6 Reptilia

Reptiles are the first vertebrates which became adapted completely to terrestrial life. They are the *creeping* animals. They flourished well during the *Mesozoic* era and they were the dominant and ruling animals for 300 million years. Hence Mesozoic era is called the *Golden Age of Reptiles.* Most of the reptiles became extinct by the end of mesozoic era and now they are represented by only a few groups, namely lizards, snakes, turtles, crocodiles and *Sphenodon.*

The embryos of reptiles are protected by an embryonic membrane called *amnion.* As this membrane is also found in birds and mammals, reptiles, birds and mammals are together called *amniota.* Fishes and amphibians are called *anamniota* as they do not possess an amnion.

The study of reptiles is called *herpetology.*

Reptiles originated in the Carboniferous period of *Palaeozoic* era from *Labyrinthodont* amphibians.

General Characters

1. Reptilia are *creeping* land vertebrates. They are the *first land* vertebrates.
2. Reptiles are *poikilothermic* or *cold blooded* animals.
3. They are included in the phylum *Chordata* because the embryos develop a *notochord.*
4. They contain a *vertebral column.* So they are included in *Vertebrata.*
5. The brain is enclosed in a *cranium.* So they are included in *Craniata.*
6. They contain *jaws.* So they are included in *Gnathostomata.*
7. They contain 4 limbs. So they are called *Tetrapods.*
8. They develop *amnion.* So they are called *Amniota.*
9. They are *uricotelic* animals.

10. They are *terrestrial* and some are secondarily *aquatic.*
11. The body is covered with *horny scales* or *scutes.*
12. The skin is dry and skin glands are absent.
13. The limbs are *pentadactyl* type.
14. The skull has a single median *occipital condyle.*

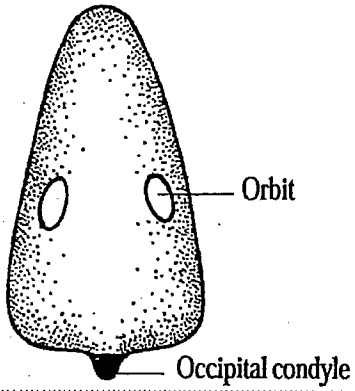


Fig.6.1: Skull of Reptilia with a single occipital condyle.

15. The mandible consists of many pieces and articulates with the cranium through the *quadrate* bone.
16. The vertebrae are *gastro-centrous.*
17. A true *sternum* is present.
18. Respiration is carried out by the *lungs.*
19. The heart is divided into two auricles and an incompletely divided *ventricle.* It is 3-chambered.

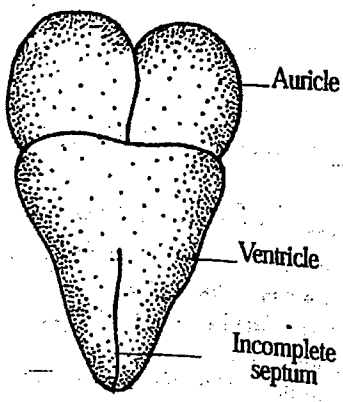


Fig.6.2: 3 Chambered heart of Reptilia.

20. It has 3 pairs of *aortic arches.* The right and left systemic arches are complete and functional.

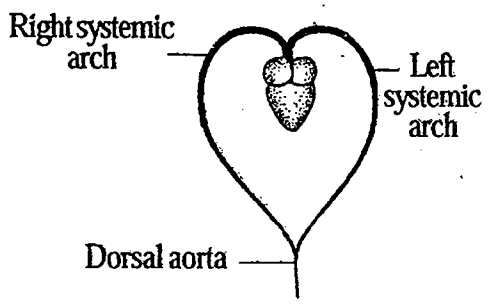


Fig.6.3: Complete right and left systemic arches of Reptilia.

21. The ***red blood corpuscles*** (RBC) are nucleated.

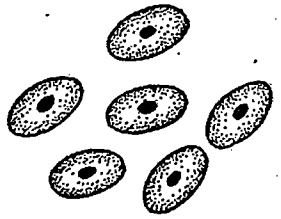


Fig.6.4: Nucleated RBC of Reptilia.

22. The kidneys are the ***metanephric*** type.
23. Twelve pairs of ***cranial nerves*** are present.
24. Lateral line sense organs are absent from reptiles.
25. A ***cloaca*** is present.
26. Copulatory organs are present.
27. Fertilization is ***internal.***
28. The eggs are ***cleidoic, megalecithal*** and ***amniotic.***
29. The embryos are protected by foetal membranes, namely ***chorion, amnion, allantois*** and ***yolk sac.***
30. Development is ***direct,*** metamorphosis is absent.

Classification of Reptilia

Reptiles are ***creeping*** land vertebrates.
They are included in the phylum ***Chordata*** because the embryos develop a ***notochord***.
They contain a ***vertebral column***. So they are included in ***Vertebrata***.
The brain is enclosed in a ***cranium***. So they are included in ***Craniata***.
They contain ***jaws***. So they are included in ***Gnathostomata***.
They contain 4 limbs. So they are called ***Tetrapods***.
They develop ***amnion***. So they are called ***Amniota***.
Class Reptilia is divided into four subclasses based on the presence or absence of ***temporal fossa*** in the skull. They are the following:

Subclass 1. Anapsida
Subclass 2. Parapsida - Extinct

Subclass 3. Diapsida

Subclass 4. Synapsida - Extinct

Subclass 1. Anapsida

In ***Anapsida***, the temporal fossae are absent in the skull. The body is enclosed in a ***dorsal carapace*** and a ventral ***plastron***.

Anapsida is divided into two orders, namely

Order 1. Cotylosauria

Order 2. Chelonia

The order ***Cotylosauria*** includes ***extinct reptiles***. They were ***primitive*** and resembled ***labyrinthodont Amphibia***. They were called ***stem reptiles*** because they formed the ancestor for all reptiles. Eg. *Seymouria*.

The order ***Chelonia*** includes modern reptiles like ***tortoises, turtles*** and ***terrapins***.

Tortoises are terrestrial.

Turtles are marine.

Terrapins are freshwater forms.

In ***Chelonia***, the body is enclosed in a dorsal ***carapace*** and a ventral ***plastron***.

Subclass 2. Parapsida

In ***Parapsida***, the skull has a single ***temporal fossa*** on each side. The vacuity is called ***supra temporal fossa***. It is bounded below by an arch of bone called ***supra temporal arcade***. It includes ***extinct*** reptiles.

Parapsida is divided into three orders, namely

Order 1. ***Protosauria***. Eg. *Arae-osccelis*.

Order 2. ***Plesiosauria***. Eg. *Plesi-osaurus*.

Order 3. ***Ichthyosauria***. Eg. *Ich-thyosaurus*.

Subclass 3. Diapsida

In ***Diapsida***, the skull has ***two temporal fossae*** on each side. The fossa present above is called ***supratemporal fossa***. The fossa present below is called ***infratemporal fossa***.

The bar of bone lying between the two fossae is called ***supratemporal arcade***. The arch of bone lying below the infratemporal fossa is called ***infratemporal arcade***.

It includes extinct as well as extant reptiles.

Eg. *Sphenodon* *Crocodiles*
Lizards *Dinosaurs*
Snakes

Diapsida is divided into 8 orders, namely

Order 1. ***Rhynchocephalia***. Eg. *Sphenodon*.

Order 2. ***Squamata***. Eg. *Lizards, Snakes*, etc.

Order 3. ***Crocodilia***. Eg. *Crocodiles*.

Order 4. ***Pseudosuchia***. Eg. *Salto-posuchus*.

Order 5. ***Phytosauria***. Eg. *Phyto-saurus*.

Order 6. ***Saurischia***. Eg. *Bronto-saurus*.

Order 7. ***Ornithischia.*** Eg. *Stego-saurus.*
Order 8. ***Pterosauria.*** Eg. *Pter-anodon.*

