بســـم الله الرحمـــن الرحيـــم

FACULTY OF EDUCATION HURGHADA

4TH MAJOR ZOOLOGICAL &BIOLOGICAL

ZOOLOGY (8) 2023

رؤية الكلية

- تسعي الكلية الي مساعدة الجامعة في تحقيق أهدافها الاستراتيجية من خلال أن تكون واحدة من الكليات المتميزة و المنافسة داخليا و خارجيا في التعليم و خدمة المجتمع و البحث العلمي من خلال تحقيق مستوي رفيع من الأداء و تقديم خريج متميز يقابل الاحتياجات المتعددة لسوق العمل المحلي و الخارجي.

رسالة الكلية

- تهدف كلية التربية بالغردقة الي التميز من خلال :
- اعداد المربين و المعلمين المتخصصين و القادة في مختلف التخصصات التربوية.
- تنمية القدرات المهنية و العلمية للعاملين في ميدان التربية و التعليم بتعريفهم بالاتجاهات التربوية الحديثة.
- اجراء البحوث و الدراسات في التخصصات التربوية المختلفة بالكلية.
- نشرالفكر التربوي الحديث و اسهاماته لحل مشكلات البيئة و المجتمع.
- تبادل الخبرات و المعلومات مع الهيئات و المؤسسات التعليمية و الثقافية.
- تنمية جوانب شخصية الطلاب و رعاية الموهوبين و المبدعين.

Introduction to Comparative Anatomy

Comparative anatomy : is a branch of Zoology deals with studying the relationship of structure , origin and functions of all organs in systems of all forms in the animal kingdom (all forms of vertebral animal) and compare between them .

Animals fall into two categories:

Invertebrates- without vertebral column

Vertebrates – with vertebral column

- **Protochordates – small marine animals that are transitional between invertebrates and vertebrates.**
- **They have no vertebral column but share 3 morphological features as that of vertebrates (notochord ; dorsal hollow CNS; pharynx with paired pouches and cleft in embryo stage.)**
- **These are animals that have a notochord in the embryo stage:**
- **Subphylum Urochordata – notochord is confined to the tail .Subphylum Cephalochordata – notochord extends the length of the body.**
- **Subphylum Vertebrata (Craniata).**

EVIDENCE FOR EVOLUTION

1- Fossils

2-Comparative anatomy (homologous, vestigial and analogous)

3- Similar embryo development

4- Geographical distribution

EVIDENCE FOR EVOLUTION
COMPARATIVE ANATOMY

By comparing the anatomy of different animals much can be learned about their evolution.

HOMOLOGOUS STRUCTURES

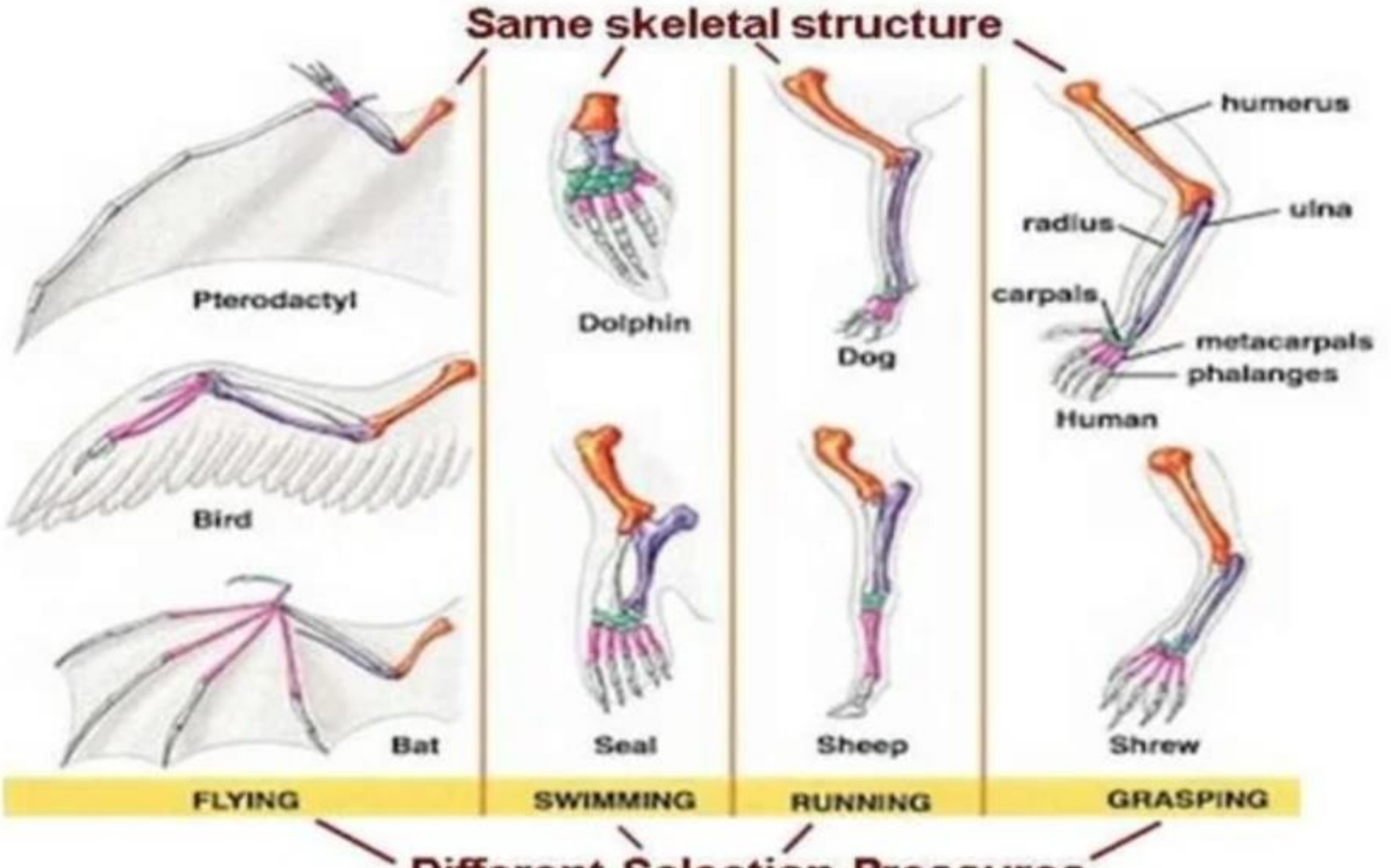
Bones in the forelimb of the human, whale, cat, bat, bird, alligator are used for vastly different movement, they all have remarkably similar structure and organization (bones, nerves, blood vessels)

This indicated common ancestry (DNA)

Organs with similar structures but different functions are called

HOMOLOGOUS STRUCTURES

COMPARATIVE ANATOMY:
Homologous Structures



COMPARATIVE ANATOMY
Vestigial Structures

- Many animals have structures in their bodies which seem to be of no use to them, these parts are called **Vestigial Structures.**
- In other species the same structures exist and they have a definite function.

COMPARATIVE ANATOMY
Vestigial Structures

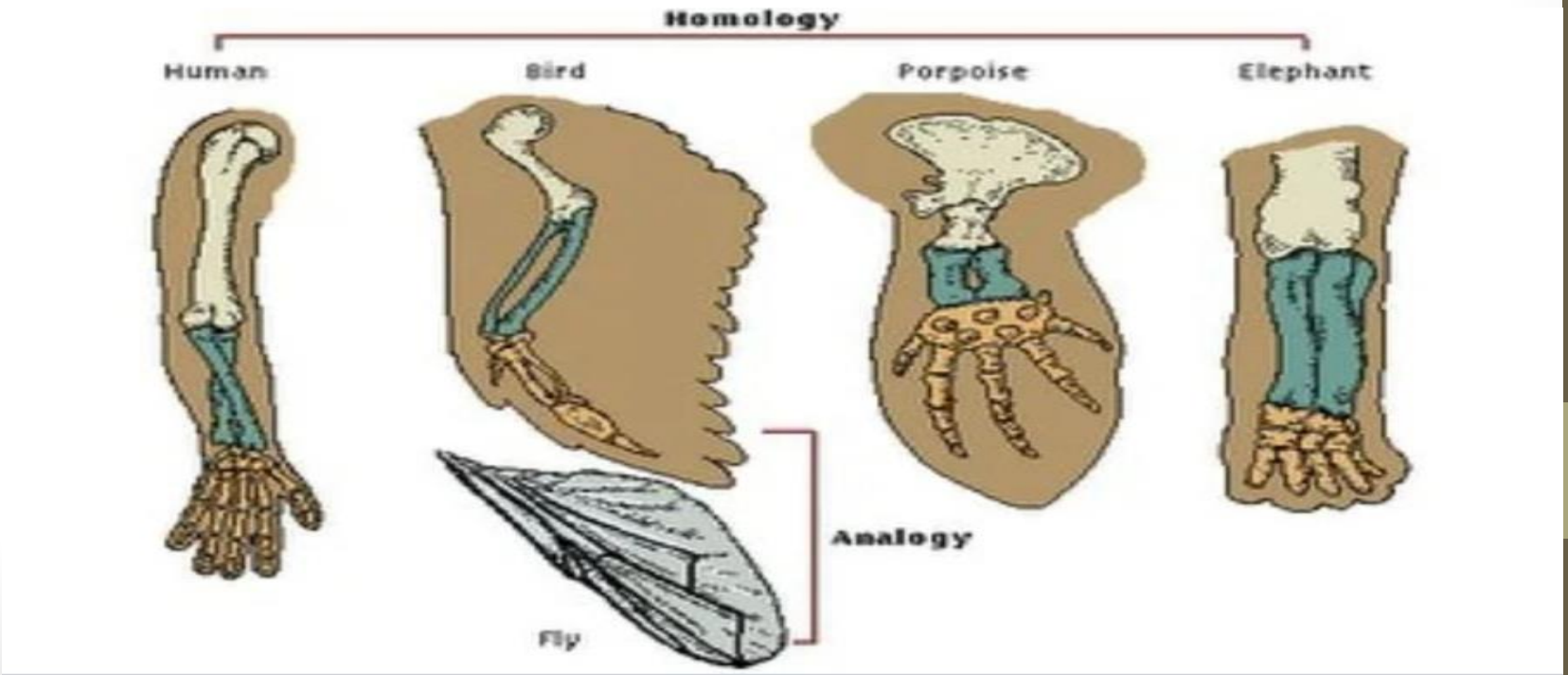
- Dogs & humans have a similar set of muscles attached to their ears, the dog can use these to “point” its ears in the direction of a sound, humans cannot.
- In humans the appendix, coccyx and hair are all vestigial structures.

