REPTILIA

The first terrestrial amniotes

- The word Reptilia comes from Latin which means creeping.
- These are the first true land vertebrates and amniotes to lay eggs on land.
- They had an obscure beginning in the **Palaeozoic era**, and enjoyed a dominant status (golden age) in the **Mesozoic**, faded out in the **Coenozoic** era.
- Reptiles evolved during carboniferous period of **Palaeozoic era**.
- **The reptiles were evolved from labyrinthodont Amphibia**.
- The study of reptiles is called **Herpetology.**
- Largest reptile is **Crocodylus porosus**
- Smallest reptile is **Sphaerodactylus ariasae**

GENERAL CHARACTERS:

- They are **cold blooded or poikilothermic** animals.
- They are the first true land vertebrates. Their skin is dry without any glands.
- Their body is covered by dry, cornified epidermal scutes or scales made up of Keratin.
- Bony plates called osteoderm develop beneath the horny scales in crocodiles and some lizards
- The **pentadactyl limbs** end in clawed digits.
- Skull is **monocondylic** and is provided with one or two **temporal fossae.** These fossae help in attachment of the temporal muscles.
- Lower jaw consists of **six bones** on each side.
- Sternum well developed with ribs.
- Ribs are single headed except crocodiles.
- **T-shaped interclavicle** is present in the pectoral girdle.
- Vertebrae are **procoelous**.
- Vertebral column is divided in to Cervical, thoracic, lumbar, sacral and caudal regions
- First two cervical vertebrae are **Atlas & Axis**
- Number of sacral vertebrae is **two.**
- Abdominal ribs are also called **gastrilla (not true ribs)**
- Teeth are **homodont, acrodont** (teeth are present on the top of the jaw bone), (or) **pleurodont** (teeth are attached on the inner side of jaw bone) and **polyphyodont.**
- Cloaca is divided into **coprodaeum** that contains the anus, **urodaeum** that contains the opening of urinary and genital ducts and **proctodaeum** that opens out by a cloacal aperture.
- Truncus areteriosus is absent.
- Respiration is by lungs and ventilatory movements are due to intercostal muscles of the ribs. **Cloacal respiration is seen in turtles.**
- Heart is three chambered with two auricles and a partly divided ventricle. In crocodiles ventricle is completely divided.
- The three arterial trunks (left and right systemics and pulmonary) directly develop from the ventricle.
- Kidneys are metanephric. Excretory product is uric acid. So these are uricotelic animals. Aquatic reptiles excrete considerable ammonia and urea
- **Jacobson's organ** (vomaronasal organ) is well developed in some lizards and snakes
- Central nervous system is better developed than in amphibians.
- Cranial nerves are 12 pairs (snakes have 10 pairs).
- Male possess copulatory organs except in *Sphenodon.*
- *Penis of reptiles consists of carpora cavernosum*
- *Hemipenis is without erectile tissue*
- Mostly oviparous. Eggs are large, yolky (**megalecithal**) and shelled (**cleidoic eggs**). Cleavage is **meroblastic.**
- Embryonic membranes are amnion, chorion, yolk sac and allantois and they appear during development. So these are amniotes.
- Yolk sac is without yolk in placental mammals

CLASSIFICATION:

- The living reptiles are grouped into 4 orders.

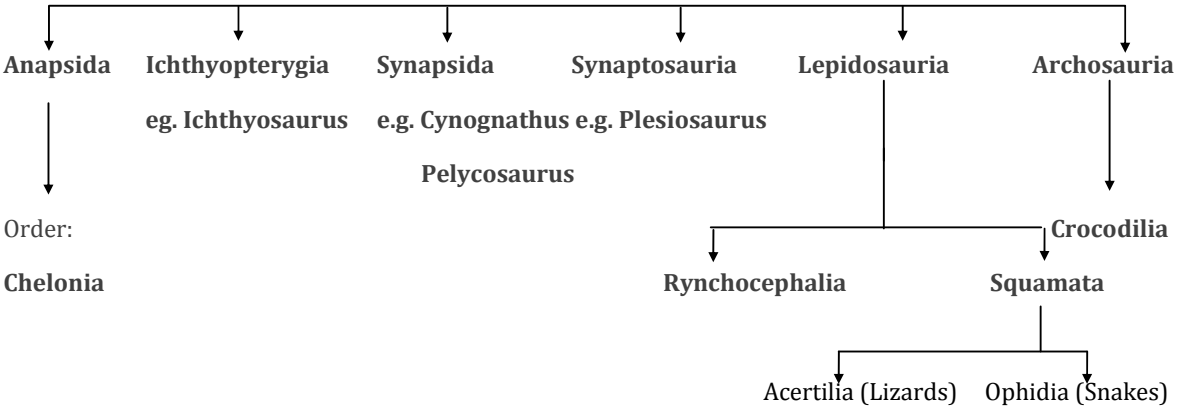
- Class Reptilia is divided in to 6 subclasses on the basis **of temporal openings** of the skull.

