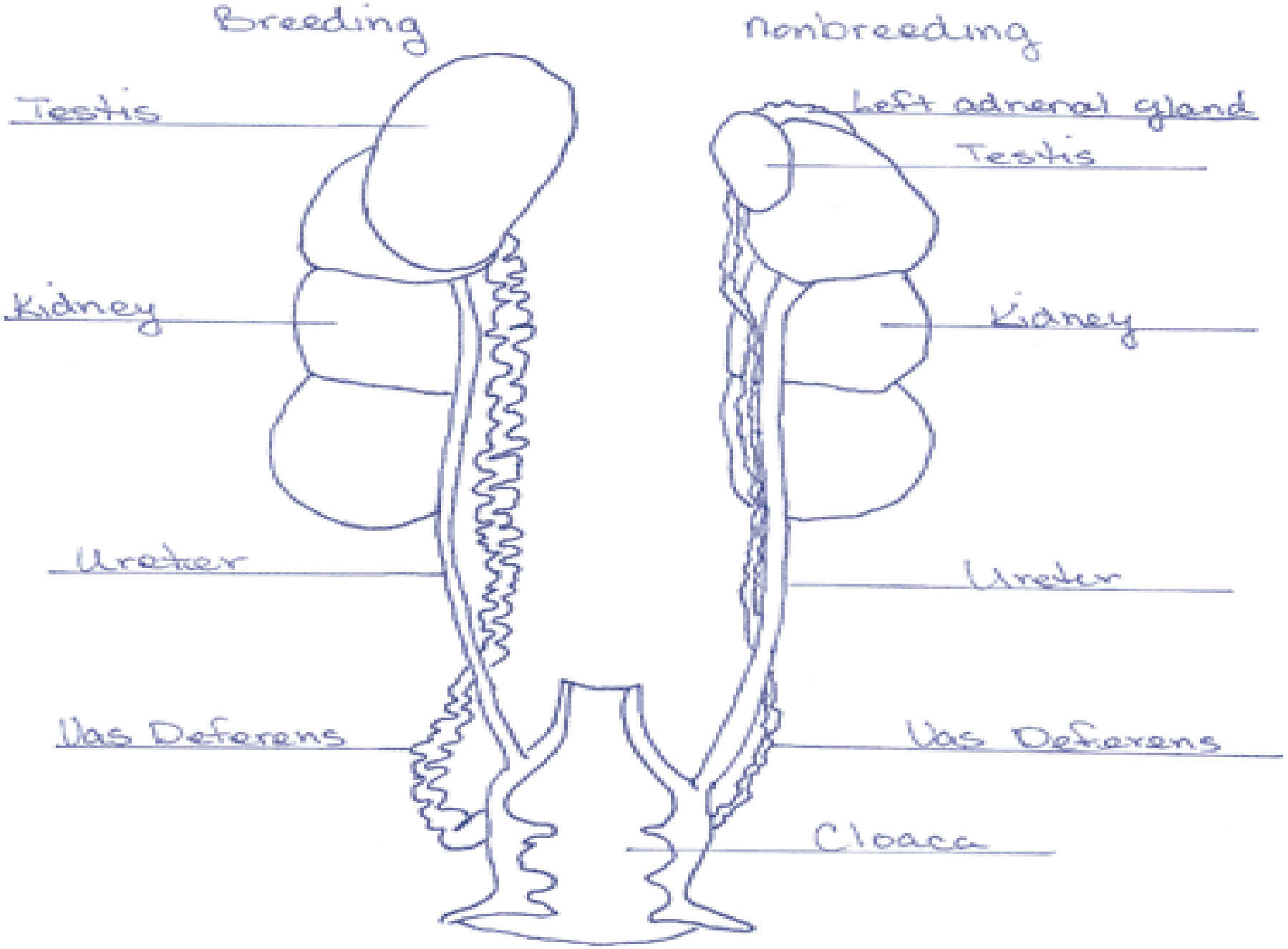
Medullary bone: it is a store of Ca for egg shell formation . It is represented by spikes of bone tissue in the medulla of long bones except

Humerus.it has osteoblast & osteoclast.

From the time of oviposition until 5-6 hrs before the next oviposition, the no. of osteoblast increased under the effect of estrogen and medullary bone is formed and plasma Ca decreased.

On the other hand, at the time of egg shell formation by the shell gland, the no. of osteoclast increased under the effect of parathormone and thus medullary bone is resorbed and plasma Ca increased.

Male Reproductive System



Excretory System

It is consists of :

1- kidneys.

2- nasal glands.