The wings on flightless Birds

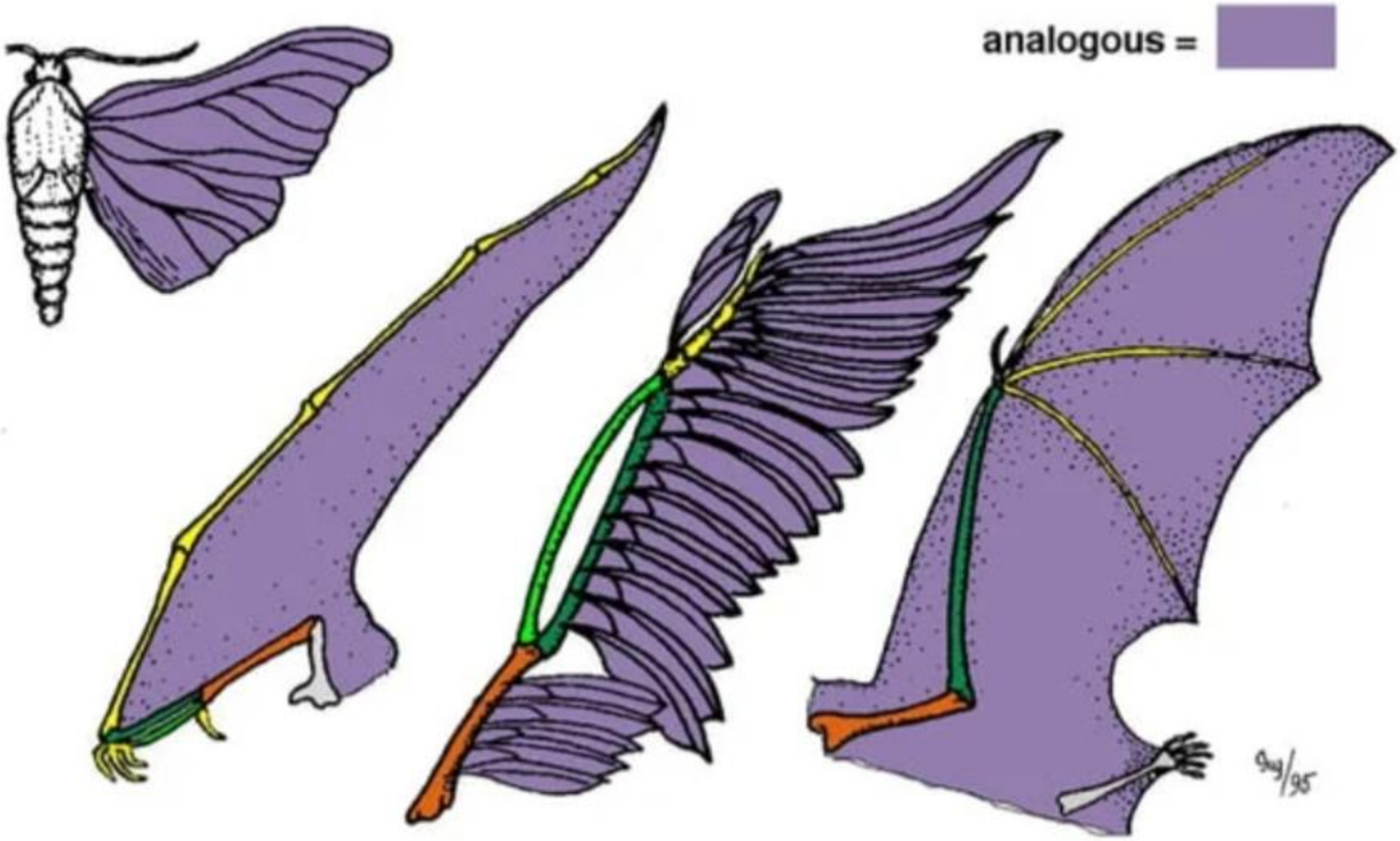
In general, wings of a bird are considered complex structures that are specifically adapted for flight and those belonging to flightless birds are no different. They are , anatomically, rudimentary wings, but they could never give these bulky birds flight. The wings are not completely useless, as they are used for balance during running and in flagging down the honeys during courtship displays.

COMPARATIVE ANATOMY
Analogous Structures

- Features of different species that are similar in function but are structurally different .
- Do not have a common ancestry.
- Evolved due to a similar environmental challenge.
- Ex) Birds & insects have wings to fly although their wing structure is different.
- Ex) fat insulated, streamlined shapes of seals & penguins.



COMPARATIVE ANATOMY:
Analogous Structures



Integumentary and Exoskeletal Systems

The outer most protective covering of the animal body

The dermal system consists of the skin and its derivatives

The skin derivatives such as : Scales, feathers, claws, nails, beaks , hair, horns, hoofs

- The skin glands such as : mucous glands-sweat glands-mammary glands –poisonous glands
- The integument covered all the surface of the body
- **The skin has many important functions :**

1-**Protection** : separation the animal from its external environment and protection from around objects

2-**Respiration** : some animal use the skin in respiration process such toad

3-**Regulation** : regulate the osmotic pressure of organisms that live in marine water

4-**Locomotion**: fin rays ,claws, feathers all these structures help in the movement

The glands : are developed from epidermis and sinked into the dermis (formed by Malpighian layer)

There are two types of glands :-

A-Simple **unicellular glands** : where one cell of the cells of the mucous stratum becomes specialized and secretory in function such as ,mucous and goblet cell

B-Compound (**multicellular**) glands :-where the cells of stratum germinativum invaginate into the dermis and form saccular structure which opens on the surface of the skin through the neck of the gland

- **Tubular type** : such as sweat and mammary glands
- **Alveolar type** : such as sebaceous gland and poisonous glands, poisonous gland found at the base of the pectoral spines or on the dorsal spines of teleost.
- **Mucous gland** : secrets mucous which form sticky mucous layer in the surface and it keep the skin moist and protects against harmful bacteria such in amphibian skin ,they may be unicellular or multicellular
- **Poisonous gland** : they secret poison to protect the animal against predators and they are modified multicellular cutaneous glands such as fishes and amphibians

Exoskeleton derivatives

1. Epidermal exoskeleton

Is produced as a result of the activity of the Malpighian layer.it consists of flat horny cells which condense together forming a hard layer (keratin layer) Such as :

1-horny teeth of cyclostomes 2-horny scales of reptiles

3-feathers of birds 4-hairs of mammals

5-claws of some amphibians , reptiles ,birds and some mammals. 6-nails of human 7-horns of mammals

.

2-Dermal exoskeleton

It is produced by the mesenchymal cells which originate from the mesoderm such as :

1-bony scales of bony fishes

2- fin rays and fin spines of fishes

3- scales and scutes of tetrapods

the mesenchymal cells condense together and give dermal papilla

3-Epidermis and dermis

the derivatives from both epidermis and dermis

The epithelium germinative (Malpighian layer) from epidermis and mesenchymal cells from dermis give this exoskeleton such as :

1-placoid scales of cartilaginous fishes

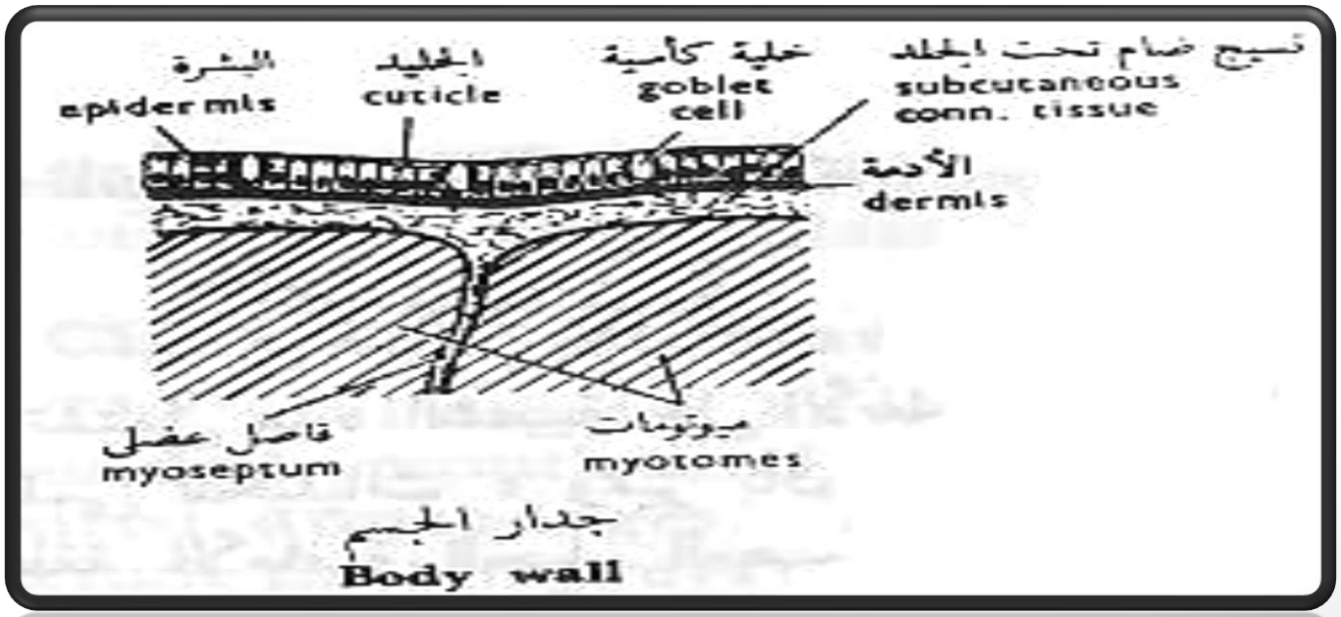
2- true teeth of mammals

3-ganoid scales of ganoid fishes

The dermal system of Amphioxus

The skin consists of two layers (epidermis and dermis)

1-Epidermis :is a single layer of columnar epithelium cells –there are glandular unicellular cells called goblet cells secret the mucous substance protect the body surface, it covered by a cuticle secreted by Columnar cells .