Skull type	**sub class**	**Number and arrangement of temporal fossae**	**Principal groups**
Anapsid	Anapsida	None	Cotylosaurs, Chelonians
Synapsid	Synapsida	One pair (infratemporal fossa). Low behind the eye. Postorbital and squamosal meet above.	*Pelycosaurus* *Cynognathus* (therapsid mammal like reptile)
Parapsid	Icthyostegia	One pair (supratemporal fossa). High behind eye. Usually postfrontal and supratemporal meet below.	*Ichthyosaurus*
Eurapsid	Synaoptosauria	One pair (supratemporal fossa). High behind the eye. Bordered below by postorbital and squamosal	*Plesiosaurus*
Diapsid	i.Lepidosauria ii. Archosauria	Two pairs. Postorbital and squamosal. Usually meet between them.	*Sphenodon*, lizards, snakes. Crocodiles

Only living orders of these groups are discussed here.

CLASS REPTILIA

Subclass :



Subclass-1: Anapsida

- Primitive reptiles with a solid skull roof.
- It includes cotylosaurs (stem reptiles) and chelonians.

Order Chelonia:

- They probably represent an early offshoot from the primitive cotylosaurs
- Chelonians have a box like exoskeleton forming bizarre armour.
- They remained relatively unaltered since Triassic period.
- They are said to have a longest life span.
- Temporal fossae are absent. Skull is anapsid.
- Body is short oval and broad.
- Limbs are clawed in terrestrial forms, while paddle like in aquatic forms.
- Body is enclosed in a box like armour consisting of dorsal **carapace** and ventral **plastron.**
- Neural arches of vertebra and ribs are fused with carapace
- Clavicles, interclavicles and gastrilla fused to form plastron.
- Sternum is absent.
- Palate is incomplete secondary palate
- Teeth are absent (edentate). Jaws are covered with horny sheath.
- A small blood vessel called **ductus Botalli** connects the systemic arch with pulmonary arch.
- Nasal opening is single.
- Some aquatic forms like turtles have a vascular cloaca for aquatic respiration.
- Cloacal aperture is a longitudinal slit.
- Males have single penis

E.g.

- Marine water chelonians called **turtles**
- Fresh water chelonians called **terrapins**
- Terrestrial chelonians are called **Tortoises**
- The leather back turtle is **Dermochelys coriacea**
- The largest living turtle is **Dermochelys coriacea**
- *Testudo* is a land dwelling **tortoise.**
- *Testudo abingdoni* of Galapagos Islands has an estimated age of 200 to 400 years.
- *Trionyx* is a soft shelled fresh water edible **terrapin.**
- *Chelone mydas is* **green sea turtle**

Subclass-2: Ichthyopterygia (parapsid skull)

- It is a group of extinct reptiles with a single temporal fossa (supratemporal fossa) bound on the lower side by postfrontal and supratemporal bones. E.g. *Icthyosaurus.*

Subclass-3: Synaptosauria (euryapsid skull)

- All are extinct
- These are Palaeozoic and Mesozoic aquatic reptiles with a single temporal fossa (supratemporal fossa) bound on the lower side by postorbital and squamosal in the skull.

E.g. *Plesiosaurus.*

Subclass 4: Lepidosauria (diapsid skull)

- Representatives of this subclass have two temporal vacuities.
- The surviving lepidosaurs belong to Rhynchocephalia and Squamata.

Order 1: Rhynchocephalia

- The group apparently not very large but was once widespread.
- The sole living representative of this group *Sphenodon* which grows to about 2 Ft.
- This reptile has well developed pentadactyl limbs adapted for walking.
- It is restricted to coastal islands of New Zealand where it burrows into soft soil, emerging only at nights.
- It is popularly called as **'Tuatara lizard or Hatteria.**
- Skin covered by granular scales and mid dorsal row of spines. Colour is dark olive with yellow spots above and white below.
- Tail is bilaterally compressed.
- Limbs are pentadactyl.
- Skull is unmodified diapsid type.
- Parietal foramen with vestigeal **pineal** eye is present.
- Vertebrae are **amphicoelous.**
- Many abdominal ribs are present.
- Copulatory organ is absent. Internal fertilization is by **cloacal apposition**
- Cloacal aperture is **transverse.**
- Since **Sphenodon** retained many primitive characters, it is appropriately called as **"living fossil"**.
- *Sphenodon* is nocturnal, oviparous
- *Sphenodon has acrodont and monophyodont dentition*
  E.g. *Sphenodon punctatum, Sphenodon guntheri.*