kidneys

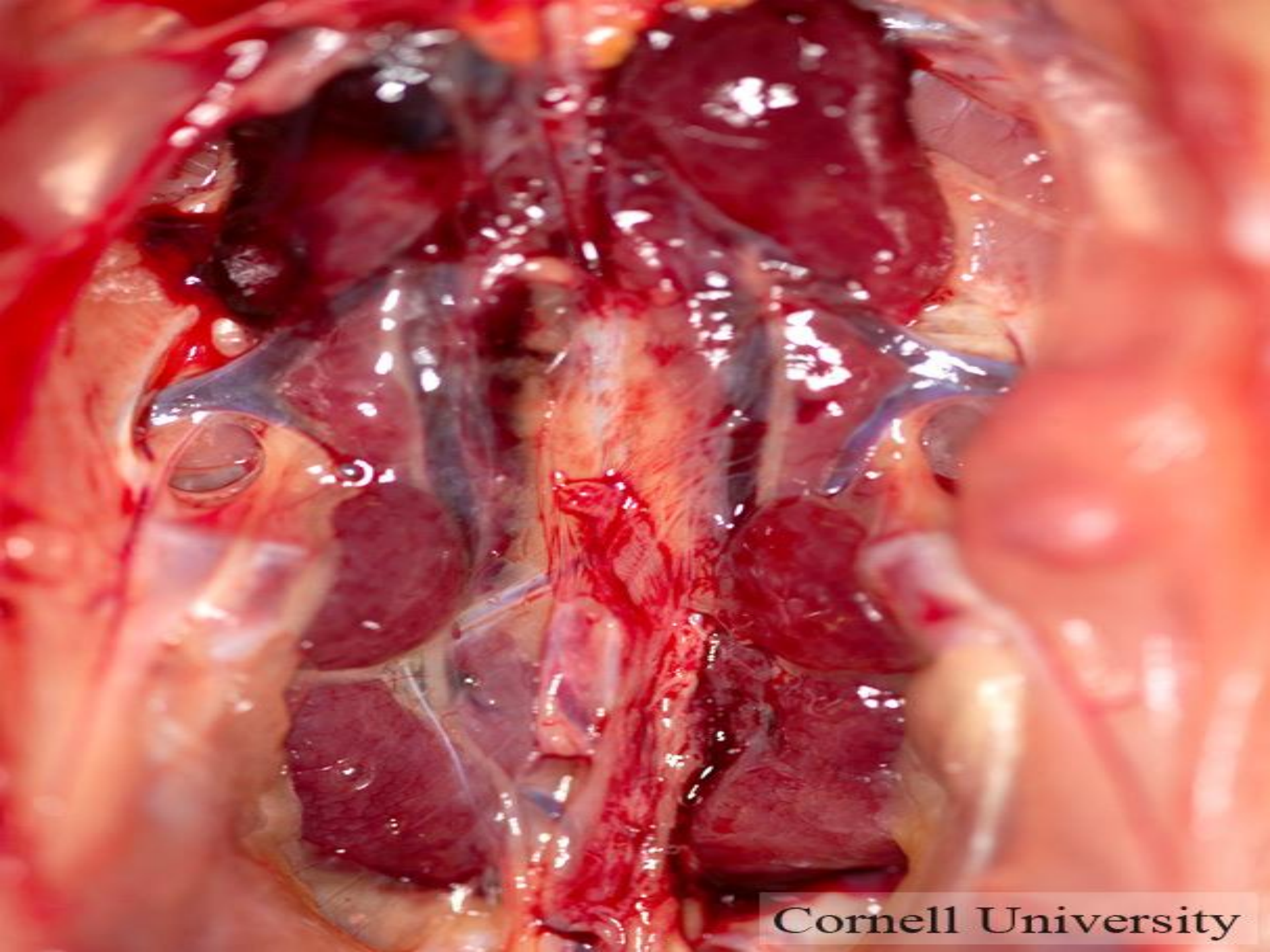
It is consists of two large elongated kidneys.

Located tightly against the tops of abdominal cavity associated with the back bone.

The kidneys is divided into 3-lobes.

Each lobe is divided into lobules, which contain the nephrons.

There is no bladder, no urethra, and no renal pelvis


Cornell University

Birds can produce a concentrated urine, like mammals , hypertonic to blood plasma.

The counter current mechanism is not well developed like that of mammals.

Therefore birds are less able than mammals to concentrate urine.

Birds excrete the end products of nitrogen metabolism as uric acids , which synthesized in the liver.

Uric acids and its salts (urates) can form colloidal solution with 2% concentration. This allows transport through the tubules and collecting tubules without precipitation

In the ureter the urine becomes viscous and stringy and may need mucus to lubricate the ureter for the movement of precipitated urates .

Excretion of nitrogen as urates enables birds to economize on water by excreting a semisolid urine instead of the much more watery excretion of mammals.

The urine that leaves the ureter enters the urodeum (urinary cloaca) and moves by retroperistalsis to coprodeum (reproductive cloaca) and rectum.

- A small amount may reach the caeca , stored until defecation occur as it is mixed with fecal material to form white or cream colored paste-urine characterized by high concentration of uric acid than urea and increasing quantity of creatin over creatinine.
- In dehydrated or salt depleted fowl, about 14% of urates and 66 % of NaCl are reabsorbed. Therefore, the cloaca is important for water and salt conservation.

Nasal (salt) glands
supra-orbital glands

It is a bilobed gland present on the top of the head , above the orbit of the eye.

In most birds it consists of a lateral and medial lobes. Each lobe with its own duct in vestibular region of nasal cavity.

In aquatic birds, the gland is present in cloaca while in desert birds it is supra-orbital