2- dermis :is a very thin layer below the epidermis and it is mesodermal in origin and consists of

1-connective tissue 2-blood vessels 3-nerve endings

Below the dermis there is a compact layer with few fibers called subcutaneous layer that surrounded the muscles of the body wall (myotomes) and continued with myosepta which found among

myotomes

- The skin is not pigmented
- There is no exoskeletal derivatives

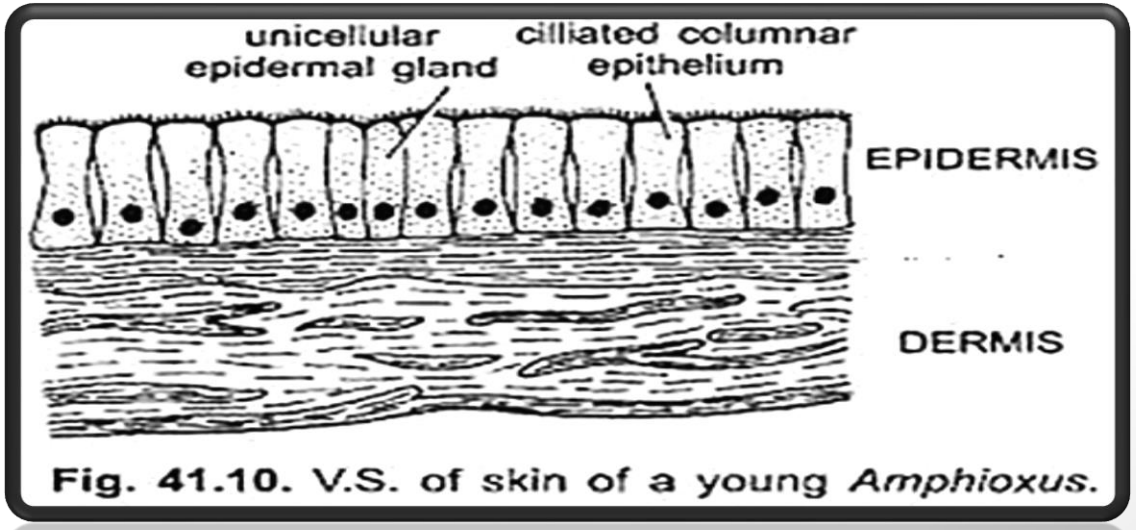
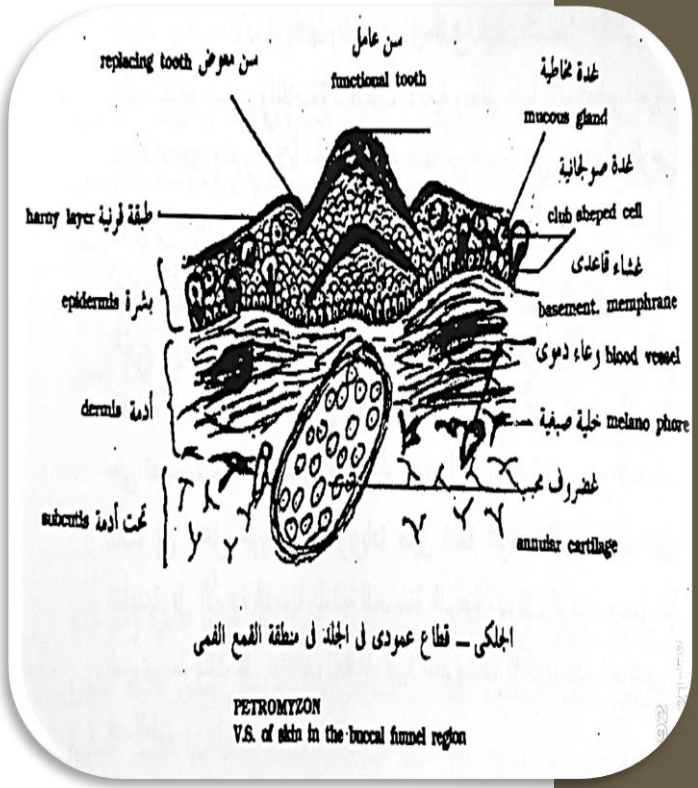


Fig. 41.10. V.S. of skin of a young *Amphioxus*.

The dermal system of *Petromyzon* (cyclostomata)

The skin composed of two layers :

1- **Epidermis**: is stratified epithelium ,consists of an active layer (stratum germinative)and polygonal cells above covered with cuticle, numerous mucous secretory (large in size , mono nucleated and containing several granules) and sensory cells (binucleated or club shaped cells) are distributed in the epidermis.



2-**Dermis** : is much thickness ,and consists of

1- fibrous connective tissue 2- blood capillaries 3-nerve endings

- Pigment cells are present in both epidermis and dermis just below the epidermal layer .

The skin is smooth ,there is no skeletal derivatives ,except the horny teeth in buccal cavity

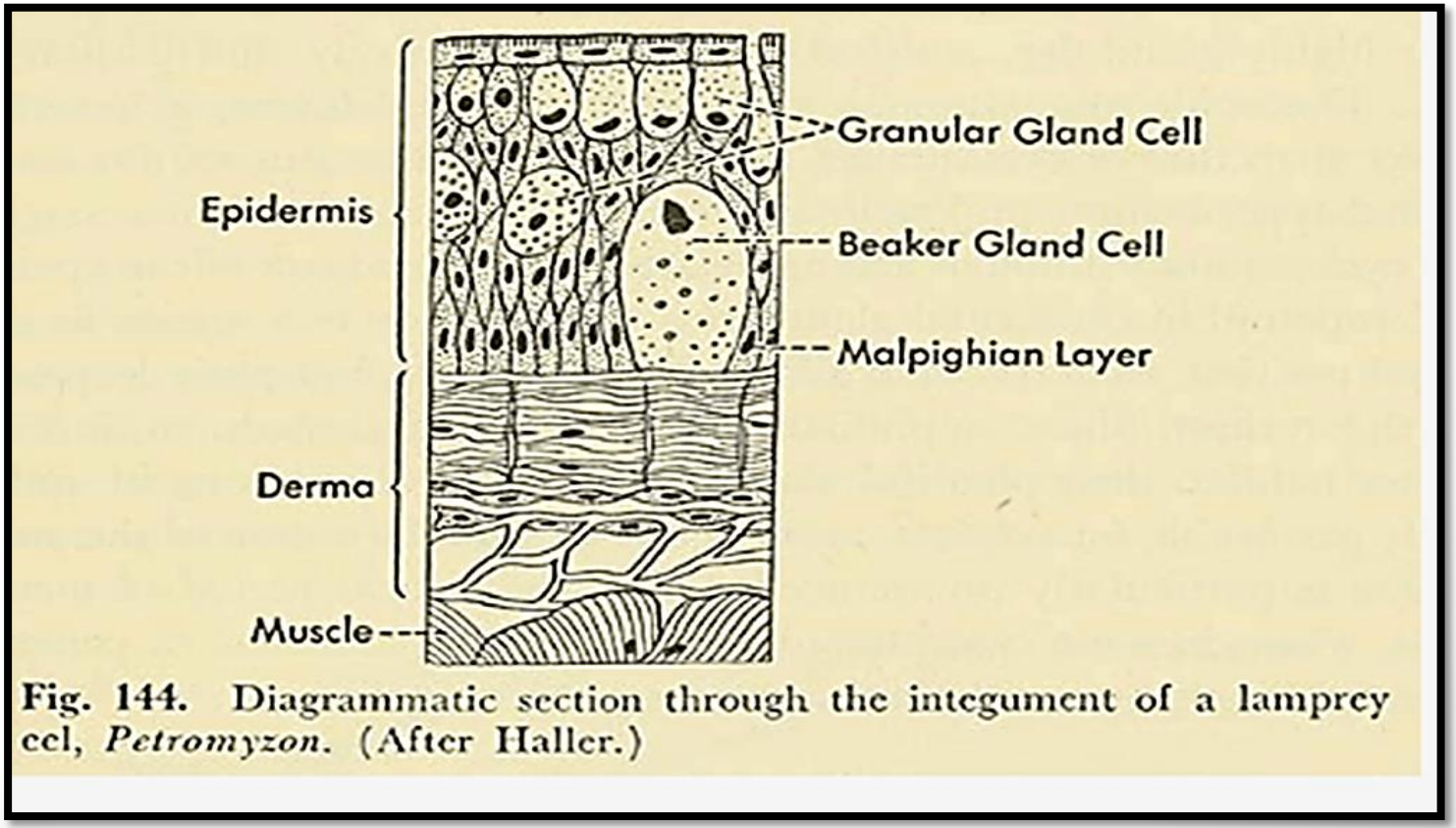


Fig. 144. Diagrammatic section through the integument of a lamprey eel, *Petromyzon*. (After Haller.)

The dermal system of cartilaginous fishes.

The skin is composed of two layers:

1-**Epidermis** : is soft (not cornified) relatively thin and also stratified and covered by cuticle .

- There are unicellular and multicellular mucous glands
- Stratified epithelium consisting of abased layer called stratum germinative and several layer of polygonal cells covered by cuticle

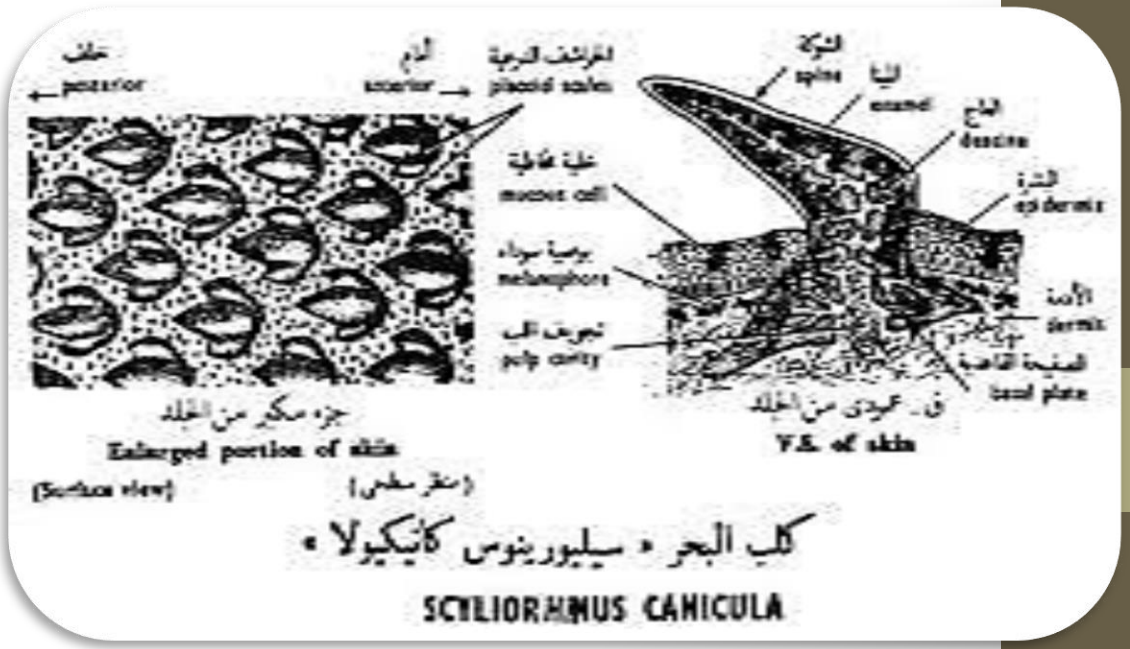
2-**Dermis** : consists of loose outer layer which have chromatophores cells with melanocytes granules ,

Giving the fishes black ,red and yellow colors, and a deeper more compact layer which composed of connective tissue with compact fiber cells ,blood vessels ,nerve endings ,pigment cells and below the dermis the myotomes are present .