Order 2: Squamata

- It includes **lizards** and **snakes**.
- They are **most successful living reptiles**.
- Squamata are the reptiles in which the skull has lost both temporal vacuities. E.g.: **snakes and some lizards.**
- Cloacal aperture is transverse.
- Ribs are single headed.
- **Quadrate is movable**.
- Vertebrae are procoelous.
- Articulations of spines are **zygosphenes and zygantra**
- zygosphenes and zygantra are found in **some lizards and snakes**
- The order Squamata is divided into two suborders. 1. Lacertilia that includes lizards and suborder 2. Ophidia that includes snakes.

Suborder 1: Lacertilia

- Limbs and limb girdles are often well developed.
- Neck is distinct.
- Caudal autotomy is seen in many lizards and some snakes
- Thoracic vertebrae bear Ribs
- Lumbar vertebrae are without ribs or rudimentary ribs
- Eye lids are well developed and movable.
- Tympanum and Eustachian recess are well developed.
- Tongue is forked in **Varanus**
- Sternum, episternum and urinary bladder are present (absent in some).
- Both lungs are equally developed.
- Cranial nerves are 12 pairs.
- Copulatory organs are a pair of **hemipenis.**

  Examples
- ***Hemidactylus:*** Common wall lizard, exhibits **autotomy.**
- ***Draco:*** Flying Lizard. The body has a thin parachute like fold called patagium supported by ribs. The patagium is useful in gliding. A vertical narrow gular pouch hangs down from middle of the throat. Found in forests of Kerala.
- ***Phrynosoma:*** The horned toad of Mexico.
- Ejects blood through the eyes when irritated. It has numerous small spines with two enlarged horns on the head.

- ***Chameleon:*** Famous for changing their body colours to blend with their surroundings.
- Feet exhibit syndactylus condition.
- Tail is prehensile. Tongue long, club shaped and sticky.
- Eyes exhibit independent movement.
- ***Heloderma****:* The only poisonous lizard in the world.
- This is called **'Gila monster"** or **beaded lizard**.
- It is found in Mexico. Its poison is neurotoxin.
- ***Varanus****:* (The monitor lizard). Indian species is *Varanus monitor.*
- **Komodo dragon** of Indonesia is the largest lizard measuring about 12 ft.
- ***Ophiosaurus****:* Limbs are absent.
  Lizards with assymetrical lung is **ophiosaurus**
  Lizards without sternum and episternum are ophiosaurus.
  It is called **glass snake**.
  They have movable eyelids and external ear openings which the snakes lack.
- Study of lizards is called **Saurology.**

Suborder 2: Ophidia:

- Includes all snakes.
- Study of snakes is known as **serpentology** or ophiology.
- Snakes are absent in NewZealand and Ireland.
- The body of snakes is extremely elongated and cylindrical.
- The limbs and limb girdles are absent, except in certain species like python where vestigial hind limbs are in the form of small protruberances.
- Snakes move with the help of ribs attached to muscles.
- The whole scaly epidermis is cast off several times. The phenomenon is called **ecdysis** or **moulting.**
- The tympanic membrane, tympanic cavity and eustachian tubes are absent.
- Males are provided with paired spiny copulatory organs called hemipenis.
- Lungs are asymmetrical; the left lung is either very small or absent.
- Cranial nerves are 10 pairs.
- Eye lids are immovable.
- Snakes are highly sensitive to earth borne vibrations due to the attachment of **columella to quadrate**.
- Kidneys and lungs are asymmetrical and urinary bladder is absent.
  e.g.: *Cobra, Krait, Python* and *Dryophis.*

Subclass-5. Archosauria: (Diapsid skull)

- The members of these groups are diapsids.
- The Archosaurians differ widely from Rhynchocephalia and Squamata and exhibit striking modifications in the limb girdles.
- Hind limbs are longer and more powerful.