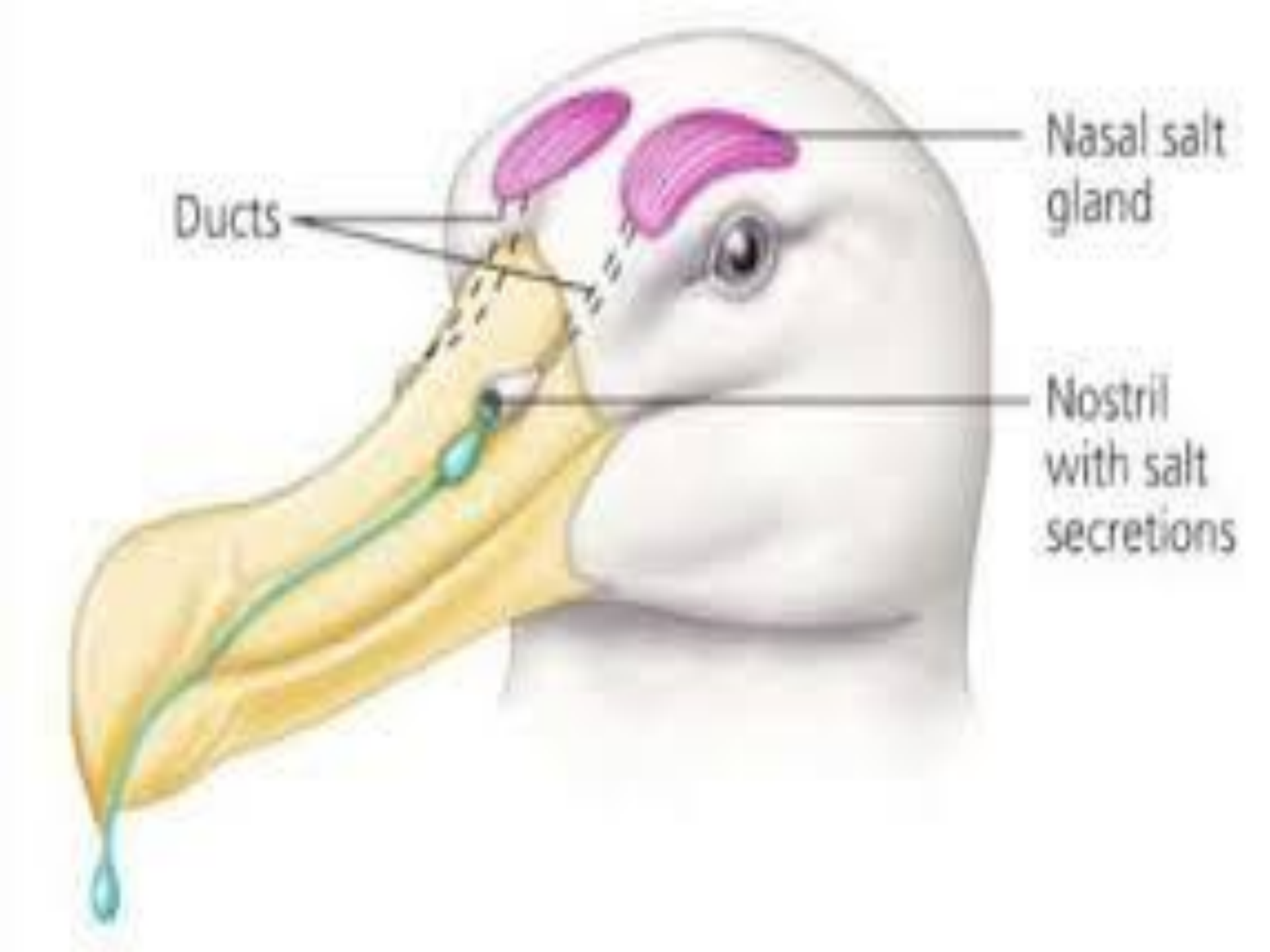
In sea gull it is present on the top of skull in the form of two flat crescent- shaped glands

Located on a shallow depression in the bone with two ducts one each side down to the nose. Its secretion flows out through the nares and drips off the beak.

The glands consists of blind ending secretary tubules radiating out from a central canal.

Blood capillaries extends between and parallel to the secretary tubules in a such a manner that the flow of secretion of tubules.

A counter current exchange system exists between the blood and the cells of the secretory tubules.


Nasal salt gland
Ducts
Nostril with salt secretions

The gland secrets a hypertonic solution of NaCl (5%) in marine birds enabling them to drink sea water 3 % NaCl.

It has an osmoregulatory function in marine and desert birds.

In desert bird it enables them to remain in water balance despite either limited fresh water and water losses or high level of NaCl in the diet.

Salt is the principle stimulus to nasal gland secretion.

Control

↑Salt loads (marine) or

↑Dehydration (desert).

Stimulate osmoreceptors hypothalamus CRH Pituitary ACTH adrenal cortex aldosterone→ ↑ nasal gland secretion.

Significance

The kidneys is unable to handle very high concentration of ions because the urine is hypertonic to blood plasma. So, these bird make use the external pathway for elimination of Na, K and Cl ions.

The degree of loading (marine) and dehydration (desert) affects the rate of secretion.

Endocrine glands of birds
1- Pituitary gland :

Lacated beneth the floor of the brain ,it connected by a stalk.

The entire gland in an adult hen is about the size of wheat.

It consists of : Anterior lobe.

Posterior lope.

Intermediate lobe.

Anterior lobe
1- Gonadotropins

FSH and LH in pituitary chick embryo by 18th day .

FSH stimulate tubular growth of testis and spermatogenesis in male and ovrian follicular follicle in female

LH stimulate interstitial cell stimulating hormones in male and ovualtion in female so called (OIH)

Male pituitary contains 11 times as much FSH as those of laying hens and 7 times as those of non laying hen.

It is potency in immature males and females and non laying hen is about the same.

Control of gonadotrobin secretion

Both FSH and LH secretion is controlled by neurohumoral mechanism through hypothalamo-hypophyseal portal system.

Hypothalamus respond to stimulation by secretion of (GnRH).

2- Prolactin hormone

It has several function:

1- Suppress the gonads in sexually mature birds.

2- Its content in the pituitary is inversely proportional to the level of gonadotropins.