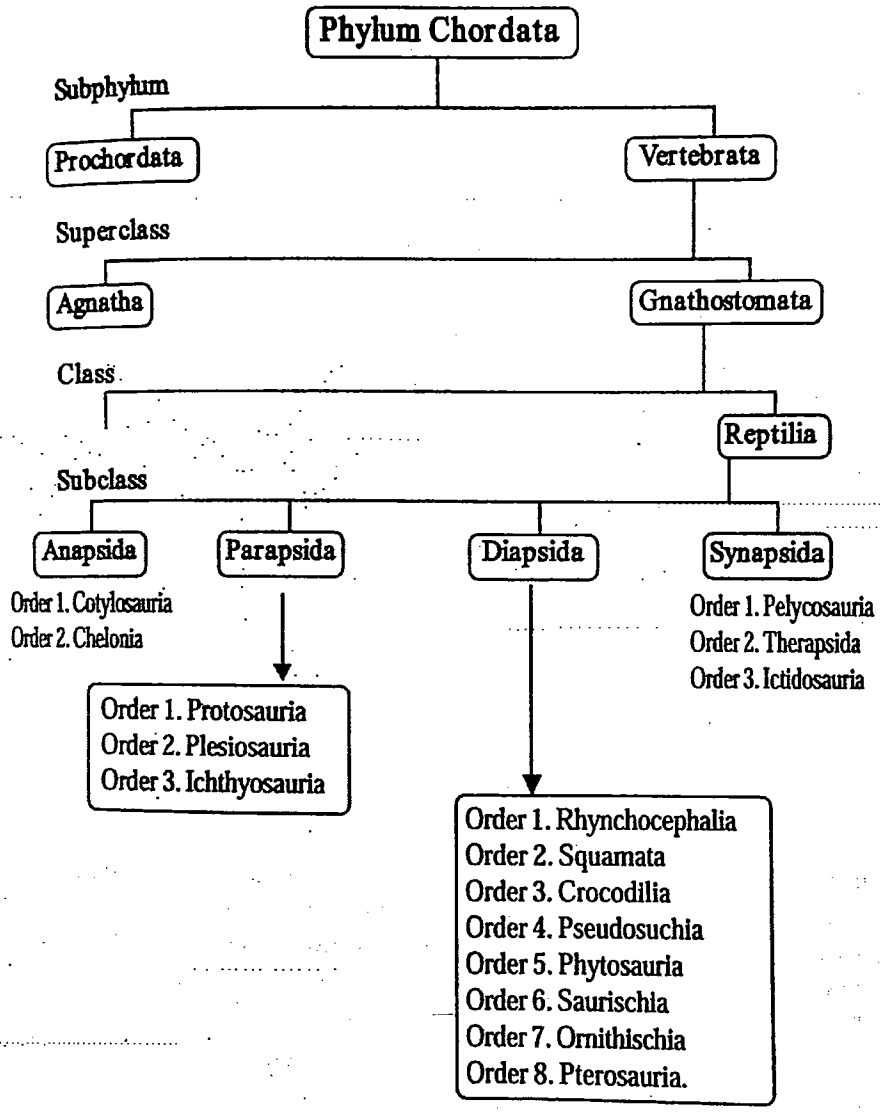


Fig.6.5: Synoptic classification of Reptilia.

Subclass 4. Synapsida

Synapsida has a ***single temporal fossa*** on each side. It is called ***infratemporal fossa***. It is bounded below by a bar of bone called ***infratemporal arcade*** (Fig.6.10).

It includes only extinct reptiles.

It is divided into 3 orders, namely

Order 1. ***Pelycosauria***. Eg. *Vára-nosaurus.*

Order 2. ***Therapsida***. Eg. *Mammal like reptiles*

Order 3. ***Ictidosauria***. Eg. *Diarthro-gnathus.*

Anapsida

A group of reptiles without any vacuity (skull opening) in the temporal region of the skull (***An*** - no; ***apsis*** - vacuity). Thus the ***roof*** of the ***skull*** is ***complete.*** It includes primitive reptiles.

Eg. *Seymouria* *Turtles*
Tortoises *Terrapins.*

Parapsida

Parapsida is a group of reptiles with a ***single vacuity*** on each side of the skull. This vacuity is called ***supratemporal fossa.***

It includes extinct reptiles like *Mesosaurs, Ichthyosaurs,* etc.

Diapsida

Diapsida is a group of reptiles with ***two vacuities*** on each side of the skull.

One vacuity is located above called ***supratemporal fossa*** and the other vacuity is located below called ***infratemporal fossa.***

Below the supratemporal fossa, there is a bar of bone called ***supratemporal arcade.*** It is formed of ***squamosal*** and ***postorbital.***

Similarly, below the infratemporal fossa, there is a bar of bone called ***infratemporal arcade.*** It is formed of ***jugal*** and ***quadratojugal.***

Eg. *Dinosaurs* *Lizards*
Sphenodon *Snakes.*
Crocodiles

Synapsida

A group of reptiles with a ***single vacuity*** on each side of the skull. The vacuity is known as ***infratemporal fossa*** because it is located far below. It is bounded on the lower side by a bar of bone called ***infratemporal arcade*** formed of ***quadratojugal*** and ***jugal.***

It appears that the single vacuity is formed by the fusion of two vacuities and hence the name ***synapsid.***

It includes extinct ***reptiles***-like ***mammal***-like reptiles.

Poisonous Snakes

Snakes are reptiles, belonging to the order ***Ophidia.*** There are about 3000 living species of snakes in the world. Of these 300 species are ***poisonous.***

According to the estimates of World Health Organization (WHO), about 30,000 to 40,000 persons die of snake bite every year in the world. In India, about 7,000 to 12,000 persons die of snake bite every year. The main poisonous snakes found in South India are the ***Vipers, Cobras, Kraits, Coral snakes*** and ***Sea snakes.***

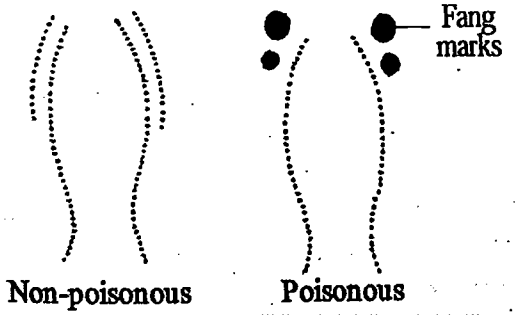
Identification of Poisonous Snakes

The poisonous snakes are identified by the following features:

1. The nature of the ***snake bite***
2. The nature of the ***tail***
3. The nature of the ***ventrals***
4. The nature of the ***head shields***
5. The nature of the ***sub-caudal scales***
6. The nature of the ***vertebrals***

1. From the Nature of the Snake Bite

a. When a poisonous snake bites, there will be ***two punctures*** or only ***one puncture*** or just a scratch on the skin of the victim. If a non-poisonous snake bites, there will be many punctures on the skin.



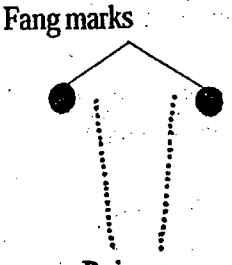


Fig.6.55: Snake bite marks.

b. If a poisonous snake bites there will be a ***continuous flow of blood*** from the wound. The venom prevents the ***clotting of blood.*** If a non-poisonous snake bites the flow of blood is stopped after sometime owing to the clotting of blood.

2. From the Nature of the Tail

a. If the tail of a snake is ***flat***, laterally compressed and ***oar***-shaped, it is a sea snake and is highly poisonous. Eg. *Enhydrina*.

Fig.6.56: Cylindrical tail.

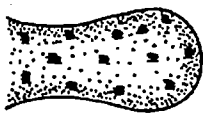


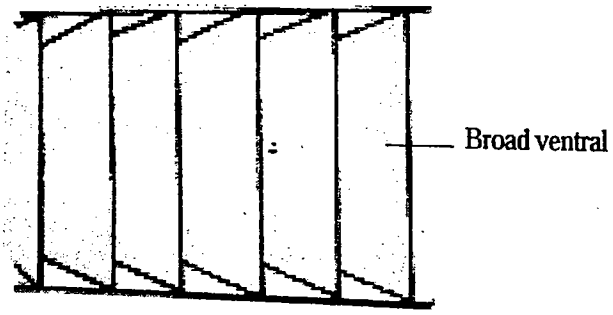
Fig.6.57: Flattened tail.

b. If the tail is cylindrical and pointed, it may be poisonous or non-poisonous.

3. From the Nature of the Ventrals

If the tail is ***cylindrical***, the ***ventrals*** (scales on the ventral side of the trunk) are examined.

a. If the ventrals are narrow, it is a non-poisonous snake.



Fg.6.58: Broad ventrals.

b. If the ventrals are broad extending completely across the belly, it may be poisonous or non-poisonous.

4. From the Nature of the Head Shields

If the ventrals are broad, the head shields are examined.

a. If the head is covered with small scales and not with shields, it is a ***viper*** and is very poisonous. The viper may be ***pit viper*** or ***pitless viper.***

Pit Viper: The head has ***small scales.*** A ***loreal pit*** is present between the ***eye*** and the nostril. It is highly ***poisonous.*** Eg. *Trimeresurus.*

Pitless Viper: The head has small scales, but without any loreal pit. It has a ***double sub-caudal.*** Eg. *Russel's viper.*

b. If the head is covered with shields it may be poisonous or non-poisonous.

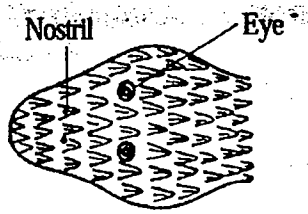


Fig.6.59: Head scales (Viper).

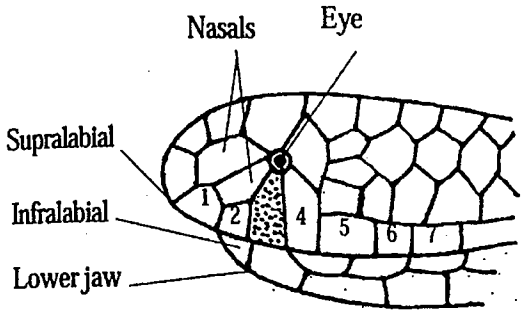


Fig.6.60: Head shields (Cobra).

5. From the Nature of the Vertebrals

If the head is covered with shields, the ***vertebrals***, (scales present along the mid-dorsal line on the back) are examined. They may be large or small.

a. If the vertebrals, are large, it is a Krait and is ***highly poisonous***. In addition the Krait has only four ***infralabials*** of which the fourth is the largest. The ***sub-caudals*** are ***single***. Eg. *Bungarus*.