The skin

Is characterized by the presence of exoskeletal derivatives such as the placoid scales which they are epidermal and dermal derivatives of the skin .placoid teeth and cartilage fin rays (ceratotrichia)

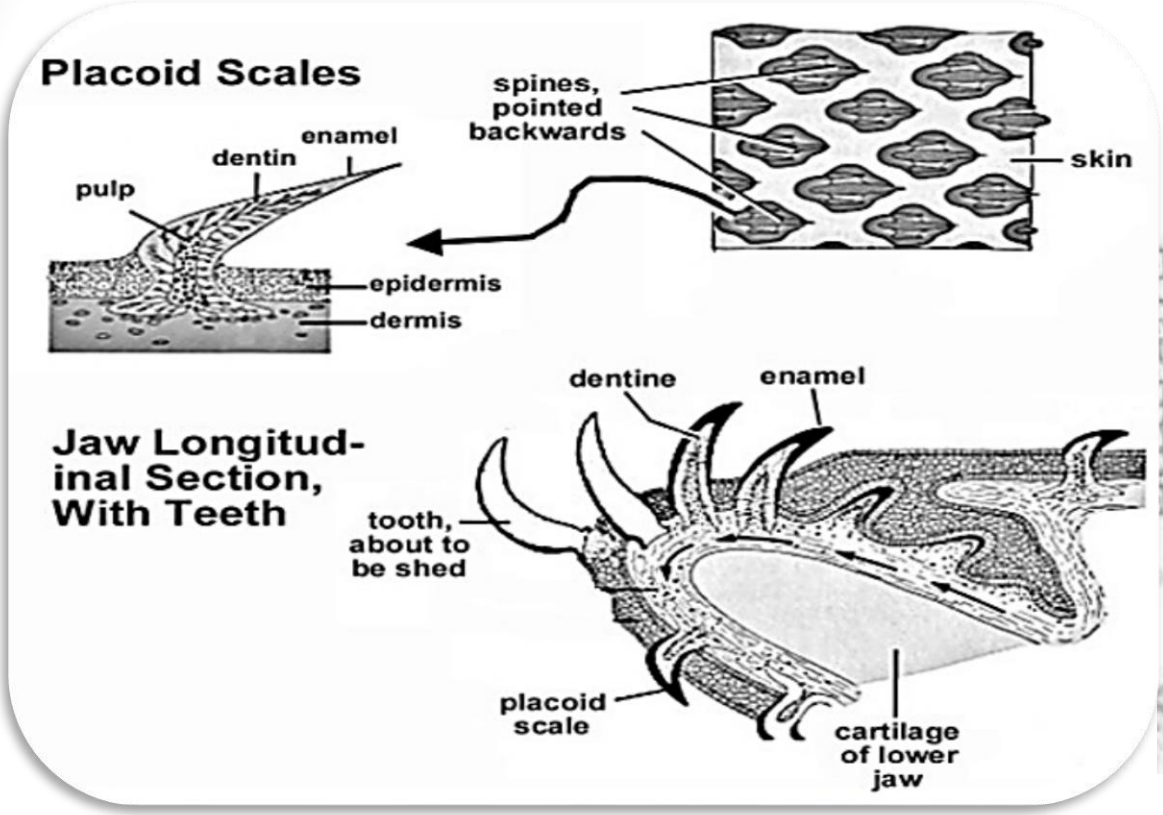
The structure of placoid scales

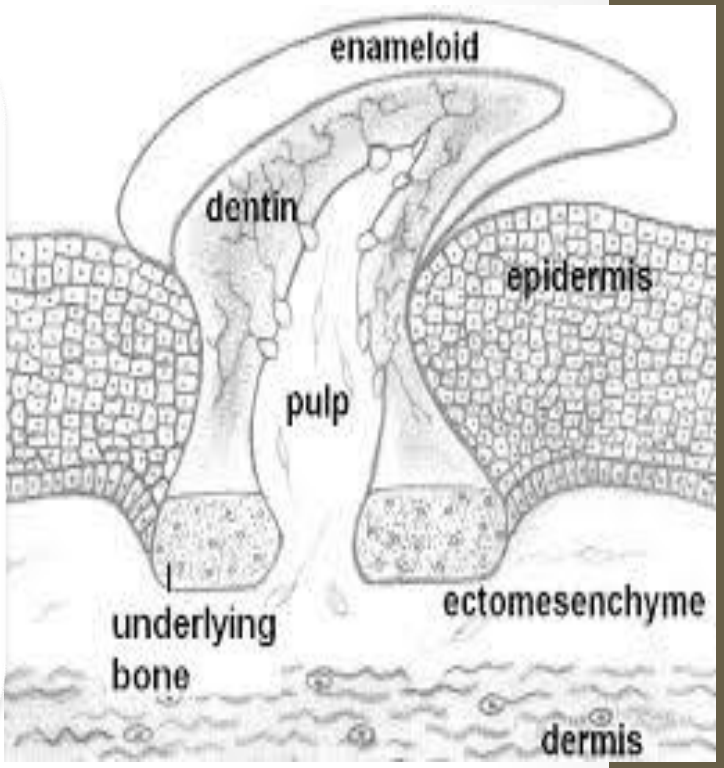


Consists of 1-basal plate inserted in the dermis

2- Spines projected outward through the epidermis

- A- basel plate or disc has two lobes and consists of hard dentine substance
- B- the spine composed of an inner dentine substance covered by a thin layer of more hard dentine called vitro dentine (enamel)
- In the center of the scale ,there is apulp cavity with presence of blood vessels and nerve endings
- **The placoid scales grow to certain size ,then shed away and new scales replace the old ones.**
- **In the elasmobranchii, these palcoid scales are very small .**


Placoid Scales
spines, pointed backwards
skin
enamel
dentin
pulp
epidermis
dermis
Jaw Longitud-inal Section, With Teeth
dentine
enamel
tooth, about to be shed
placoid scale
cartilage of lower jaw


enameloid
dentin
epidermis
pulp
ectomesenchyme
underlying bone
dermis

The development of placoid scale of dog fish

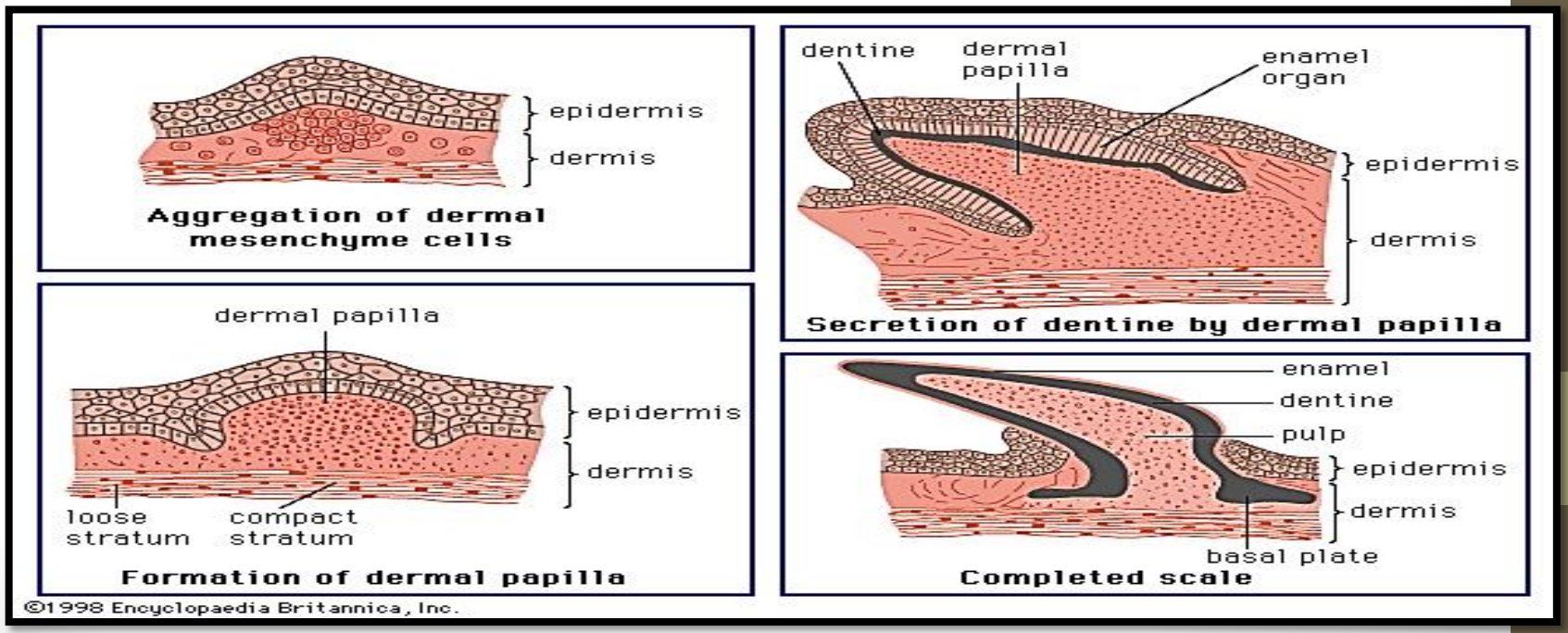
1- The cells of the stratum germantive of epidermis at some places become active ,at the same time mesenchymall cells of the dermis accumulate at these activated areas forming the dermal papilla

2- the cells of stratum germantive of epidermis as well as the dermis in these areas envaginate to form conical projections ,the mesenchymal cells of mesoderm arranged themselves to form irregular layer underneath

The cells or stratum germantive are paralle to them

3- the active cells of str.germ in contact with the dermal papilla differentiated into tall columnar cells forming the enamel or enameloblasts (epidermal cells)

4- at the same time the outer mesenchymal cells of the dermal papilla secreted another hard material on their outer border .this material called dentine and the dermal cells which secret it are known as odontoblasts



the remaining part of the papilla constitutes the nutritive part in the pulp of the placoid scale

5- by secretion of more dentine from the dermal papilla .the scale increase gradually in size and pushes it self in the epidermis and the spine becomes exposed externally and points posteriorly

6-At the same time , more dentine is secreted at the base of scale forming the basal plate which embedded in the dermis and enclosed the rest of the dermal papilla leaving a passage for blood vessels called the pulp cavity.