3- Responsible for appearance of brooding behavior in chickens

4- Produce parental behavior.

Incubation patch (brood patch)

During brooding time the ventral region of many species become defeathered, highly vascularized, edematous just prior or during egg laying and epidermis of this region may become hyperemic.

This region is called incubation patch or brood patch .

When in contact with the eggs provides an efficient transfer of warmth from the parent to the eggs.

The incubation patch may be formed in both female or male or both depending on species and sex which is responsible for incubating eggs.

Formation of incubation patches involves cooperative action of both estrogen and prolactin hormone.

Estrogen stimulates vascularization of both patch region and prolactin stimulates defeathering and epidermal hyperplasia.

Control of prolactin secretion

It is through prolactin inhibiting hormone from hypothalamus.

In addition prolactin release is stimulated psychologically when the offspring hatches. As is occurs in some birds like pigeon and dove.

In both sexes prolactin release occurs to provide crop milk synthesis.

3- Growth hormone

Function:-

1- Stimulates lipolysis resulting in elevation of plasma concentration of free fatty acids.

2- Has a prolonged effect on protein metabolism and increase permeability to amino acids.

3- It plays fundamental role in growth of birds especially skeletal muscle and bone.

4- Iincrease sodium retention in body.

5-Exert the role of estrogen induction of synthesis of yolk proteins and lipids in birds.

6- Have a diabetogenic effect through increase rate of gluconeogenesis and increase the rate of amino acids utilization during short and long term starvation.

7- The plasma level of growth hormone is maximal in young chicks when the rate of protein synthesis is high during egg laying in turkey and in spring and summer breeding in gees.

Control of growth hormone secretion

- The hypothalmus exerts a dual stimulatory and inhibitory control over GH secretion in all birds.
- Both GHRH and TRH increase GH secretion.
- Avian somatostatin decrease GH secretion
- The release of these hypothalamic-hypophysiotropic factor is under the nervous control.
- Serotonin depress GH secretion.
- Noradrenaline stimulates GH secretion.

Function

1- stimulates the functional activity of thyroid gland

2- increase iodine uptake

3-help and stimulates synthesis of thyroid hormones

Control

Hypothalamic control of TRH which stimulates secretion of thyroid hormones

4- Thyrotropin (TSH)

Function:-

1- Stimulates the functional activity of thyroid gland.

2- Increase iodine uptake.

3-Help and stimulates synthesis of thyroid hormones.

Control

Hypothalamic control of TRH which stimulates secretion of thyroid hormones.

5- Adrenocorticotropic hormones

Function:-

1- It influence both corticoestrol and aldesterol secrtion.

2- Stimulate synthesis of steroid hormones from cholestrol or active acetates.

Control

CRH from hypothalamus regulates its secretion.

6- Melanotropin stimulating hormones (MSH)

Produced by anterior lope of pituitary gland.

It causes an expansion of melanophores in the skin.

The function and chemical structure of MSH in aves is not known.

The only reported action of MSH in birds is related to the developmental action.

In birds feather pigments (melanin) is under the control of gonadal, thyroid and gonadotropic hormones.

Posterior pituitary

1- Oxytocin

Secreted from fowl neurohypophysis and produce contraction of the oviduct (ovipostion).

2- Arginin vasotocin

a- It is released at the time of egg expulsion producing contraction of oviduct.

b- Have ant diuretic effect.

c- It is 20 times more powerful than oxytocin.

The neurosecrtory cells of hypothalamus produce oxytocin and arginin vasotocin which transmitted through the neurosecrtory tract to pos. pituitary where it is stored.

2- Thyroid gland

Paired organs, oval in shape and dark red in colour.

They located on either side of trachea just exterior to thoracic cavity, in the lower neck.

It secretes T3 and T4 which transported by prealbumin and not by α2 globulin (unlike mammals)

Thyroid hormones of birds have relatively short half – life.

The potencies of T3 and T4 are similar (unlike mammals)


TRACHEA
OESOPHAGUS
THYROID GLAND
7
8
9
10
11
12
13
14
15

Role of thyroid hormones

1- Effect on growth:

Essential for regulating harmonious growth.

Thyroidectomy causes marked retardation in growth leading to the classical thyroid short leg dwarfism associated with abnormal fat deposition and sometimes obesity.

2- Heat production:

It essential for maintenance a generally normal metabolic rate throidectomy is not lethal but lead samarked depression of heat production.

On other hand the administration of thyroprotien enhances heat production.

3- Carbohydrate metabolism:

T3 and T4 reduce glycogen level and produce mild hyperglycemia. Thyroidectomy causes hypoglycemia.

4- Effect on reproduction:

Injection of moderate doses of thyroxin in males promotes growthof testis in young chickens while thyroidectomy causes delayed gonadal maturation and decrease egg production, egg weight and egg shell thickness.

5- Migratory behavior:

Migratory bird have very active thyroid while resting one have inactive thyroid.

6- Effect on skin and feather:

Thyroid hormones are essential for healthy skin and feather.

7- Thyroid and molt

It is a complex physiological mechanism during which the bird shed their feather and new feather grows.

In some cases birds may molting twice a year and in rare cases occur every two years. .

Molting is controlled by the action of goands and thyroid hormones and is associated with drop in estrogen level and decrease egg production the loss of feather stars with the head followed by the neck, body, wings and finally the tail.

A high producing bird may for a short time molt and lay simultaneously, but usually they shed more rapidly and a decline in egg production occurs when molting begins. .

In general there are 3 kinds of molters in birds hatching during the spring : early, medium and late

1- Early molters: The bird cease to lay in june, july or early august.