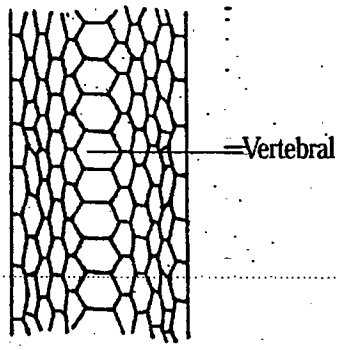


Fig.6.61: Vertebrals.

b. If the vertebrals are not large, examine the ***supralabial shields*** (shields forming the margin of the upper jaw). If the 3rd supralabial touches the nasal shield and the eye, it is a cobra. The cobra is identified by a ***neck*** with a ***hood***.

Coral snakes have ***cylindrical tails*** and elongated ***broad ventrals***. The ***head is covered*** with ***shields*** and not ***scales***. The vertebrals are small and elongated. ***Peculiar markings*** are present on the belly.

Poison Apparatus

All poisonous snakes contain a ***poison apparatus*** in their head.

The poison apparatus is formed of a pair of ***poison glands***, a pair of ***poison ducts*** and a pair of ***fangs***.

The poison glands are the modified ***salivary glands***. They are situated in the roof of the ***buccal cavity***. Each poison gland is in the form of a ***sac***.

The anterior end of the poison gland is produced into a ***poison duct***. The poison ducts open at the tip of the ***fangs***.

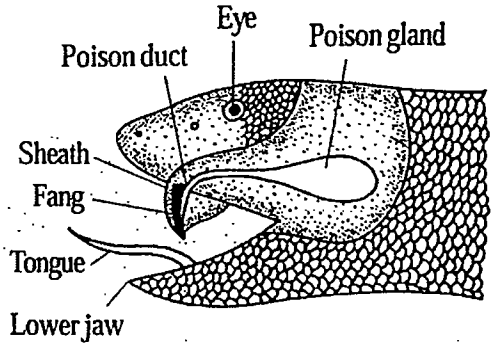


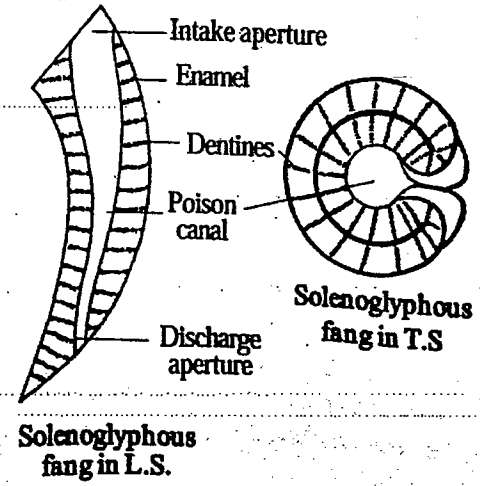
Fig.6.62: Poison apparatus.

Fangs

Fangs are ***specialized teeth*** located on the upper jaw. They are ***long, curved, sharp*** and ***pointed***. They serve to inject poison into the body of the victim. When a fang is lost, it is replaced by a ***reserve fang***. The fang is kept in a ***sheath***.

The fang has a ***canal*** or ***groove*** extending from the base to the tip. Based on this, the fangs are classified into three types. They are the following:

Solenoglyphous fang is ***hollow*** and it contains a ***canal*** extending from the base to the tip. This type of fang is found in *vipers* and *rattle snakes*.



Poison apparatus

All poisonous snakes have a poison apparatus (Fig. 18.7) in their head (absent in non-poisonous snakes). It is made up of three parts:

(1) Poison glands, (2) Poison ducts, (3) Poison fangs.

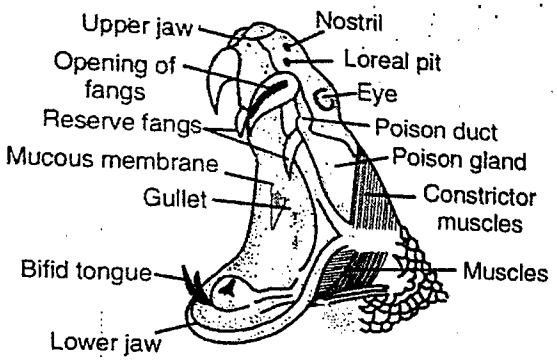


Fig. 18.7 Mouth of poisonous snake open to show the poison apparatus

Poison glands are a pair of sac-like structures situated one on either inner side of the upper jaw, below and behind the eyes. They are probably modified superior labial or parotid glands. The size and shape of poison glands vary with species being small and oval in sea snakes and long and tubular in vipers. The poison glands are held in position by **ligaments**. The anterior ligament attaches its anterior end with the maxilla and the posterior ligament with the quadrate. Each gland is surrounded by fibrous connective tissue and a fan-shaped **constrictor muscle** called **temporal** or **masseter**. It stretches during biting and forces the poison from the gland to the duct.

guarded by female.

3.Non Poisonous Snakes

1. Lycodon

Phylum	:	*Chordata*
Subphylum	:	*Vertebrata*
Superclass	:	*Gnathostomata*
Class	:	*Reptilia*
Subclass	:	*Diapsida*
Order	:	*Squamata*
Suborder	:	*Ophidia*

1. *Lycodon* is locally called '*Vellikkol varian*'.
2. It is the *wolf snake.*

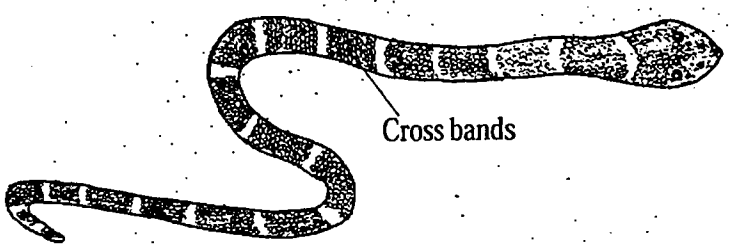


Fig.6.71: Lycodon.

3. It mimics krait in its colouration.
4. It is *brown* in colour with *white* cross bars.
5. The cross bars are distinct in the anterior region and it fades towards the tail.
6. In krait, the cross bands are distinct in the tail region and it fades towards the head. It feeds on skinks.
7. It is *oviparous.*
8. It is carnivorous.

2.Eryx johnii

Phylum	:	*Chordata*
Subphylum	:	*Vertebrata*
Superclass	:	*Gnathostomata*
Class	:	*Reptilia*
Subclass	:	*Diapsida*
Order	:	*Squamata*
Suborder	:	*Ophidia*

whole of the Mesozoic era and by the end of *Cretaceous* they completely became extinct.

Outline Classification of Mesozoic Reptiles

The major reptilian groups of the Mesozoic era are the following:

1. *Thecodonts*
2. *Dinosaurs*
3. *Pterosaurs* (Flying reptiles)
4. *Ichthyosaurs* and *Plesiosaurs* (Marine reptiles)
5. *Therapsids* (*Mammal*-like reptiles)

1.Thecodonts

The thecodont reptiles appeared at the beginning of the Triassic period and they became extinct at the end of the Triassic time. Eg. *Erythrosuchus.*

2. Dinosaurs

The word ***dinosaur*** was given by *Sir Richard Owen.* It means *'terrible lizards'.* From the middle of Triassic to the end of Cretaceous the Dinosaurs dominated the earth. At the end of the Cretaceous period, the Dinosaurs became extinct.

The Dinosaurs include two orders, namely ***Saurischia*** (*Reptile*-like Dinosaurs) and ***Ornithischia*** (*Bird*-like Dinosaurs).

Order 1: Saurischia (Reptile-like Dinosaurs)

In Saurischian dinosaurs, the pelvis was a ***triradiate*** structure in which the pubic bone of the pelvic girdle extends down and forward below the ilium and the ischium extends down and backward.

This arrangement of the pelvic is similar to that of reptiles and hence the name Saurischia which means ***reptile***-like pelvis. The early saurischians were small bipedal carnivores like the ancestral thecodonts. From this generalized type evolved the ***Theropoda*** and *Sauropoda.*

Suborder 1: Theropoda: They were carnivorous saurischians. They were bipedal in their locomotion. They include the genera-like *Ornithomimus, Tyrannosaurus, Ornitholestes Coelophysis* and *Allosaurus.*

Suborder 2: Sauropoda: They were giant Saurischian dinosaurs attaining lengths of sixty to eighty feet and body weights of 30-50 tons. They were herbivorous Dinosaurs. They were represented by *Brontosaurus* and *Diplodocus.*

Order 2: Ornithischia (Bird-like Dinosaurs)

Ornithischia evolved during the ***Triassic*** times from some thecodonts. In Ornithischian Dinosaurs, the pubic bone of the pelvis had rotated backward so that it is parallel to the ischium.

This arrangement of pubis and ischium is similar to the pelvis of birds. So these Dinosaurs are called ***ornithischia,*** which means ***bird***-like pelvis.