The dermal system of bony fishes

The skin of bony fishes composed of two layers

1- **Epidermis** :-composed of stratified basal layer called stratum germintive or Malpighian layer and several layers of flattened cells and covered by cuticle

2- **Dermis** : much thickness and composed of :

1- connective tissue A- loose conn. tissue in outer B- Deeper compact conn.tissue

2- blood vessels and lymph spaces

3- pigment cells of chromatophores are distributed in the epidermis and dermis

Derivatives

1- Hard bony scales which embedded in pouches in the dermis

2-bony fin rays

3- Glands :there are many glands which unicellular and multicellular

Development of bony scales in bony fishes

1-the bony scales begin to develop by an accumulation of special cells called mesenchymal cells in the dermis and found in the place of developed the bony scale ,these mesenchymal cells give the scleroblasts

2- these cells arranged as a pouch or small sac called dermal papilla

3-the active scleroblasts of dermal papilla secret a thin sheet of bone material at its inside site form the rudiment of bony scale

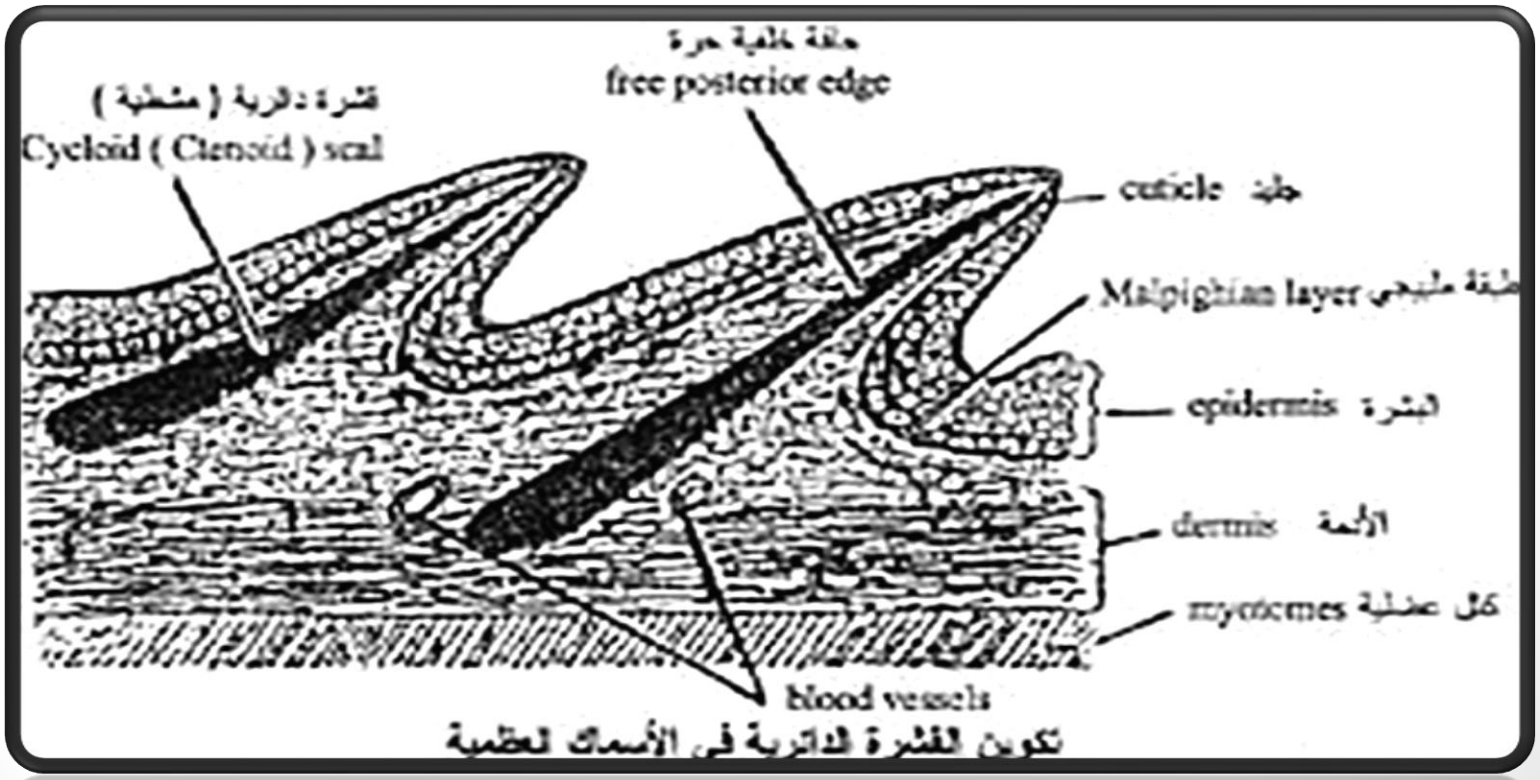
4- the connective tissue strands from the dermis separate the flattened bony scales from each other

5- by secretion more and more bony material .the scale increase in thickness and dimension

6- gradually the anterior end of each scale become deeper in

The dermis ,while the posterior end grows towards the surface and pushing epidermis above ,so the epidermis become very thin (by arrangement the scales becomes overlapping on each other)

7- the epidermis either remains a thin membrane covering the overlapping posterior edges of the scales exposed outside .



Types of bony scales of bony fishes

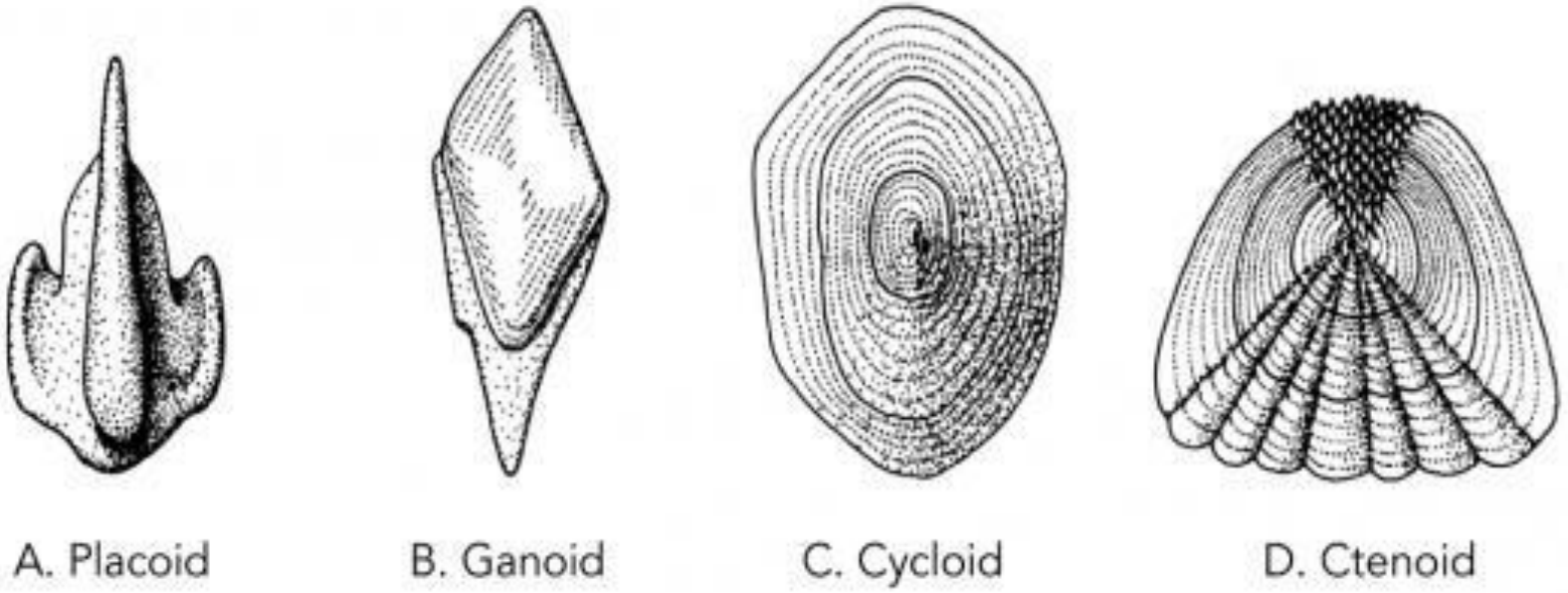
2-**Ganoid scales** :-are rhomboid scales ,thick ,enclosed, fitted side by side, in some cases they may overlap

Composed of three layers :outer enamel like ganine ,middle dentine-like cosmine and inner bony isopedine ex: ganoid fishes such as polypterus

3- **cycloid scales** :They are thin and flexible overlapping single plates thicker in the center and marked with several lines of growth which can be used for determining the age of the fish

They are composed of a thin upper layer of bone and lower layer of fibrous connective tissue .they are overlap each other .each scale embedded in a small packet of dermis ,the are found in lung fish