Order: Crocodilia

- The amphibious crocodiles, alligators and their allies are the largest living reptiles.
- They form remnants of once-widespread stock that survived Mesozoic era.
- They have a few primitive features relatively unchanged.
- Largest living reptiles. Carnivorous and amphibious.
- Tail is strong and laterally compressed.
- Limbs are powerful clawed and webbed.
- There are five digits in the forelimbs and four digits in hind limb. The digits of the forelimbs are webbed and with claws.
- Skin bears scales and scutes.
- A pseudopalate is present.
- Ribs double headed.
- A small bone proatlas is brilliant before atlas.
- Abdominal ribs present.
- Clavicles are absent but inter clavicle is present crocodiles.
- Teeth are thecodont.
- Nostrils are situated at the tip of the snout.
- A diaphragm separates the body cavity into upper thoracic and lower abdominal cavities.

- Heart is four chambered. The two systemic and pulmonary aortae are close and twisted.
- There is opening called **foramen of Panizza** between the two systemic arches.
- Cloacal aperture is longitudinal.
- Male animals are with erective grooved penis.
  e.g.: *Crocodylus, Gavialis, Alligator.*

Subclass-6: Synapsida (synapsid skull)

It is an extinct group with a single temporal fossa (infratemporal fossa) bound on the upper side by postorbital and squamosal bones, often mammal like reptiles. e.g *Cynognathus,*

SNAKES AND THEIR POISINOUS APPARATUS :

- All snakes are not poisonous, of 330 Indian species, only 69 are poisonous, out of which 29 species are sea snakes and 40 species are land snakes.
- Poisonous snakes have a poison apparatus in their heads. The apparatus consists of 1. A pair of poison glands, 2. Their ducts, 3.Fangs, 4. Muscles.

I. Poison Apparatus

- 1. **Poison Glands**: These are sac like and situated on either side of the upper jaw.
- They are modified superior labial or parotid glands.
- Homologous to Duvernoy's glands
- Each gland is covered by a constrictor muscle.
- These muscles are inserted in to surface of **proteroglyphous** and **solenoglyphous** snakes
- The stretching of the muscle during the bite, squeezes poison from the gland.
- Snakes in grooved teeth at the backs of their maxillae **Ophisthoglyphous**
- Snakes in which fangs that fit in to pockets in their outer gum of the lower jaw **– proteroglyphus**
- Snakes with tubular fangs in maxillae **solenoglyphus**
- Ophisthoglyphous snakes belongs to **Colubridae eg: dryophis**
- Proteroglyphous snakes belong to **Elapidae eg; Cobra, coral snake and sea snake**
- Nature of venom is mixture of **toxins and enzymes**
- Rapid diffusion of venom is because of **Hyaluronidase**

2. **Poison duct**: From each poison gland a narrow poison duct leads to the base of the poison fang.

3. **Fangs** : These are modified **upper maxillary teeth** attached to maxillary bones.

- They are grooved and help in injecting the poison into the body of the victim.
- Snake poison is injected into the body through the fangs serving as hypodermic needles.
- The poison is faint yellow, tasteless and odourless fluid acidic in reaction.
- It is fatal only when mixed in blood.

II. Snake venom is of two categories 1. **Neurotoxins** 2. **Haemotoxins**.

Neurotoxins :

- Neurotoxins are found in sea snakes, kraits and cobras.
- They cause death by paralysis of respiratory muscles and asphyxia.
- The poison of cobra is a neurotoxin affecting the respiratory centre of medulla.

2. Haemotoxins:

- These are characteristic of vipers.
- Lining of blood vessel is damaged
- They cause tissue destruction through proteolysins and cause haemorrhage.
- The best cure for snake bite is antivenin or antivenom.

Antivenin:

- An antivenin is prepared by injecting the horse with gradually increasing doses of a snake venom until the horse becomes fully immunised.
- Then blood serum of the horse is collected and preserved.
- In India Antivenin is produced at the Haffkin's Institute at Bombay and Central Research Institute at Himachal Pradesh.

First aid:

- **Before giving a medical or surgical treatment for a snake bite victim the following first aid methods are recommended.**
- The victim should be treated psychologically, as the fear due to snake bite may cause heart failure.
- A Torniquet or Ligature should be tied around the wound. This prevents or controls, circulation of poison to other parts.

- Wound should be washed and cooled with ice to slow down circulation.

III. Identificaiton of poisonous and nonpoisonous snakes of India

- Most of the Indian snakes are non-poisonous.
- Poisonous snakes have a poisonous apparatus and a pair of large fangs in the upper jaw.
- The bite of a poisonous snake leaves marks of the two fangs on the skin of the victim, while the bite of a non-poisonous snake exhibit many small pricks, as there no fangs.
- Common Indian poisonous snakes are cobras, vipers, kraits, and sea snakes.
- Freshwater snakes are nonpoisonous.