It has a short laying period , there is lack in vitality, laying capacity or inherited tendency to discontinue. The early molters shed and grow feather so gradually that it is not recognized unless the bird is handled.

2- Medium molters: Birds molt during late august or september.

3- Late molters: Hen molting in clinging to the bird and her body will soon be covered with pin october. The feather is dropped rapidly there may be few old feathers

The late molters is quite timid and dislike to be handled. This is due to active circulation and sensitive nerve development in feather follicle. The feather grow rapidly, such a molt indicates that the birds have a highly vitality and usually a superior producer

3- Parathroid gland

Four in number, two in each side attached to / or near posterior pole of thyroid gland.

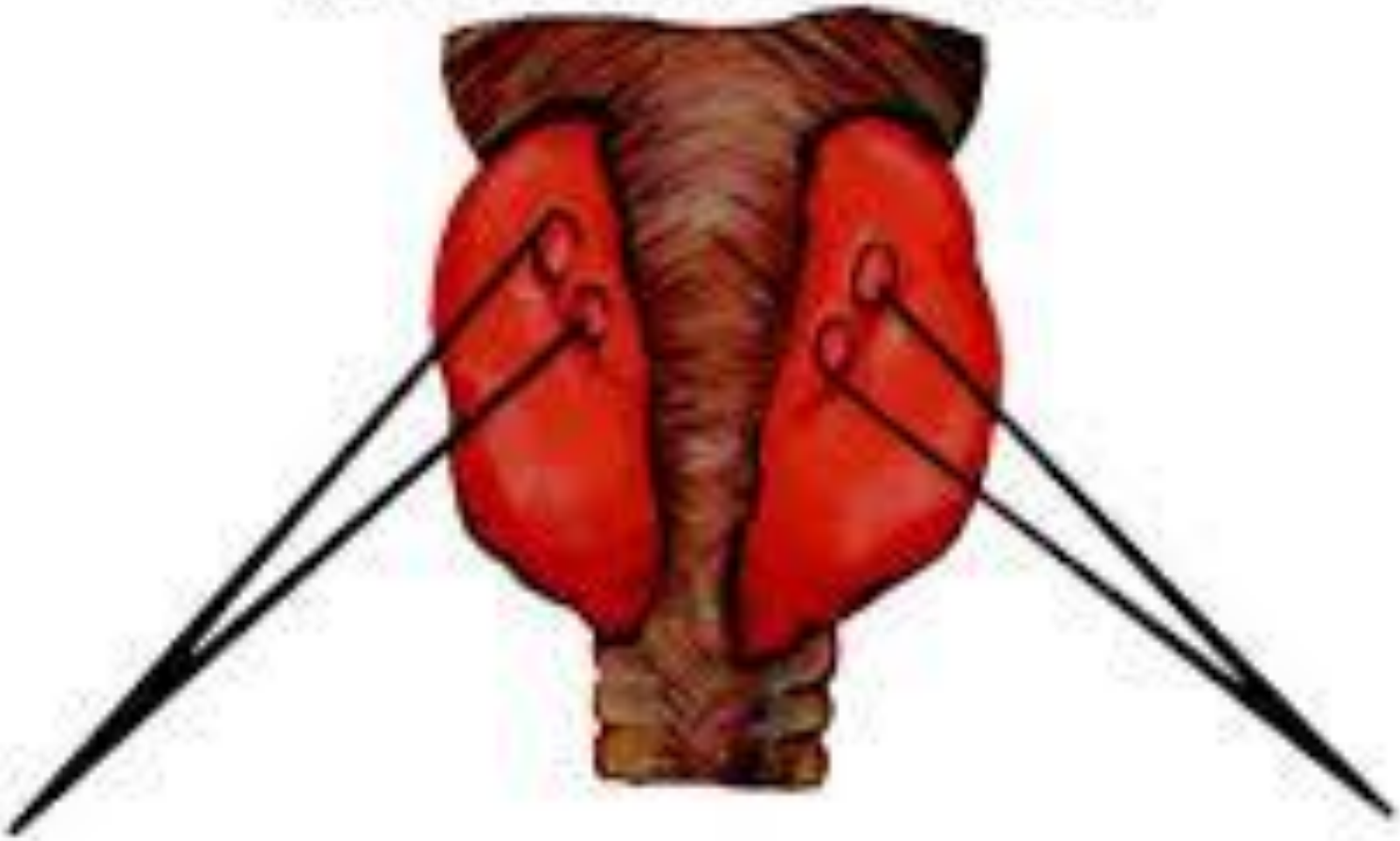
It was reported accessory parathyroid tissue in chickens in caudal lobe of thymus and in thymus under thyroid.

Physiological action of parathormone:

A-On blood calcium: Decrease urinary excretion, increase intestinal absorption, increase mobilization of calcium level in blood.

B- On phosphorus level: The opposite of its effects on blood calcium level.

THYROID GLAND
(DORSAL SURFACE)



PARATHYROID GLANDS

Regulation of parathyroid hormone release is mediated by circulating plasma level of calcium

The principle target organ of endogenous parathyroid hr are:

1- Maintain calcium homeostasis through its influence on the bone resorption.

2- It is synergistic with vitamin D in the mobilization of bone minerals.

3- It cause rapid phosphaturia in chickens.

4- it cause calciuria in chickens through its action on the kidneys tubules.

4- Ultimobranchial gland

The cell responsible for secretion of calcitonin arise from endoderm, this gland is found just posterior to parathyroid .