The pelvis was a tetrara diate structure, its four processes are formed by the anterior and posterior extensions of the ***ilium,*** by ***prepubis*** and by the closely packed *ischium* and *pubis*

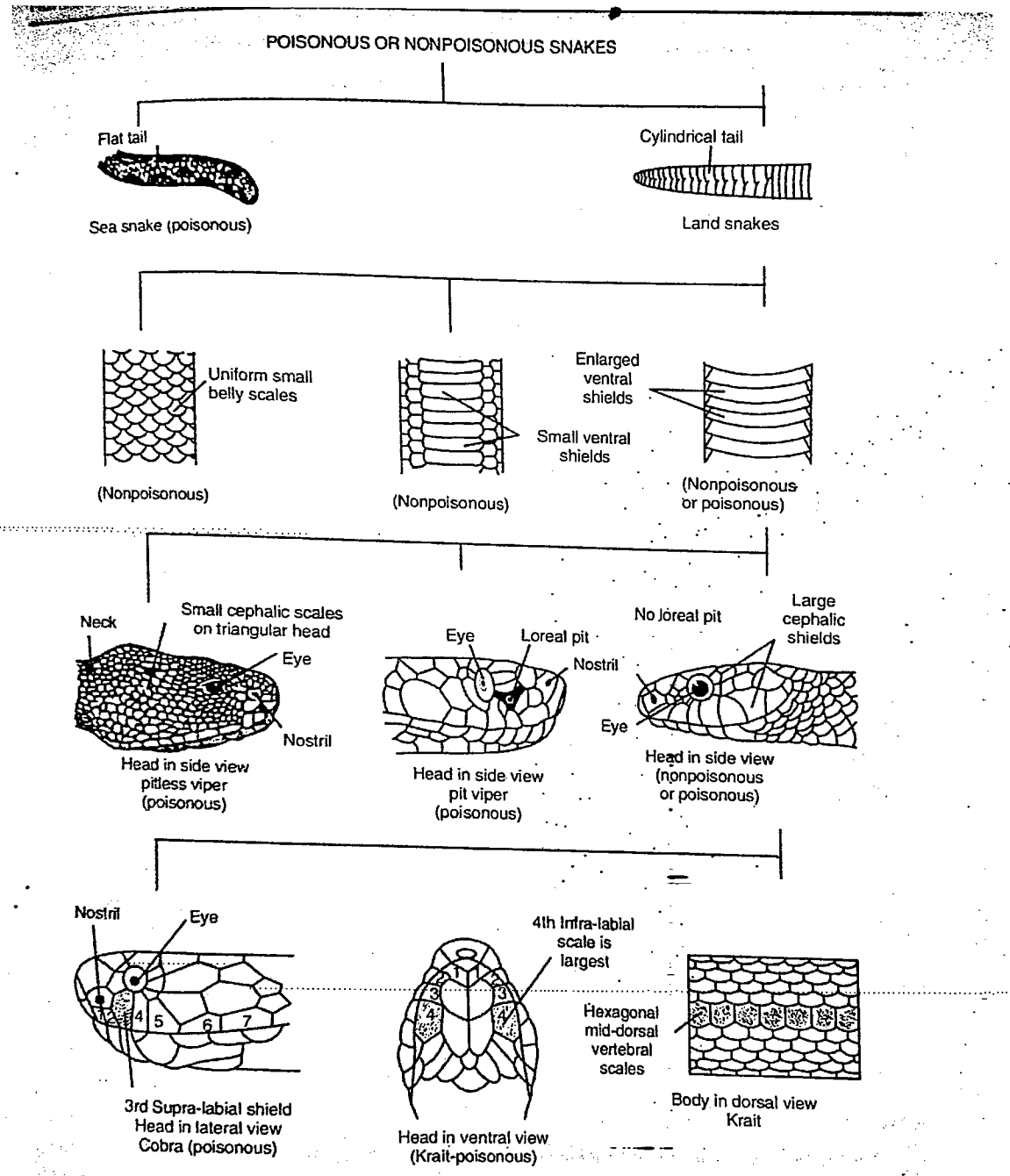


Fig. 18.9 Identification of poisonous and non poisonous snakes

Distinction between poisonous and non-poisonous snakes

Structures	Characters	Nature	Snakes
1. Tail	(a) Tail laterally compressed, oar-like	Poisonous	Sea snakes *Hydrophis, Enhydrina*
	(b) Tail cylindrical, tapering	Poisonous or non-poisonous Examine further	Land snake
2. Belly scales or ventrals	(a) Belly scales small, continuous with dorsals	Non-poisonous	
	(b) Ventrals not fully broad to cover belly	Non-poisonous	Pythons
	(c) Ventrals broad, fully covering belly	Examine further	
3. Head scales, loreal pit, sub-caudals	(a) Head scales small. Head triangular. No loreal pit	Poisonous	Pitless vipers
	(i) Sub-caudals double	"	*Vipera russelli*
	(ii) Sub-caudals single	"	*Echis carinata*
	(b) Head scales small. A loreal pit present between nostril and eye	Poisonous	Pit vipers *Lachesis, Ancistrodon*
	(c) Head with large shields. No loreal pit	Examine further	
4. Vertebrals, 4th infralabial, 3rd supralabial	(a) Vertebrals enlarged, hexagonal 4th infralabial largest	Poisonous	Krait, *Bungarus*
	(b) Vertebrals not enlarged. 3rd supralabial touches eye and nostril	Poisonous	
	(i) Neck with a hood and spectacle mark	"	Cobra, *Naja*
	(ii) Hood absent. Coral spots on belly	"	Coral snakes, *Callophis*
	(c) No such characters	Non-poisonous	—

Biting mechanism

Since the bones of the skull and jaws in poisonous snakes are movably articulated, they allow a considerable degree of adjustment during swallowing. In snakes with solenoglyphous type of fangs the biting mechanism includes two steps:

1. Erection of fang.
2. Injection of poison into the victim's body.

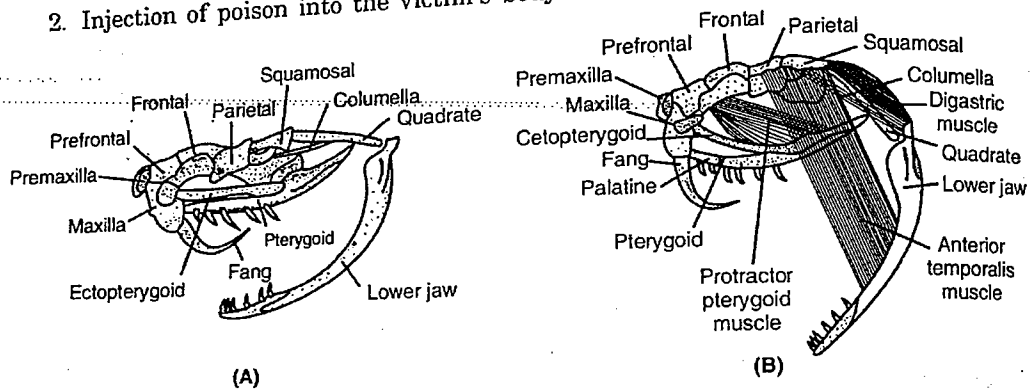


Fig. 18.8 Biting mechanism. **(A)** At rest, mouth closed and fang lies against the roof; **(B)** In striking position mouth open and fang erect

When a snake strikes a series of movements occur in a sequence (Fig. 18.8).

1. Contraction of digastric muscles lowers the mandible, thus opening the mouth.
2. The lower end of the quadrate thrusts forward and this pushes the pterygoid forward. This is also aided by the contraction of sphenopterygoid muscles.

3. This pushes the transverse or ectopterygoid upwards causing the maxilla bearing fangs to rotate through 90° at the hinge joint with lacrimal.
4. As a result the fangs become vertically erect and are ready to strike.
5. The stretching of constrictor muscles around the poison gland forces the poison through the poison duct into the groove of the fang to be injected into the victim.
6. After injecting the poison the mouth is closed by the contraction of temporal muscles and the above movements are reversed. The fangs are withdrawn into the mouth. The vertical fangs rotate and become horizontal.

mouth. The vertical fangs rotate and become horizontal.

Snake venom

Snake venom is a clear sticky liquid of faint yellow or green colour secreted by the poison gland. It is tasteless, odourless and acidic in reaction. It is a complex mixture of enzyms and specific toxins and is a good digestive juice. It is fatal only when mixed with blood. It can be swallowed without causing any damage if there is no cut in the mouth or alimentary canal and pass out with faeces. It can be precipitated with reagents like silver nitrate and potassium permaganate and can be dried and stored indefinately without losing its venomous properties. It is soluble in water, salt solution or glycerine. Snake venom may contain both neurotoxic and haemotoxic factors but in some one factor may become dominant.

Effect of snake venom

The venom of different snakes has its own effect. Degree of virulence differs in different snakes. The effect of poison on the victim depends on the amount of poison injected and the degree of virulence of the poison. There are two types of effects of snake venom.

1. **Neurotoxic,**
2. **Haemotoxic.**

The venom of krait, cobra and sea snake is **neurotoxic.** It causes death by paralysis of respiratory muscles and asphyxia.

The venom of vipers is haemotoxic. It causes tissue destruction and haemorrhage.

The symptoms of snake bite of three most common species of poisonous snakes are:

1. **Cobra bite:** The venom of cobra is most virulent. It is neurotoxic. It causes paralysis of muscles particularly the resiratory muscles. The symptoms are:

(i) Piercing pain and burning sensation causing numbness of the bitten part which becomes blue or black.

(ii) Giddiness and vomiting.

(iii) Weakness in legs.

(iv) High pulse rate.

(v) Speechlessness.

(vi) Drooping of saliva and eylids and contraction of pupils.

(vii) Death within few hours due to failure or respiration or heart.

2. **Krait bite:** Krait is the most common poisonous snake. It is very deadly because the amount of poison injected is more than three times than that of cobra. The symptoms are similar to those of cobra except unbearable abdominal pain due to internal haemorrhage. Death occurs within 6–24 hours due to destruction of RBC and paralysis of trunk and limbs.