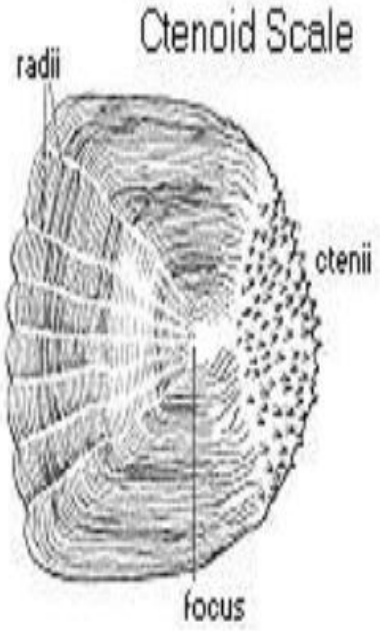
4-ctenoid scales : characteristic of modern higher teleostei ,they are similar to cycloid scales in structure ,they exposed free hind parts bear numerous small teeth or spine



Scale Types of Bony Fishes

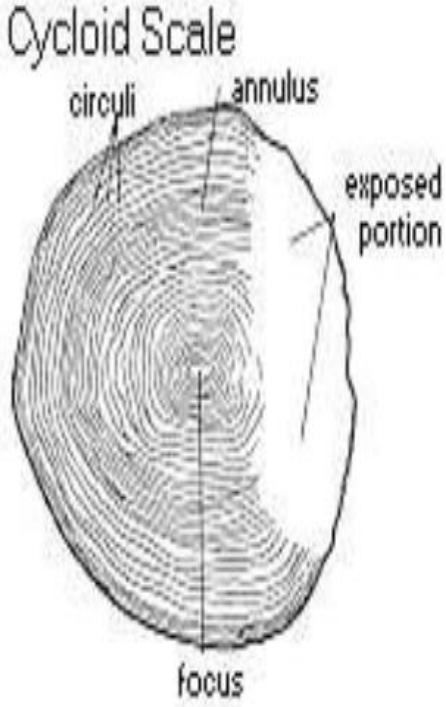
• Ctenoid
– thin, flexible, and overlapping
– posterior edge has combl-like teeth
– believed to reduce drag during swimming

• Scaleless Fish
– some fishes sacrifice the protection of scales, presumably for added flexibility
– some catfishes, sculpin, eels



Scale Types of Bony Fishes

• Cycloid
– thin, flexible, and overlapping
– grow as fish grows
– in some species scales show growth rings, with spring and summer rings well-separated, little growth in winter
– can use rings to determine age, growth rate

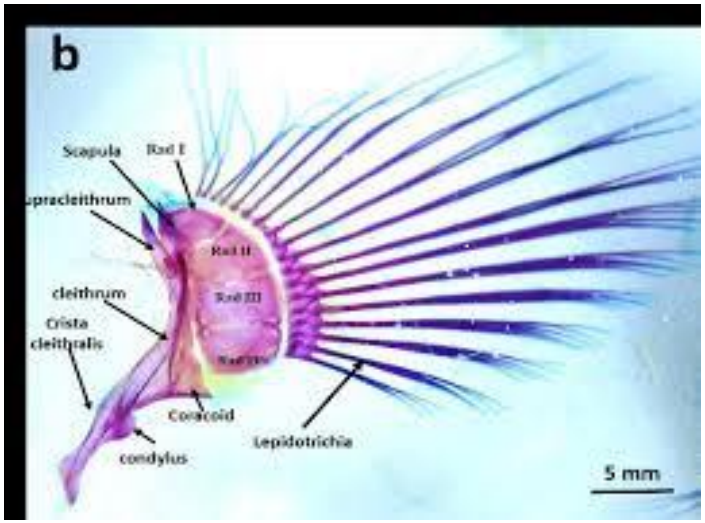


Lepidotrichia of bony fishes

These fin rays are also dermal in origin and supported the outer part of fin and composed of bony material

The lepidotrichia are long branched fin rays ,the development of these fin rays are similar to that of bony scales ,each ray consists of a series of modified scales joined end to end .

Some of bony fin rays fuse together to form hard spine



{The dermal system of Amphibians}

The skin of amphibian composed of two layers

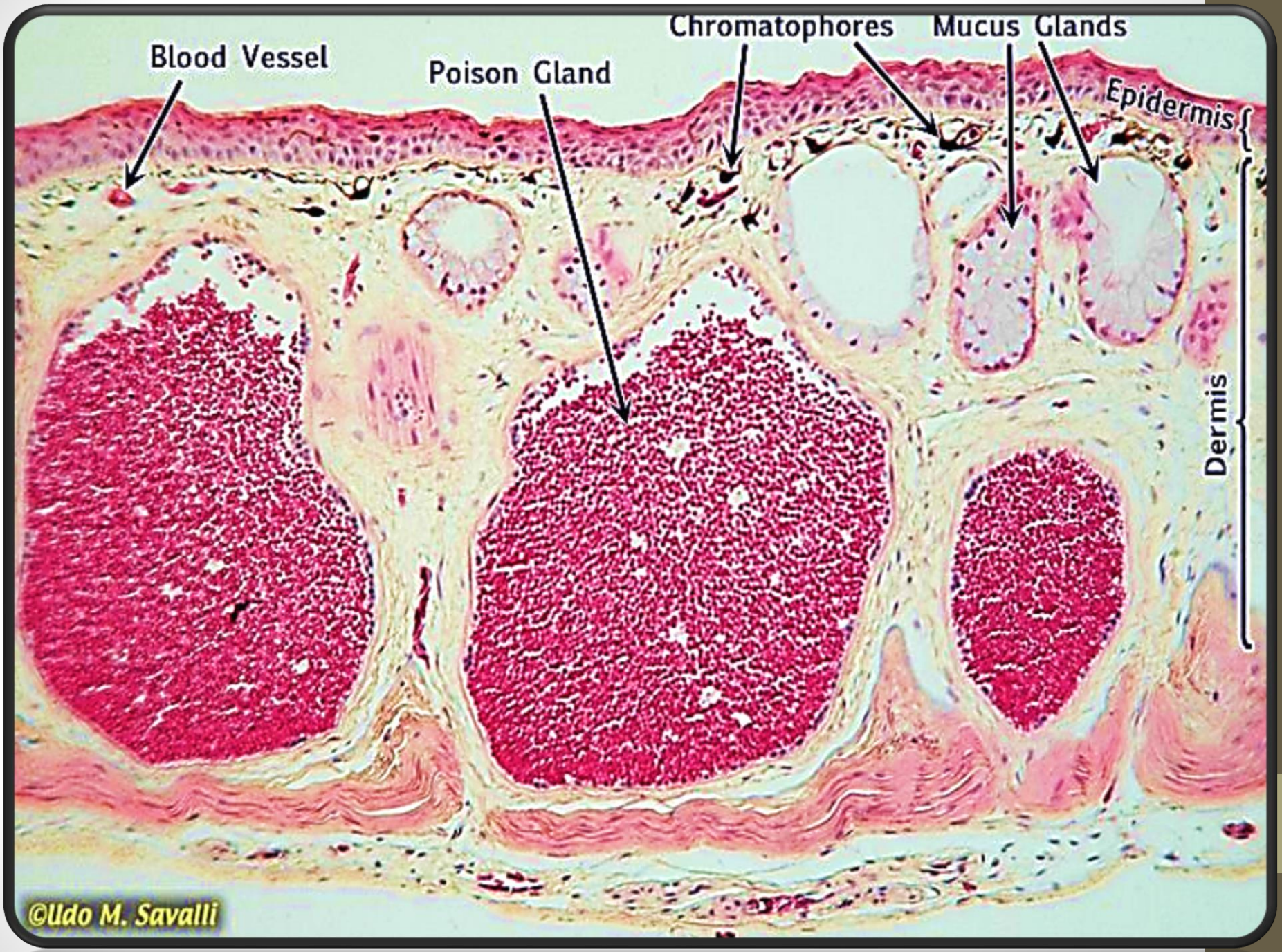
1- The Epidermis which consists of,,,,

- **Stratified squamous epithelium ,that consists of basal layer it called stratum germinative or Malpighian layer)**
- **Horny layer that exist on the surface and it very thick in terrestrial forms, but thin in aquatic forms**

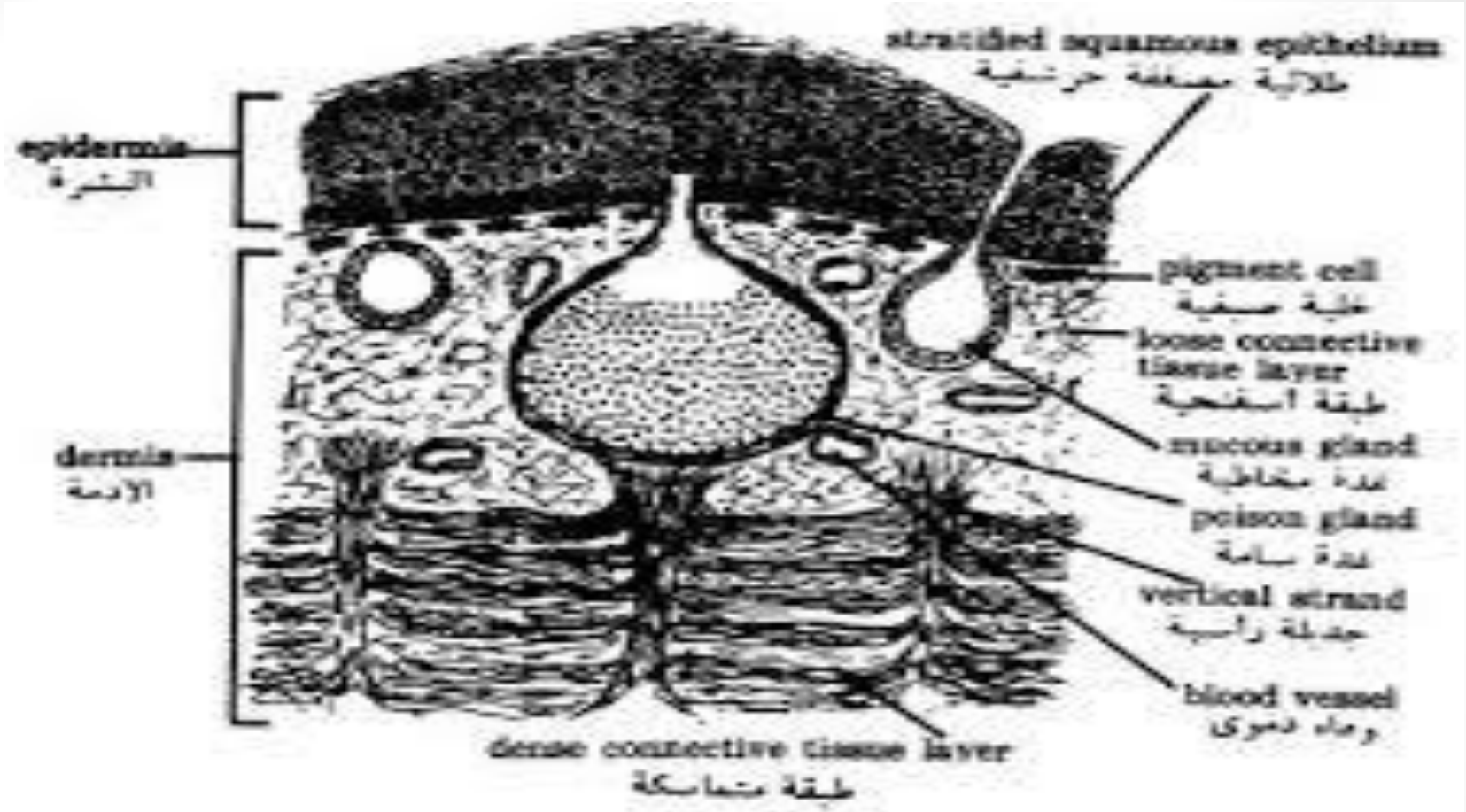
2-The Dermis which composed of two layers