Major function of parathyroid G is calcium homeostasis which is essential for egg shell formation, muscle contraction, blood clotting, enzyme activation, calcification of tissue and neuromuscular regulation

Function of calcitonin hormone

1- Lower the plasma level of calcium by inhipiting the bone resorptive activity of osteocytes (osteolysis) regulated by parathyroid gland.

2- Extract of gland cause depression of plasma calcium and phosphorus but not magnesium level.

3- It has no major role in the conversions of avian medullary bone to calcium for egg shell deposition.

4- It may play a role in serum phosphorus homeostasis independent of many action of calcium metabolism.

5- Pineal gland

It is situated on dorsum of brain in triangular space between cerebellum and cerebral hemisphere, its weight about 5 mg and it increase with age until maturity.

Physiological role: It is involved in growth and function of reproductive system, it secrets a substance that delays development of gonads through pituitary glands.

Removal of pineal gland leads to hypertrophy of pituitary gland, increase of gonadotropin

Hypertrophy of gonads.

Function pineal gland

It secrete melatonin and serotonin.

1- Seratonin degraded to 5 hydroxyindol acetic acid.

2-Melatonin affect sleep behavior and brain electrical activity.

3-Pineal gland is involved in the control of reproductive function.

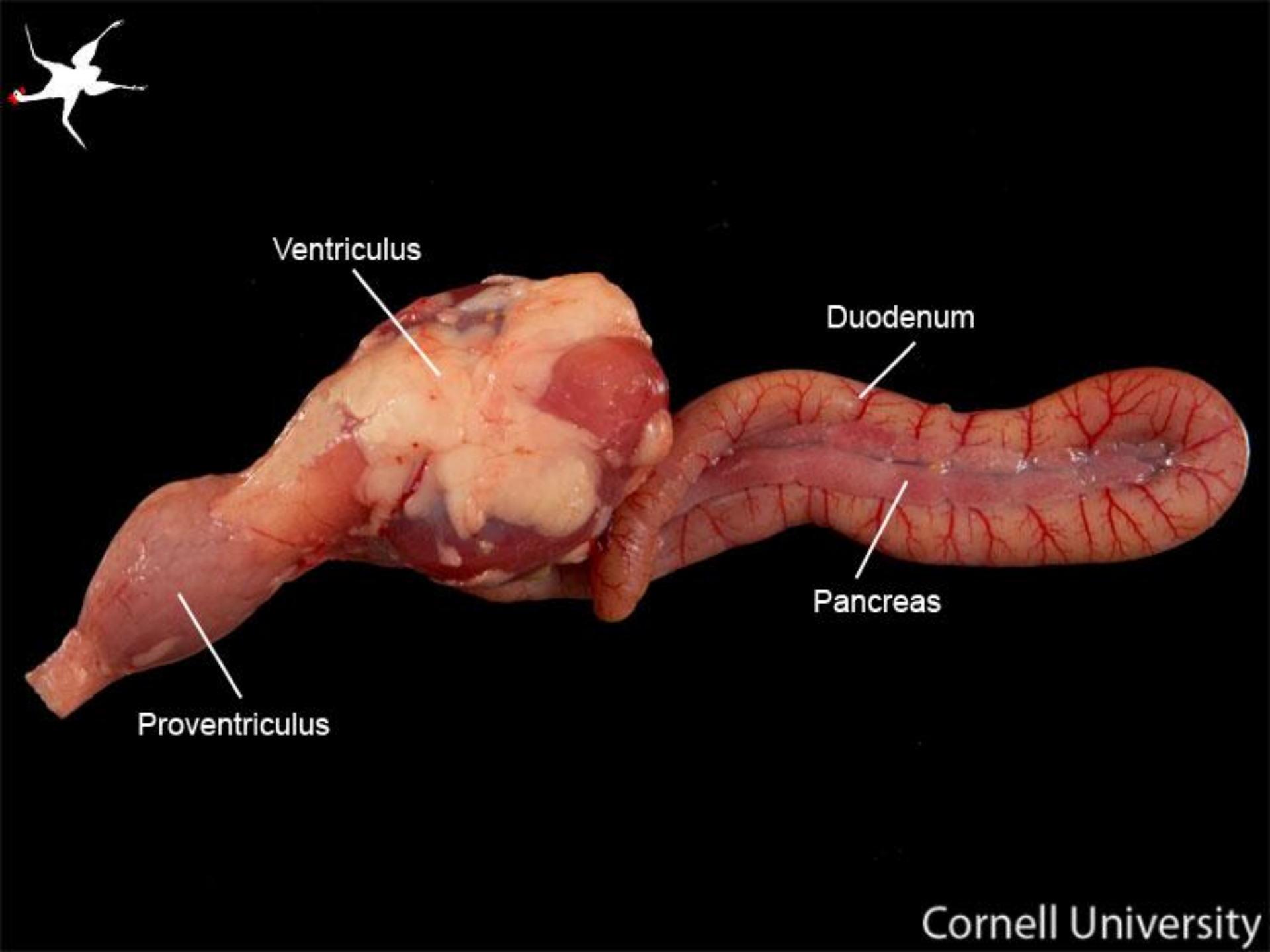
4-It plays a secondary role in the control of reproduction, the pineal affect the gonads are mediated by hypothalmic center containing the releasing factor and tropic hormones which act on pituitary gland.

Pancreas

- It is elongated gland lies between two limbs of duodenal loop.
- It consists of three lopes (dorsal, ventral and splenic).
- It responsible for secretion of:-

A-Digestive enzyme (exocrine) represent 90% of total pancreatic mass.