3. **Viper bite:** The venom is mainly haemotoxic. The symptoms are:

(i) Local swelling and discolouration of the bitten part and acute burning pain.

(ii) A red fluid oozes out of the wound due to massive tissue destruction (necrosis). This frequently requires amputation.

(iii) Pupils dilate.

(iv) Pulse rate increases.

(v) Profuse vomiting.

(vi) Person loses conciousness.

(vii) Death due to paralysis of vaso-motor centres and profuse bleeding.

Antivenin

The best way to cure snake bite is to inject **antivenom serum** or **antivenin** into the body of victim. It counteracts the snake venom. Different antivenins are required for different snake bite because of differences in the nature of the venoms.

Preparation of antivenin: An antivenin is prepared by injecting a horse with gradually increasing doses of the snake venom until the horse becomes fully immunized to any amount of venom injected. Now enough antibodies are formed in the blood of horse to neutalize the effect of that snake venom. The blood serum is collected and preserved. This is antivenom serum or antivenin.

First aid treatment

First aid treatment should be given soon after snake bite before medical treatment can be secured. It includes:

1. A toniquet or ligature should be tightly tied near the bitten part towards the heart by any suitable piece of cloth. This prevents circulation of poison in the body. The torniquet should be loosened for a few minutes in between.
2. Wound should be washed with clean water.
3. Wound should be cooled with ice to slow down blood circulation.
4. Poison may be sucked out by a suction pump and not by mouth.
5. A cut 1 cm deep should be made with a sterilized knife or blade so that some poison may let out with blood.
6. The victim may be given hot milk, tea or coffee.
7. The victim should be shifted to hospital for treatment with an antivenin injection.

7 Aves

The birds originated from reptiles in the ***Mesozoic*** era. ***De Beer*** stated that ***nothing is more certain than the fact that birds have descended from reptiles.*** Both reptiles and birds resemble with each other in many respects.

As the reptiles and birds are very similar, ***Huxley*** placed the two classes of vertebrates in a single superclass called ***Sauropsida.***

Eventhough the birds have many reptilian characters they are highly specialized than the reptiles. This made ***Huxley*** to state that birds are the ***glorified reptiles.***

Aves are birds. They are described as ***feathered bipeds. Young*** (1958) stated that birds are the ***masters of air.*** They are superior to the reptiles but inferior to the mammals in the evolutionary scheme.

The birds are defined as *warm blooded, bipedal, air-breathing vertebrates with fore limbs modified into wings and non-glandular skin covered with feathers.*

The ***feathers,*** the ***wings*** and the ***beaks*** are the three important identifying features which make the birds distinct from other vertebrates.

General Characters

1. ***Aves*** are ***birds.*** *Birds are* ***warm blooded*** *flying vertebrates with beaks, wings and feathers.*
2. They are ***Chordates*** because the embryo develops a ***notochord.***
3. The brain is enclosed in a ***cranium.*** So they are ***Craniata.***
4. They are ***Vertebrates*** because they contain a ***vertebral column.***
5. They have ***jaws.*** So they are included in ***Gnathostomata.***
6. They have 4 limbs. So they are called ***Tetrapods.***

7. They develop ***amnion***. So they are called ***Amniota***.

8. The body is ***spindle***-shaped and it consists of four regions, namely a ***head***, a ***neck***, a ***trunk*** and a ***tail***.

9. The hind limbs are adapted for ***walking, perching*** and ***swimming;*** they bear four clawed digits.

10. The bird has an epidermal exoskeleton in the form of ***feathers, scales, claws*** and ***beaks***.

11. The ***skin*** is ***dry*** and skin glands are absent.

12. The jaws are elongated into a ***beak*** or ***bill***.

13. The ***fore limbs*** are modified into ***wings***.

14. ***Preen glands*** (oil glands) are located at the base of the tail.

15. The ***lower jaw*** consists of ***five or six bones*** and it articulates with the quadrate.

16. The ***teeth*** are ***absent***.

17. The vertebrae are ***heterocoelous***.

18. The last three or four vertebrae are fused together to form a '***plough share bone***' called ***pygostyle***.

19. The ***sternum*** is ***large*** and it bears a ***keel*** for the attachment of ***flight muscles***.

20. The ribs are ***double-headed***.

21. Each rib bears a backwardly directed bone called ***uncinate process***.

22. The pectoral girdle has a stout coracoid and a ***sabre*** shaped scapula.

23. The clavicles of the two sides unite together to form a V-shaped bone called ***furcula*** or ***merrythought bone*** or ***wish bone***.

24. The pelvic girdle is ***tetraradiate***.

25. The pelvic girdle is fused with the ***synsacrum*** of the vertebral column.

26. The ***acetabulum*** is perforated.

27. The distal carpals fuse with the metacarpals to form the ***carpometacarpus***.

28. The proximal tarsals and the tibia fuse together to form the ***tibiotarsus***.

29. The distal tarsals fuse with the ***II, III*** and ***IV metatarsals*** to form the ***tarsometatarsus***.

30. The bones are ***pneumatic*** with air spaces.

31. The skull is ***monocondylic*** with a single ***occipital condyle***.

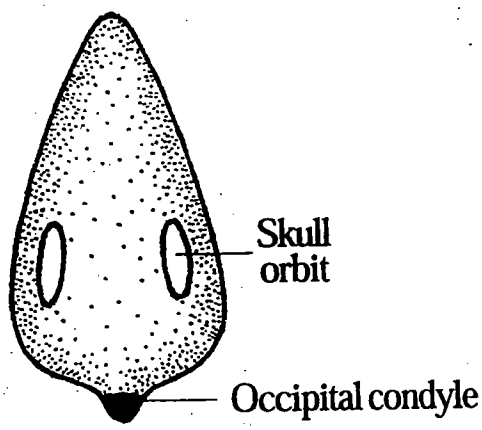


Fig.7.1: Skull of a bird with a single occipital condyle.

32. A ***synsacrum*** (fused vertebrae) is present in the vertebral column.
33. The heart is ***4 chambered*** with ***2 auricles*** and ***2 ventricles.***
34. ***Right systemic*** arch alone persists. Left systemic arch is absent.

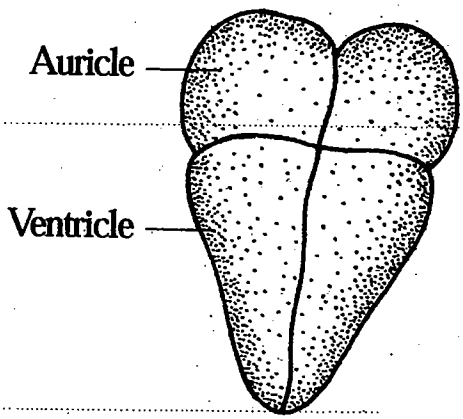


Fig. 7.2: 4-chambered heart of a bird.

35. The lungs are provided with air sacs. The birds exhibit ***double respiration.***

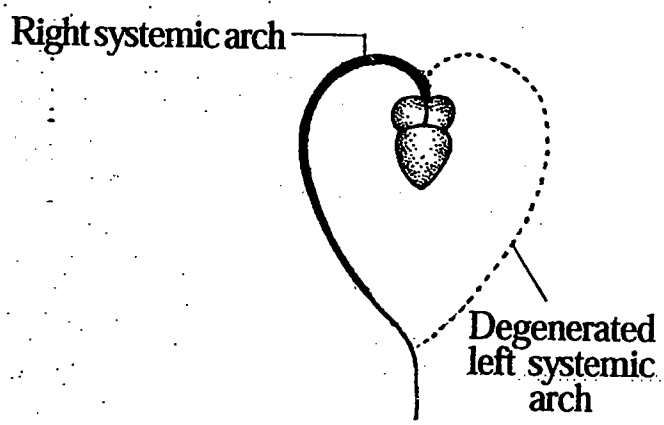


Fig. 7.3: Right systemic arch of a bird.

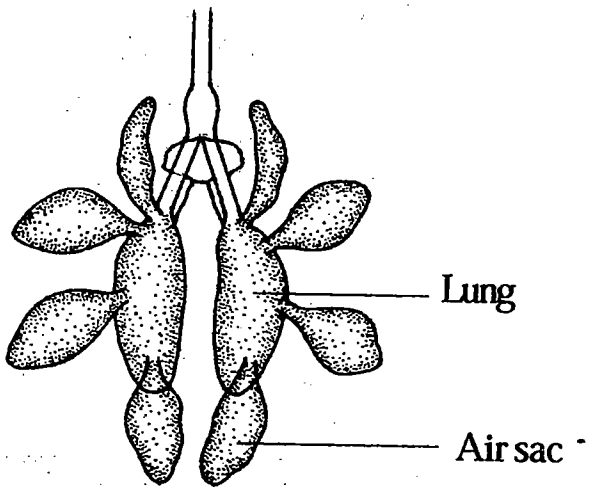


Fig. 7.4: Air sacs found in the lungs of bird.

36. They have ***twelve pairs*** of cranial nerves.
37. The eyes are surrounded by ***sclerotic plates.***
38. They have a ***cloaca.***

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39. RBC is ***nucleated.***

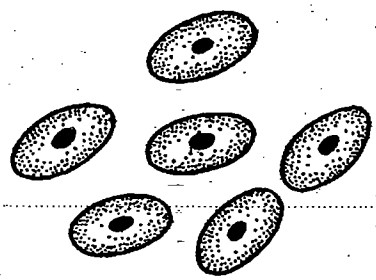

Fig.7.5: Nucleated RBC of birds.