a-the first layer (outer layer) is called spongy layer contain areolar conn. tissue, blood vessels ,nerve ending , melanophores (pigment cells)

b- the second layer (inner layer)is called compact layer contain fibrous conn. tissue


Blood Vessel
Poison Gland
Chromatophores
Mucus Glands
Epidermis
Dermis
©Udo M. Savalli

1. **Glands : amphibians contain multicellular glands ,there are two types of glands ,there are all arise from Malpighian layer**
2. **1- mucous glands : are small ,secret the mucous that moist the skin ,this mucous help in respiration process through the skin**
3. **2- poisonous gland : large in size , secret white substance with poisonous properties to kill the microorganisms and to make the toad defend it self against enemies**
4. **The skin of amphibian have no exoskeleton derivatives**



VERTICAL SECTION OF THE SKIN OF THE TOAD

قطاع راسى فى جلد الضفدعة

{ The dermal system of reptilian}

The skin of reptilians is dry due to absence of glands and it composed of two layers:

1-Epidermis : is very thin consisting of two to three layers ,the corneal layer of epidermis is thick

the outer corneal layer is periodically shed in lizard and snakes in the process of ecdysis.

2- dermis : composed of fibrous connective tissue ,melanocytes may be found in the epidermis or below it ,in the dermis

Derivatives

In all reptilians ,the skin is characterized by epidermal horny scales called cornuscutes صفائح اوحراشيف قرنية

Bony dermal plates (osteoscutes صفائح عظمية)found in turtles and crocodiles ,while a small ones may be found in some lizards and large snakes

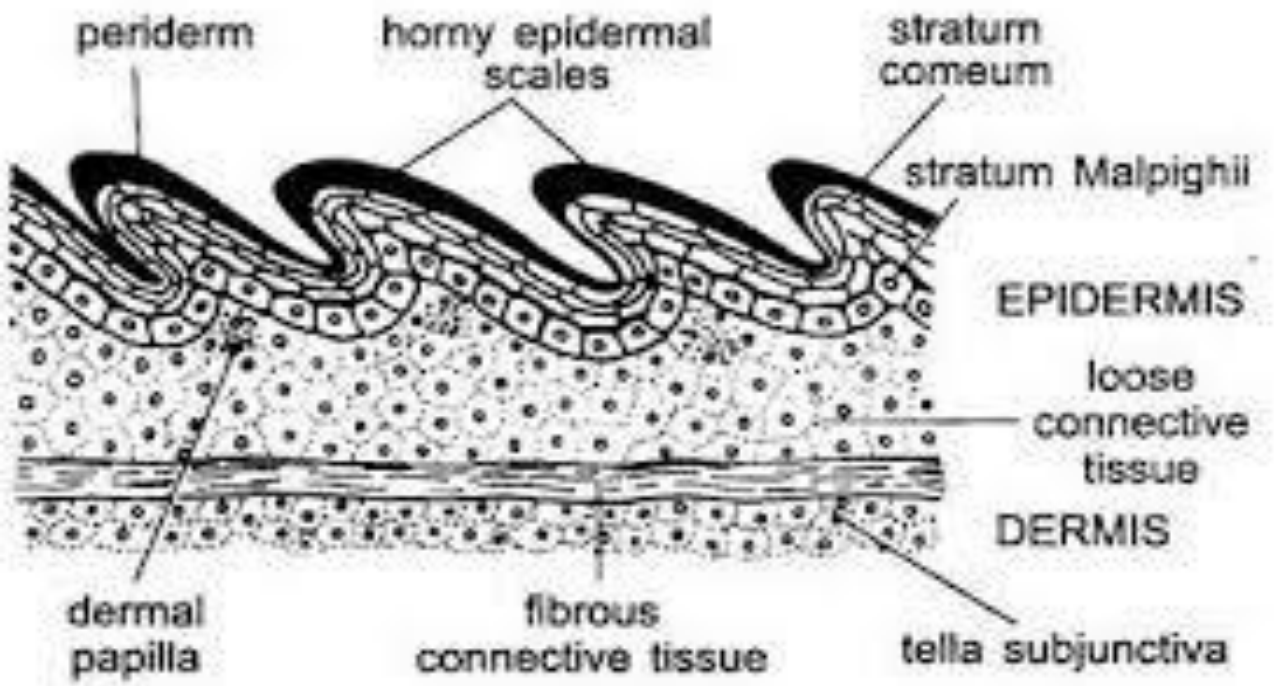
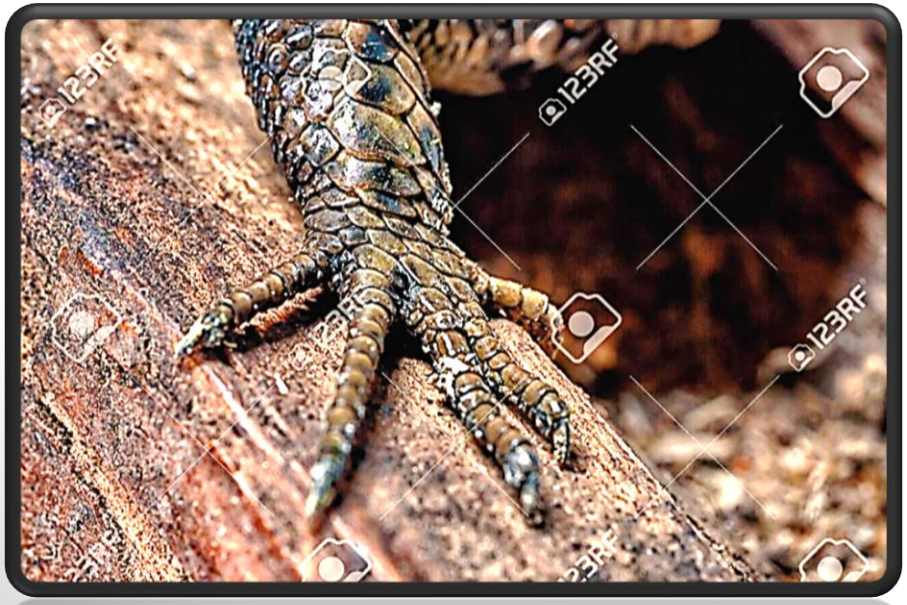


Fig. 41.17. V.S. of skin of lizard.

Claws of reptilian

Is pointed and covered the last joint of the toe ,and consists of dorsal convex horny plate called unguis او الصفيحة المخلبية الظفريةand ventral sub unguis .the junction between the two plates often forms sharp edge or angle .the region of skin following the claw at its ventral surface remain forming the pad