Key for identification of poisonous snakes

- Poisonous snakes are generally brightly coloured.
- They are identified by broad posterior portion, hood, large abdominal scales and loreal pit etc.
- Maxillary teeth in the poisonous snakes are modified into fangs and labial glands are modified into poisonous glands.
- **Tail:** Sea snakes are deadly poisonous.
- Their poison is neurotoxic and affects the nervous system.
- They are identified by the laterally **compressed** or **rudder shaped tail.**
- They are viviparous. E.g. ***Hydrophis, Enhydrina****.* The tail helps the snake in swimming.
- Land snakes have a **cylindrical tail**.
- They may be poisonous or non-poisonous.
- Then the ventrals are to be examined.
- **Ventrals :** When the ventral scales are small or somewhat broad then they are non-poisonous.
- If the ventral scales are large and extend fully across the belly, the snake may be poisonous or non poisonous. Then the head is to be examined.
- **Head:** If the head is triangular and covered by small scales then it may be a viper. Vipers are viviparous. Vipers are two types.
- a. If there is a Loreal pit between the nostril and eye then the snake is a **pit viper.**
- Loreal pit is a **thermoreceptor.**
- *Ancistrodon* is a Himalayan pit viper and *Lachesis (Trimerisurus)* is another pit viper found in India.
- *Crotalus* or rattle snake is an American pit viper.
- b. If the loeral pit is absent it is a *Viperia russels or Russel's Viper* and *Echis carinata.*
- i) ***Russel's*** *Viper.* It is the Largest Indian pitless viper, Vipera russellii.
- Upper surface of the body shows, three rows of large diamond shaped rings, which give the snake the name **chain viper.**
- Sub caudals are in two rows.
- It makes a loud hissing sound when attacked.
- ii) ***Echis carinata*** *:* It is a south Indian viper living in sandy areas and scanty vegetation.
- Sub caudals in single row.
- Dorsal scales are keeled and serrated, hence it is called, the **saw scaled viper.**
- An arrow mark is found on the head.
- It is also called as Foorsa snake**.**
- **Sheilds** : If the head is covered by sheilds, then the sheilds on the upper jaw (Supra labials) and lower jaw (infra labials) must be examined.
- **Cobras and coral snakes :** If the 3rd supra labial touches the nostril and eye then it is a cobra or coral snake.
- a) Cobra is identified from the coral snake by the hood. Hood is a dilation of neck supported by ribs. e.g. ***Naja naja*** is the common Indian cobra. There is a spectacle mark on the hood.
- A small cuneate plate present between 4th and 5th infra labials.
- Subcaudals are in two rows.
- ***Ophiophagus hanna*** is the largest and deadly, **king Cobra.**
- As the colour is black it is also called black cobra.
- It feeds on other snakes hence the name ophiophagus.
- Sub caudals are in single row near the cloaca and two rows in the remaining region of tail.
- Hood is with transverse stripes.
- b) ***Coral snake:*** If the third supra labial touches the eye and the nasal sheild and anal sheild is clefted it is a coral snake.
- Hood is absent.

- There are coloured coral spots on the belly.
  e.g. *Callophis, Hemibungarus,Micrurus fulvius.*
- **Kraits :** If there are 4 infra labials and the 4^{lh} is the largest, then it can be a krait.
- In Krait middorsal scales called vertebrals are large and hexagonal in shape.
- Sub caudals are in a single row. The poison of kraits is more venomous than that of cobra.
- **i. *Bungarus coeruleus*** is the common krait.
- Dorsal surface is bluish or brownish black with narrow white cross streaks.
- **ii. *Bungarus fasciatus*,** is the banded krait marked with alternate broad, black yellowish rings.

Non Poisonous Snakes

- Non poisonous snakes are identified by an elliptical hood or without a hood and small abdominal scales, uniform teeth and no poisonous gland.
- ***Typhlops****:* It is a small burrowing snake.
- It looks like an earth worm, hence it is called Worm snake.
- Eyes are vestigial and hidden beneath the scales, giving the name blind snake.
- ***Ptyas (Zamenis):*** Common Indian rat snake.
- It enters human dwellings in search of rats. It helps the farmer from rat menace.
- ***Tropidonotus:*** It is a fresh water snake and is commonly called pond or grass snake.
- ***Dryophis:*** It is whip snake, with a prehesile tail. It is viviparous.
- The saliva is weakly poisonous.
- ***Python:*** The largest nonpoisonous snake.
- The south east Asian snake, *Python reticulatus* is the largest species and grows over 10 metres.
- A close second is the Anaconda of S.America that grows to 8 mts.
- **Eryx:***Eryx* is commonly called double headed snake
- Rudiments of hind limbs are seen as conical prominences.