B-Hormonal secretion (endocrine) represent remainder.


Ventriculus
Duodenum
Pancreas
Proventriculus
Cornell University

Pancreatic hormones :

A- Insulin: As hypoglycemic factor secreted from B cell in lower amounts than that of mammals.

B- Glucagon: As hyperglycemic factor secreted from α cells almost 10times as that of mammals.

Role of pancreatic hormones :

1- On carbohydrate metabolism :

They have a limited importance in regulation of carbohydrate metabolism in birds.

Pancreatectomy induced either no diabetes at all, mild diabetes 1 without any further alteration in carbohydrate metabolism.

It can be concluded that :

A- In normal birds as in mammals glucagon play an important role in maintain normal blood sugar level in feeding.

B- In fasting pancreatomized birds, hypoglycemia is due to a lake of insulin.

C- Ratio of plasma concentration of glucagon and insulin seems to be major importance for the regulation of blood sugar level.

2- On lipid metabolism:

Glucagon has a stimulatory effect on the concentration of free fatty acids in plasma, while insulin has no role.

Regulation of pancreatic hormones :

1-Blood glucose level (normally 200-300mh/dl) injection of glucose increases insulin while decreases glucagon level.

2-Glucagon-insulin interaction injection of one hormone elevates the level of other.

3-Other endocrine glands GH and ACTH (hyperglycemic factor) stimulate insulin secretion.

4- Free fatty acids: Increased free F.A level in blood stimulates insulin.

5- Drugs: Administration of antidiabetic drugs may stimulate glucagon.

Adrenal glands

Pair of oval pear, yellow or orange that lie to cephalic lobe of kidney

It divided into cortex and medulla

The ratio of cortical to medullary tissue was about 2:1.

A- Hormones of adrenal cortex

1-Corticosterone.

2-Aldosterone.

3-Cortisol.

Function :

Adrenal function in birds is vital.

Adrenalectomized ducks and chickens usually die with in 6-60 hrs, unless given replacement therapy.

Effect of adrenal cortical hormones

A- On carbohydrate metabolism :

Corticosterone induces hyperglycemia (like glucagon) with enhanced accumulation of glycogen in liver.

B- On lipid metabolism :

It induces lipogenesis (like isulin) by elevation of plasma lipids, increase visceral fat deposiotion and enhaced liver fat.

C- On protien metabolism and growth :

Despite a siginificant hyperphagia, it exhibits a marked inhipition of growth.

D- On electrolyte :

It is necessary for normal function of nasal slat glands in ducks.

E- On lymphoid tissue :

It inhibits bursa of fabricius in chicks.

F- On reproduction :

It depressed egg production.

B- Hormones of adrenal medulla

It secretes catecholamines.

There are species differences in norepinephrine and epinephrine ratio.

Norepinehrine is the predominant one in pigeon.

Physiological effects of catecholamines

1- Heat production:

Not have thermogenic function in birds.

2- Lipid metabolism:

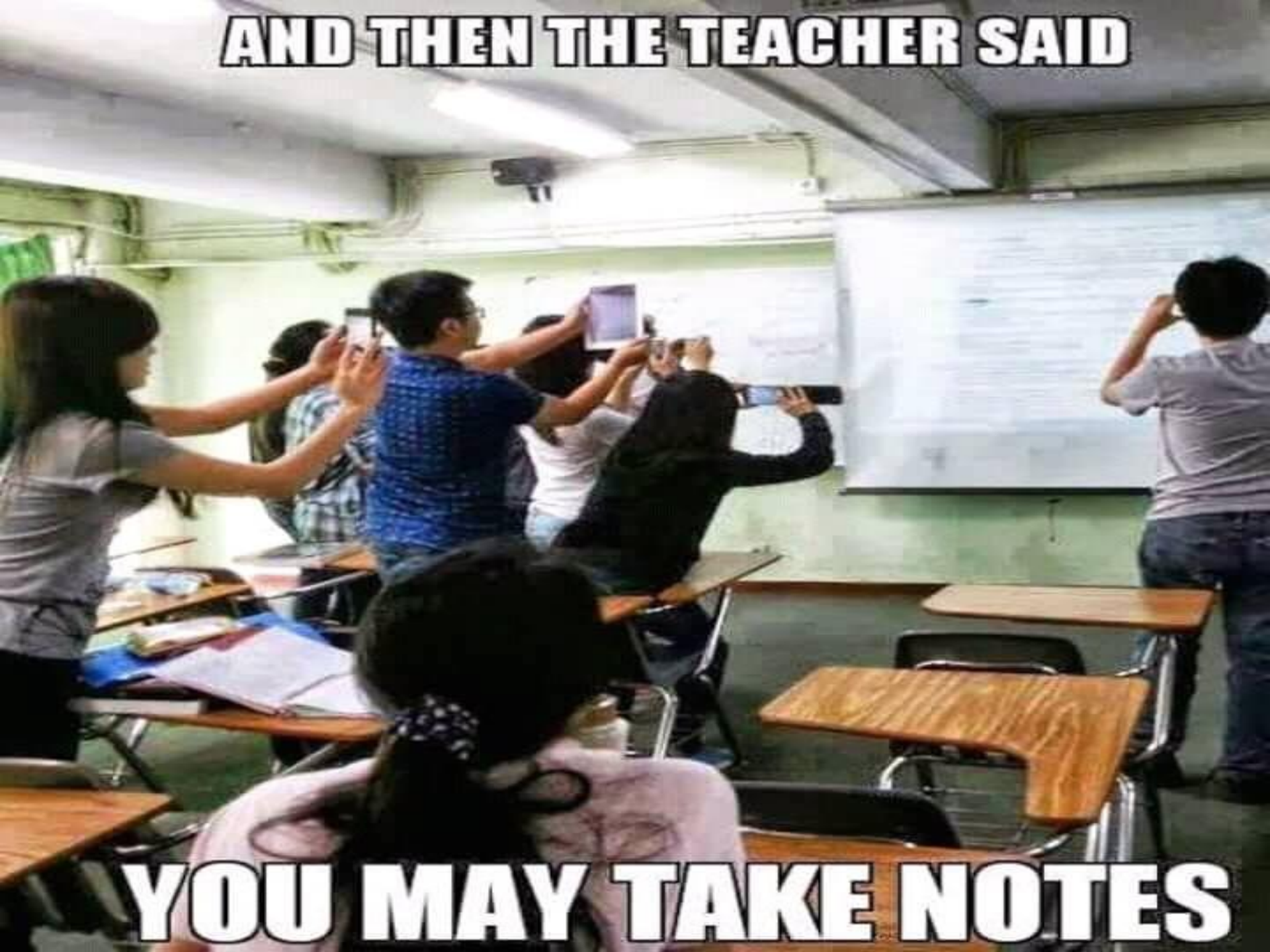
Noradrenaline induces arise in plasma free fatty acids.