40. ***Air sacs*** are present in the lungs.
41. A ***syrinx*** or ***sound box*** is present.
42. Kidney is ***metanephric.***
43. Birds excrete ***uric acid.*** Hence they are ***uricotelic animals.***
44. Two optic lobes (***corpora bigemina***) are present.
45. The ear containing a single bone called ***columella auris.***

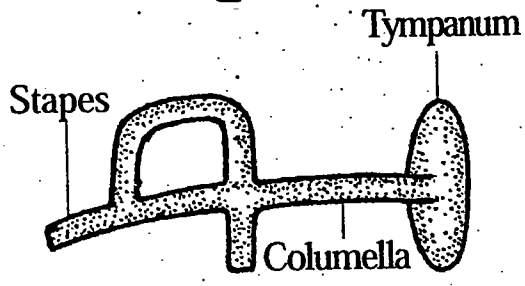

Fig.7.6: Columella auris of birds.

46. Eye contains a vascular body called ***pecten.***

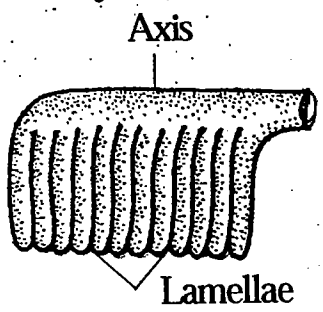

Fig.7.7: Eye of bird showing pecten.

47. Exhibit ***sexual dimorphism.***
48. ***Oviparous.***
49. Produce ***cleidoic*** eggs (eggs with a shell).

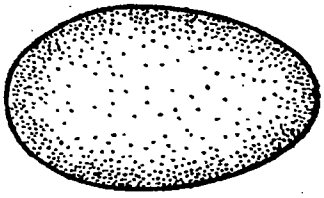

Fig.7.8: Cleidoic egg of a bird.

50. The female has a single ***ovary*** and a single ***oviduct.***
51. The fertilization is ***internal.***
52. The eggs require incubation for hatching.
53. The cleavage is ***meroblastic.***
54. The embryos develop ***foetal membranes.***
55. They exhibit ***parental care.***
56. Urinary bladder is absent.

Classification in Brief

Aves are ***birds.*** *Birds are* ***warm blooded*** *flying vertebrates with beak, wings and feathers.*

Birds are ***Chordates*** because the embryo develops a ***notochord.***
The brain is enclosed in a ***cranium.*** So they are included in ***Craniata.***
They have a ***vertebral column.*** So they are included in ***Vertebrata.***

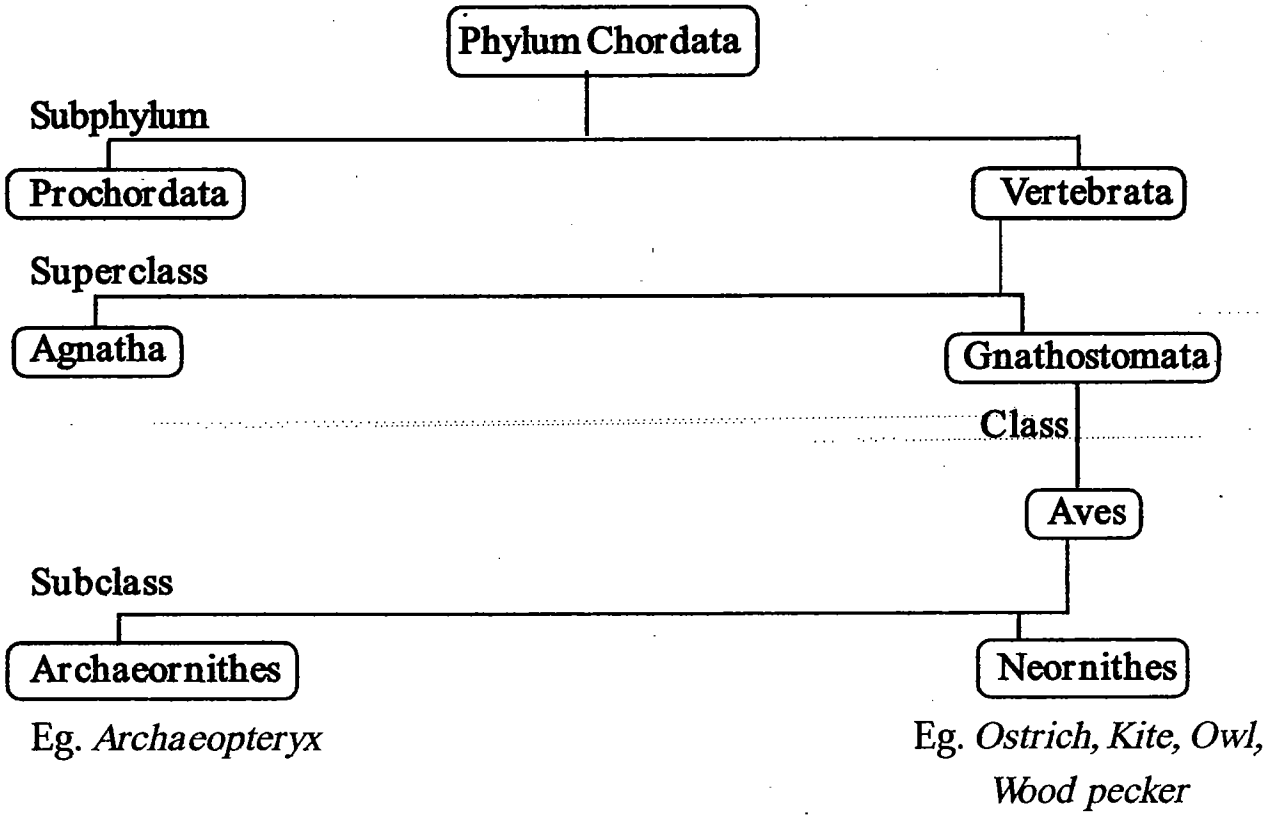

Fig.7.9: Synoptic classification of Aves.

They have ***jaws.*** So they are included in ***Gnathostomata.***
They have 4 limbs. So they are grouped in ***Tetrapoda.***
The embryo develops an ***amnion.*** So birds are ***Amniota.***
There are about 30,000 varieties of birds in the world.
Class ***Aves*** is divided into two subclasses, namely
Subclass 1. Archaeornithes
Subclass 2. Neornithes

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Subclass 1. Archaeornithes

Archaeornithes includes ***ancient birds.***
They were extinct and lived about 155 million years ago in the ***mesozoic*** era.
The power of flight was poor.
The fore limb was provided with ***three clawed digits.***
The jaws were provided with teeth.
The keel was absent.
The ribs were devoid of uncinate processes.
Eg. *Archaeopteryx.*

Subclass 2. Neornithes

This subclass includes ***modern*** as well as ***extinct*** birds.
The ***tail*** is ***short.***
A ***pygostyle*** is present.
The ***wings*** are ***well developed.***
The digits of the fore limbs are without claws.
The sternum has a ***keel.***
The ribs bear ***uncinate*** processes.
The vertebrae are ***heterocoelous.***
The abdominal ribs are absent.
Eg. *Struthio camelus* (Ostrich), *Pelecanus* (Pelican), *Apteryx* (Kiwi), *Pavo cristatus* (Peacock).
Subclass ***Neornithes*** is divided into 4 superorders, namely
Superorder 1: Odontognathae,
Superorder 2: Palaeognathae
Superorder 3: Impennae
Superorder 4: Neognathae.

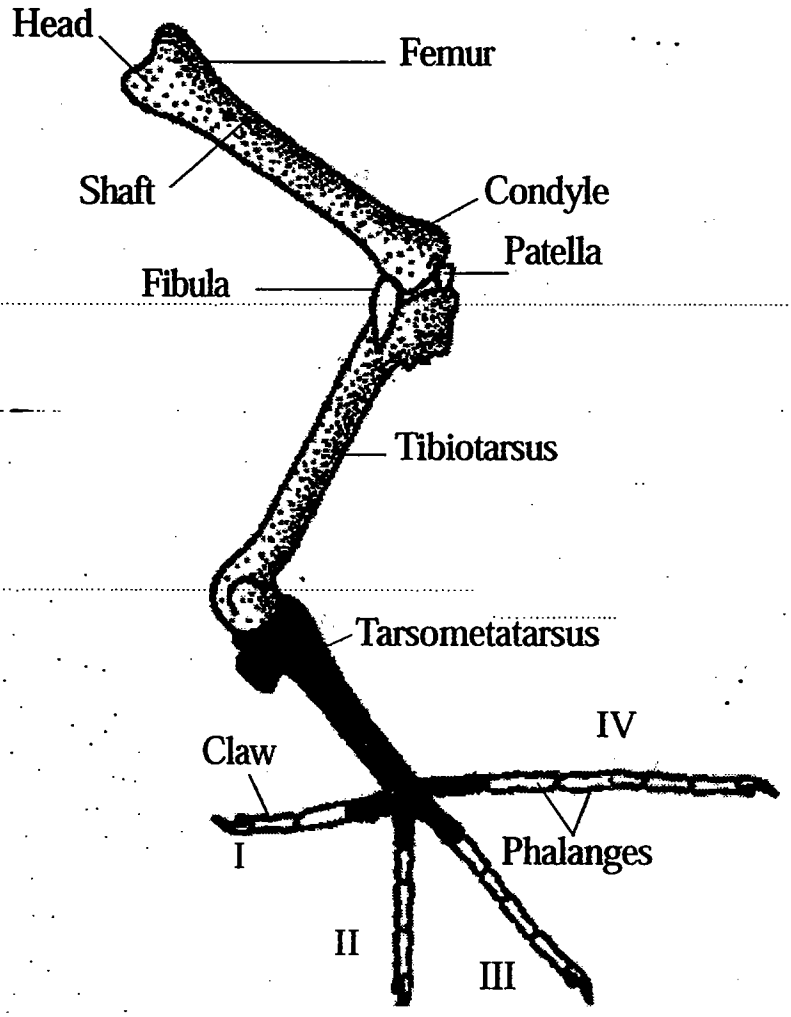

Fig.7.61:Pigeon - Hind limb skeleton.

The hind limb has four toes. The toes are supported by phalanges. The phalangial formula is 2,3,4,5,0. All the toes bear ***claws***.

General Topics

1.Migration of Birds

The periodic travelling of birds from one place to another and back, for breeding is called ***bird migration***. It is a two-way migration. It involves ***emigration*** and ***immigration***.

Emigration is the outward migration from the ***feeding ground*** to the ***breeding ground***.

Immigration is the inward migration or return journey from the ***breeding ground*** to the ***feeding ground***.

Migratory Birds

The following are the important migratory birds:

Swift	*Golden plover*
Sparrow	*Humming bird*
Robin	*Paradise flycatcher*
Oriole	*Greylag goose*, etc.

Purpose of Bird Migration

Birds migrate for the following purposes:

1. Breeding
2. Feeding
3. For getting suitable climatic conditions.

Causes of Bird Migration

The migration of birds is caused by the following factors:

1. The ripening of gonads
2. Instinct
3. The scarcity of food
4. The shortening of day light
5. Fall in temperature.

Speed of Migration

The average speed of ***migration*** is 30 - 50 miles per hour. However, some birds like swifts are capable of flying at a speed of 200 miles per hour.

Distance of Migration

Birds travel thousands of miles to reach their destination. ***Starlings*** of Berlin travel about 2000 km. ***Manx shear water***, a sea bird travels about 4940 km across Atlantic ocean from Boston to the West coast of England.

The *golden plover* of North America migrates from its winter home in the Hawaian islands to its breeding place in Northern Canada.

Types of Bird Migration

1. Altitudinal Migration

The migration of birds from mountain tops to valleys is called ***altitudinal migration***. It is done by mountain birds.

2. Latitudinal Migration

The migration of birds from the North to the South and vice versa is called ***latitudinal migration***. During winter the northern hemisphere is very cold. So the birds there migrate towards South. During summer the birds migrate towards North to avoid high temperature.

3. Longitudinal Migration

The migration of birds in the east-west direction and vice versa is called ***longitudinal migration***.

4. Total Migration

When all the members of a species, living in a particular area participate in the migration, it is called ***total migration***.

5. Partial Migration

When only a few members of the species take part in the migration, it is called ***partial migration***.

6. Diurnal Migration

The migration of birds during day time is called ***diurnal migration***.

7. Nocturnal Migration

Certain small birds ***migrate*** only during night time. This is called ***nocturnal migration***.

8. Daily Migration

Certain birds like crows, gulls, etc. fly away from their nests in the early morning and return to the same nests in the evening. This is called ***daily migration***.

9. Seasonal Migration

Some birds migrate regularly at a definite season in every year. This is called ***seasonal migration***. For example, swifts, swallows, nightingales, cuckoos, etc. migrate from the South to the North during summer. These birds are called ***summer visitors***. Certain birds like fieldfare, snowbunting and redwing migrate from North to South during winter. These birds are called ***winter visitors***.

Ranges of Migration

Migratory birds travel thousands of kilometres for breeding. The bird which covers the longest distance during migration is the ***arctic tern***. It travels 17,600 kms. ***Barn*** the ***swallows*** travel about 14,400 kms. ***Bobolink*** travels 11,200 kms.

Altitudes of Migration

Some birds migrate close to the earth; other birds fly up to a height of 300 feet. But birds prefer to fly below the level of clouds.

Regularity of Migration

Birds maintain striking regularity and accuracy in migration. They are very punctual in migration. The arrival of certain birds can be predicted with 100% accuracy. The purple martins return on the same day each season.

Bird Navigation

The birds migrate through well established routes year after year. They follow the same route and reach the same destination year after year. How do the birds find their way? This is greatest mystery for the ornithologists. However, there are a few explanations. They are the following:

1. **Land marks:** Certain birds find their way by recognizing land marks. The important land marks used by birds are rivers, valleys, coastal lines, oceans, seas, deserts, mountains, etc.

2. **Magnetic field:** *Griffin* (1948), suggested that birds are guided by the earth's magnetic field.

3. **Stars:** *Sauer* demonstrated that stars serve as a guiding force for nocturnal migration. This is true for warbler birds.

4. **Sun:** *Kramer* and *Mathews* proved that many wild birds use the sun as the compass for migration.

5. **Internal clock:** The birds have a ***built-in time-keeping mechanism*** or ***internal clock*** or ***biological clock***. This biological clock helps the birds to navigate.

6. **Experience:** It is believed that birds learn their way by experience. This is possible when old members of the team guide the young birds.

Bird Ringing

Bird ringing or *bird banding* is a technique which provides information about the movements of birds, the routes used by birds, the duration of migration and the approximate time they have been travelling.

In this technique, the bird is either taken from the nest or is trapped and a numbered ***band of aluminium alloy*** is fixed around one of its legs. Thousands of birds are ringed in this way. If the ringed bird is captured the information on the ring is recorded and the bird is released. The information is then notified to the concerned authority.

Origin of Migration

There are two theories to explain the origin of migration of birds. They are the following:

1. Northern ancestral home theory

2. Southern ancestral home theory

1. Northern ancestral home theory: According to this theory, the non-migratory birds lived all over the entire northern hemisphere in the olden days.

When there was seasonal changes in climate, they were driven southwards.

When the climate was normal in the North, they returned to their homelands. They lived there until they were forced southwards again. By constant repetition of this behaviour over many generations, birds have developed the habit of migrating.

2. Southern ancestral home theory: According to this theory, Southern hemisphere was the homeland for the birds. Owing to over-population they were driven to the northern hemisphere. Then they returned to their homelands. As this process was repeated for many years, the birds have developed the habit of migrating.

Mystery of Bird Migration

The behaviour of migration is still under mystery. The following factors are still under mystery.

1. The factors which determine the direction and destination of migration.
2. The factor which guides the birds to follow the route to its destination.
3. The factor which guides the young birds to under take long journeys with perfect accuracy.

Advantages of Migration

Migration provides the following advantages for the birds:

1. The birds avoid cold and stormy weathers by migrating in winter.
2. They obtain long day light hours for searching food when they migrate in winter.
3. They can avoid scarcity of food owing to freezing and snowfalls.
4. They obtain suitable and uncongested dwelling places.

2.Flight Adaptations

Birds are aptly described as the ***masters of air***. Man constructed aeroplanes after seeing birds. Birds are good fliers. They are the fastest animals. Their morphology, anatomy and physiology are highly modified for movement in the air. The following are the flight adaptations of birds:.

1. Shape

Birds have a ***stream lined, boat-shaped*** or ***spindle-shaped*** body. It gives very little resistance while flying.

2. Feathers

The body is fully covered by feathers. They have the following functions:

1. Reduce friction.

2. They reduce weight.
3. Wing feathers are used for striking the air.
4. Tail feathers are used for lifting up and steering.
5. Body feathers form a ***blanket.*** The blanket holds certain amount of air between the body and the feather covering. This air helps the birds to keep a ***buoyancy.***

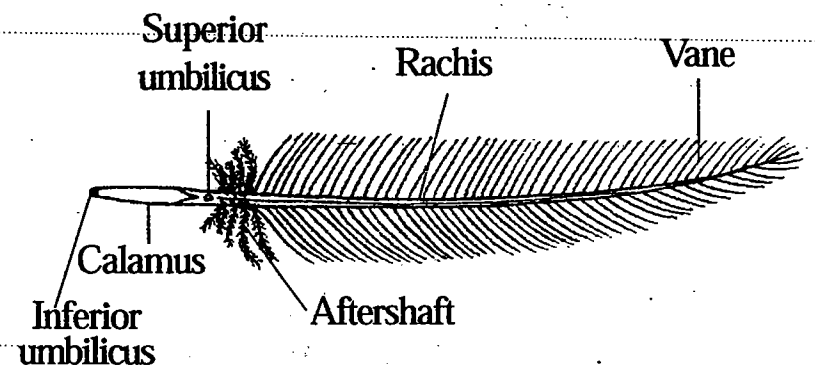

Fig.7.62: A quill feather-A portion of vane magnified.

3. Wings

Fore limbs are modified into wings which are used for striking the air.