3- Carbohydrate metabolism:

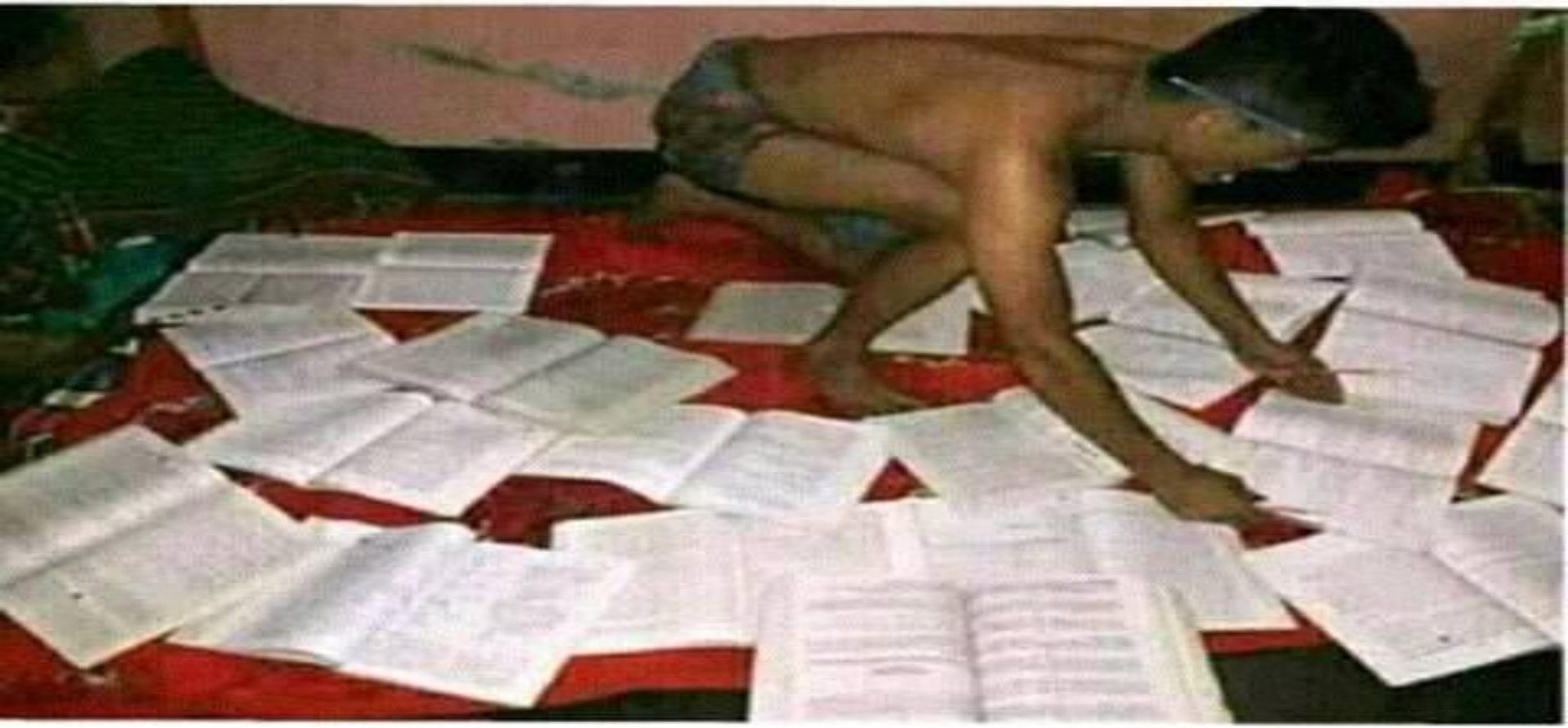
Hyperglycemic effect of epinephrine has been known in ducks, chickens and pigeon.

4- Blood pressure:

In anaesthetized chickens, epinephrine and nor lead to a siginificant rise in both systolic and diastolic blood pressure.


AND THEN THE TEACHER SAID
YOU MAY TAKE NOTES

Mention That friend



Who's condition is like this in the night befor exam 😂