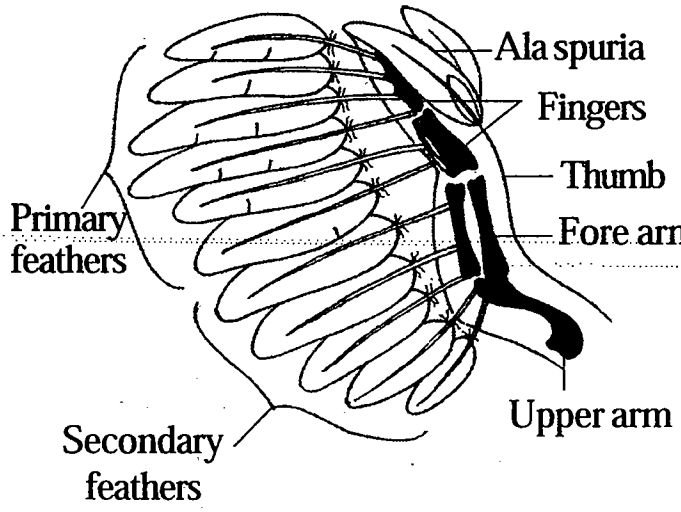

Fig.7.63: A wing.

4. Tail

Tail feathers help in lifting up and steering.

5. Loss of Weight

For flight, weight must be reduced. This is achieved by the following features:
1. Bones are ***pneumatic*** i.e. they are provided with air sacs.
2. Skull bones are thin and the sutures are obliterated.
3. Absence of ovary and oviduct from one side.
4. Absence of urinary bladder.
5. Production of solid excretory product in the form of ***uric acid.***
6. Absence of teeth.

7. Presence of feathers.

6. Flight Muscles

The wing is operated by a set of muscles called ***flight muscles.*** The flight muscles are highly developed in flying birds and poorly developed in flightless birds.

There are four sets of flight muscles. They are

1. *Pectoralis major*
2. *Pectoralis minor*
3. *Coracobrachialis*
4. *Tensor muscles*

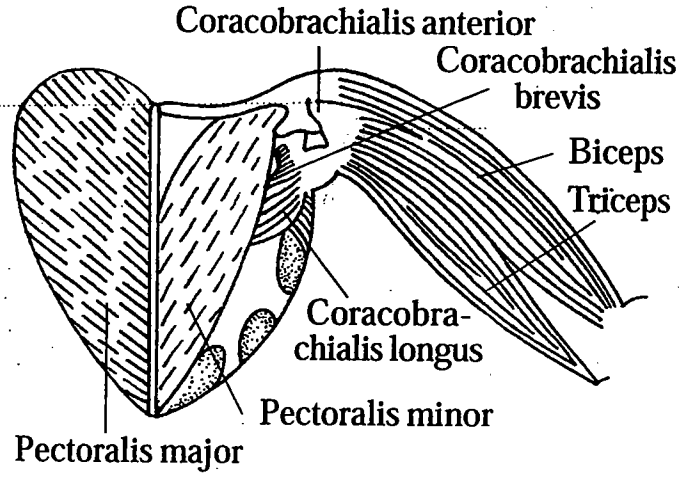

Fig.6.64: Flight muscles.

The pectoralis major and coracobrachialis bring about the downstroke of the wing. The pectoralis minor brings about the upstroke of the wing. The tensor muscles keep the prepatagium tensely stretched when the wing is extended in flight.

7. Air Sacs

Air sacs are thin walled, non-muscular sacs connected to the lungs. There are ***paired cervical air sacs, anterior thoracic air sacs, posterior thoracic air sacs*** and an unpaired ***inter clavicular air sac.*** The air sacs serve as reservoirs for air.

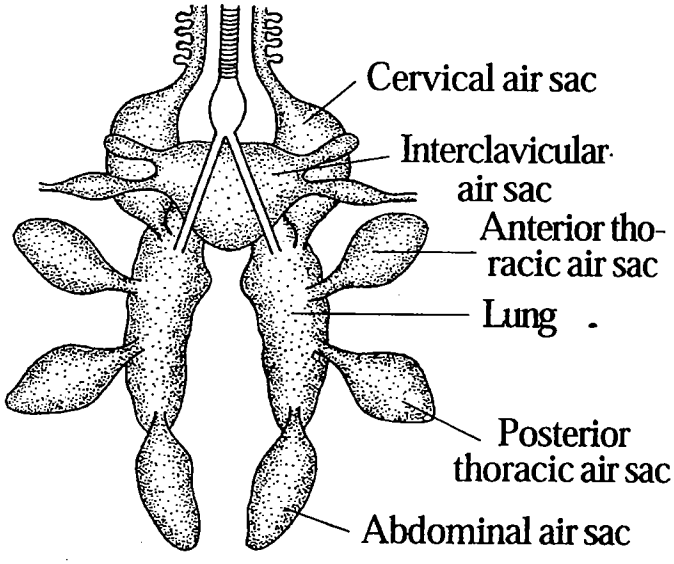

Fig.6.65: Air sacs of pigeon.

In other vertebrates, air is supplied to the lungs only once and that is during inspiration. But in birds, during expiration also air is supplied to the lungs from the air sacs. Thus in birds blood is oxygenated twice during a single breathing. This is called ***double oxygenation*** or ***double ventilation***. Thus the respiratory system is highly adapted to supply more oxygen to the muscle.

8. Warm Bloodedness

Birds are warm blooded animals. This helps the perfect aeration of the blood and a great output of energy. The constant body temperature helps the birds to take flight at high altitudes and in all seasons.

9. Efficient Circulatory System

Active flight requires high output of energy. High output of energy requires more oxygen. The circulatory system is highly adapted for carrying more oxygen.

1. The blood contains large amount of haemoglobin.
2. Heart is large and divided into four chambers.

10. Excretion

The excretory system is highly modified to reduce weight.

1. Urinary bladder is absent.
2. Urine is in the form of ***semi-solid uric acid.***

11. Vision

The power of eyes is very high. It has ***pecten.*** This helps birds to see objects from very high altitudes.

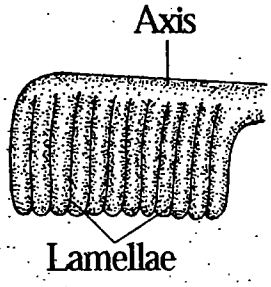

Fig. 7.66: Pecten.

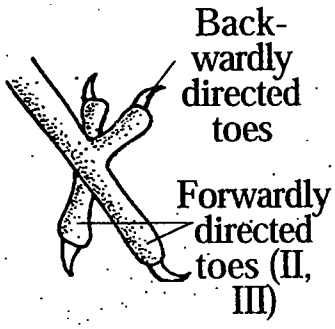

Fig. 7.67: Foot of a bird.

12. Perching

The hind limbs and their muscles are well adapted for perching. Thus a bird sleeping on a perch cannot fall down.

13. Pneumatic Bones

The bones in birds are pneumatic containing air sacs. This renders their weight less.

14. Synsacrum

In the vertebral column about ***fourteen vertebrae*** are fused together to form a ***plate***-like structure called ***synsacrum***. It acts as a girder to support the entire weight of the bird. It is formed by the fusion of the following vertebrae:

Thoracic Vertebra	-	1 (last)
Lumbar Vertebra	-	6
Sacral Vertebra	-	2

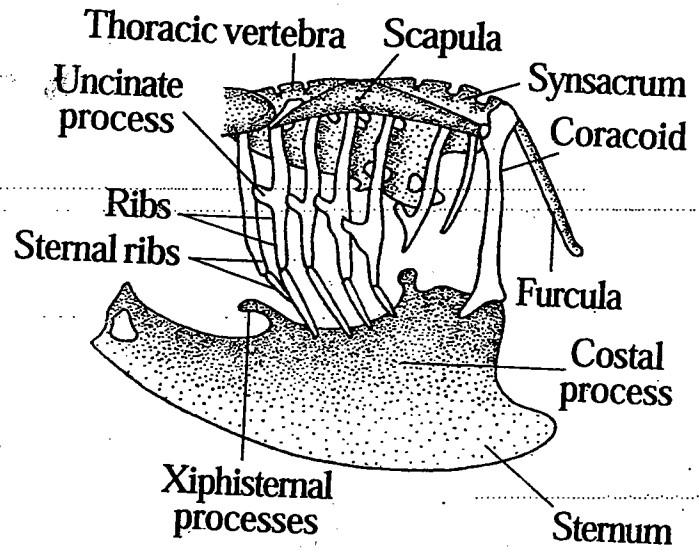

Fig. 7.68: Thoracic framework of pigeon to show sternum, ribs with uncinate process, synsacrum and furcula.

15. Keel

The sternum bears a median ridge called ***keel*** or ***carina***. The flight muscles are firmly attached to the keel.

16. Furcula

The clavicles of the two pectoral girdles are fused ventrally to form a 'V'-shaped structure called ***furcula*** or ***merry thought bone*** or ***wishbone***. It works like a spring between the two wings.

3.Beaks in Birds

*Beaks are the **horny** projections of the **jaws** of birds.*

They are also called ***bills***.

The beak is covered by a horny covering called ***rhambhotheca***.

Functions of Beak

The beak is formed of an ***upper jaw*** and a ***lower jaw***.

The beaks functions as the ***hand*** and ***mouth*** of the birds. They do the following functions,

1. To obtain food.
2. To handle food.
3. To breen the feathers.
4. To collect nest materials.
5. To build nest.
6. To feed the youngones.
7. For defence.
8. For courtship.

Types of Beaks

The beaks of birds are modified according to the type of food and the mode of feeding.