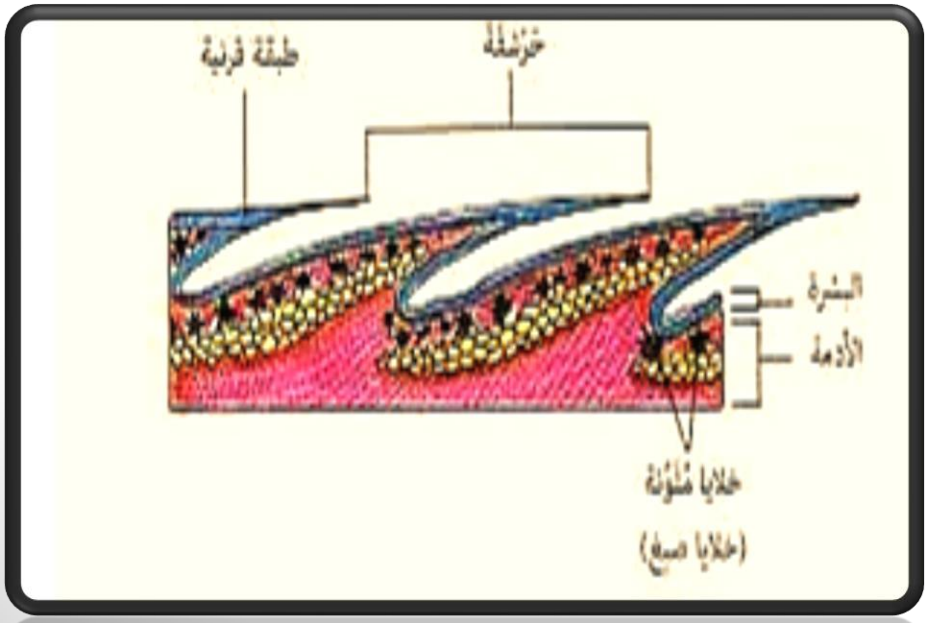


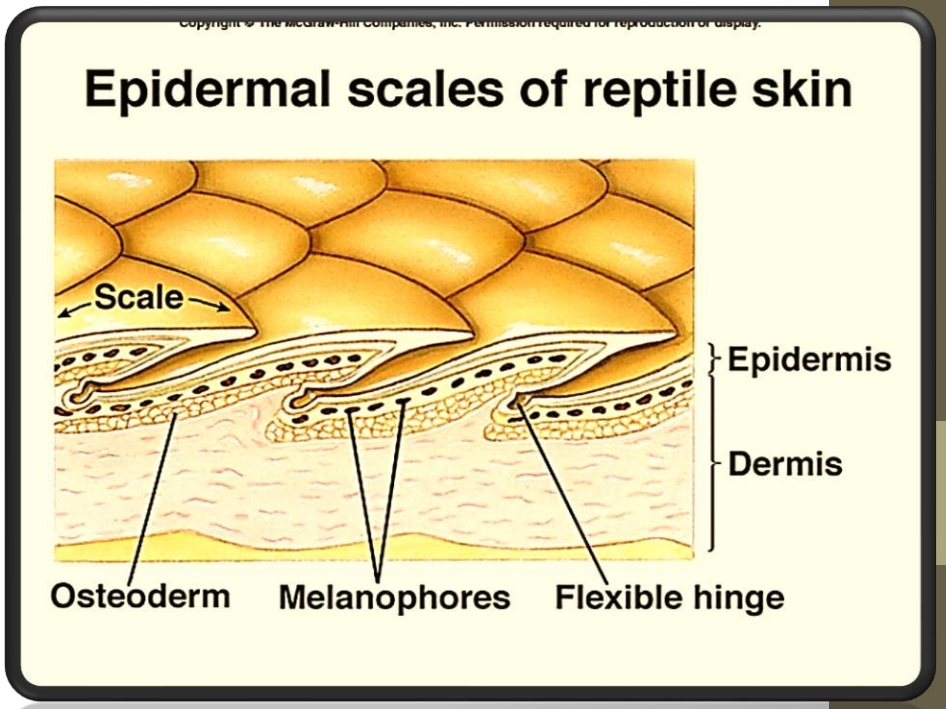
1- Derivatives

***Epidermal horny scales called "cornuscutes" coverd the body of all reptilians.**

*** Bony dermal plates "osteoscutes" found in turtles and crocodiles, while small ones may be found in some lizards and large snakes.**

*** Claws of reptilians**





The dermal bony shell دروعin turtles

Found in many reptilians and it is dermal in origin and found beneath the epidermal horny scales

Bony shell consists of an arched carapace above ,and flattened plastron below ,and they united together by lateral bridges

Structure of plastron carapace ,it composed of thin epidermal cornuscutes in the surface and bony plates osteoscutes inside (in the dermis)

The bony plates of carapace are fused with the vertebrae and ribs The osteoscutes or the bony plates originate from dermal cells called osteoblasts which secret the ostein (bony)material

Development of horny scales in reptilians :

1- accumulation of dermal special mesenchymal cell and forming the dermal papilla

2- the dermal papilla supplied with the blood vessels in the dermis ,so the dermal papilla supplied the stratum germinative with blood .

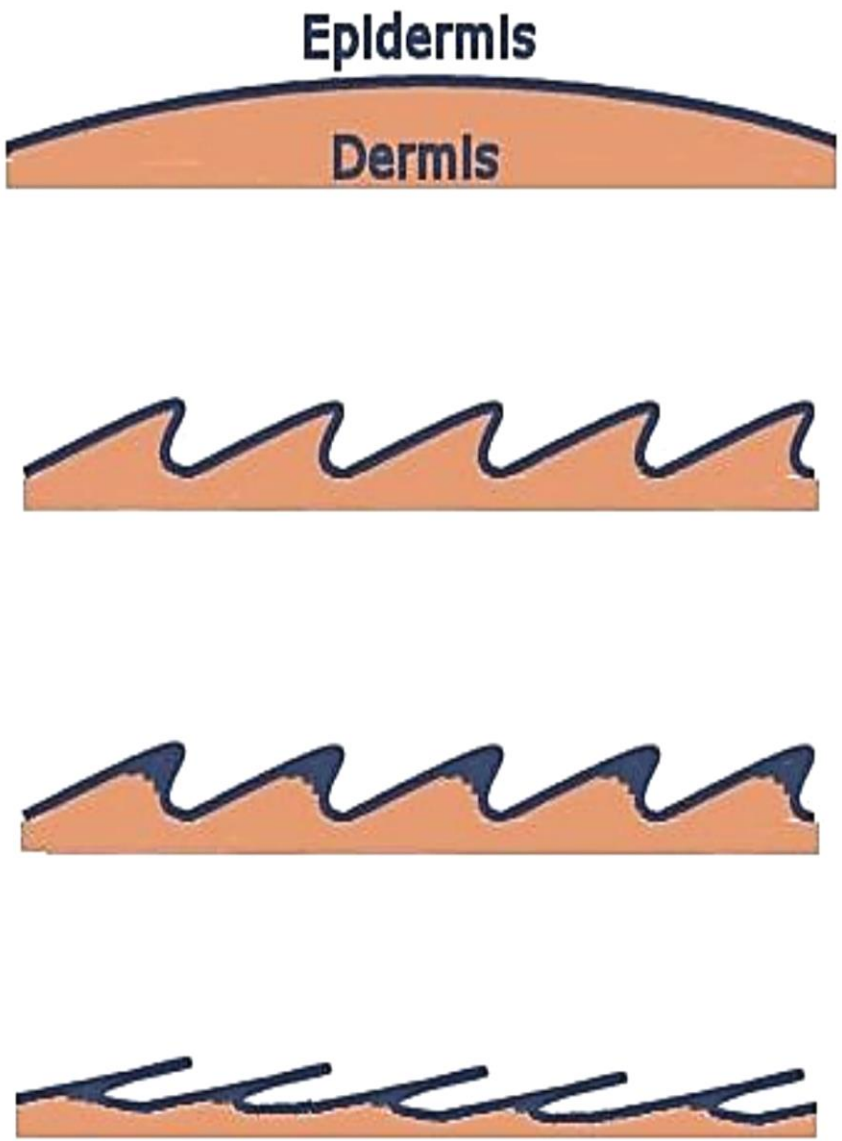
3- the cells of stratum germinative become active and divided to form large numbers of cells

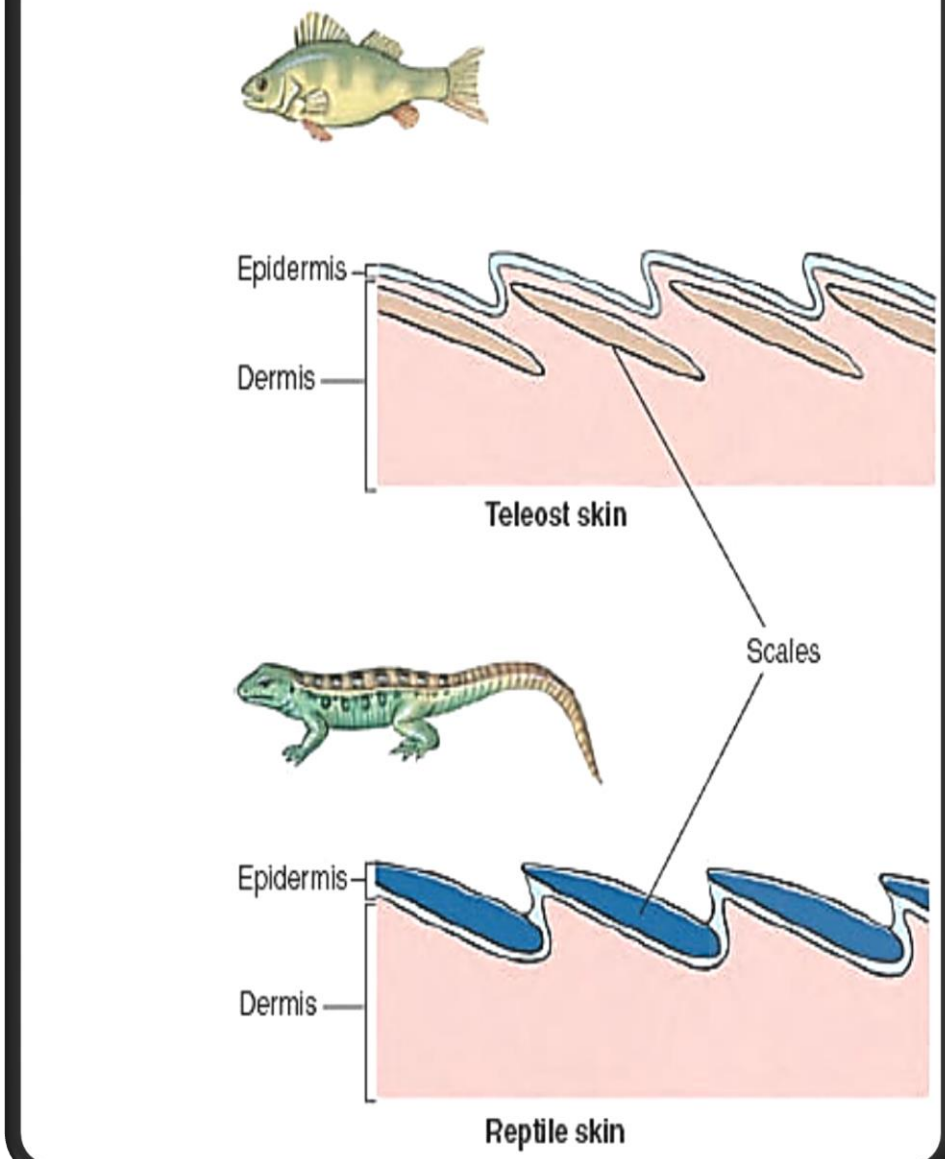
4- the cells of stratum germinative compressed and flatted and transformed into horny material by keratinization التحول القرنىand give arise to the horny scales

5-the pulp of horny scales is filled with conn. tissue ,blood vessels and nerve endings to nourishment this horny scales (the dermal papilla forming the horny scales)

6-thick horny scales are connecting together with a membrane called articulating membrane غشاء مفصلى(not cornified)that help in the movement of this horny scales

- **Horny scales of reptilians are considered as thickened areas of the stratum corneum طبقة قرنية**
- **There is not separated from each other like fishes but they are thickened parts of continous horny layer**


Epidermis
Dermis


Epidermis
Dermis
Teleost skin
Scales
Epidermis
Dermis
Reptile skin

The dermal system of birds

- The skin of birds is loose
- The epidermis is thin with heavy cornified layer
- The dermis formed of fibrous layer
- The melanocytes may absent or present in the longitudinal ridges that are found in the feather follicle
- The glands are absent except in the end of the tail, there are oily gland that secret oil to lubricate the feathers

The dermal system of birds

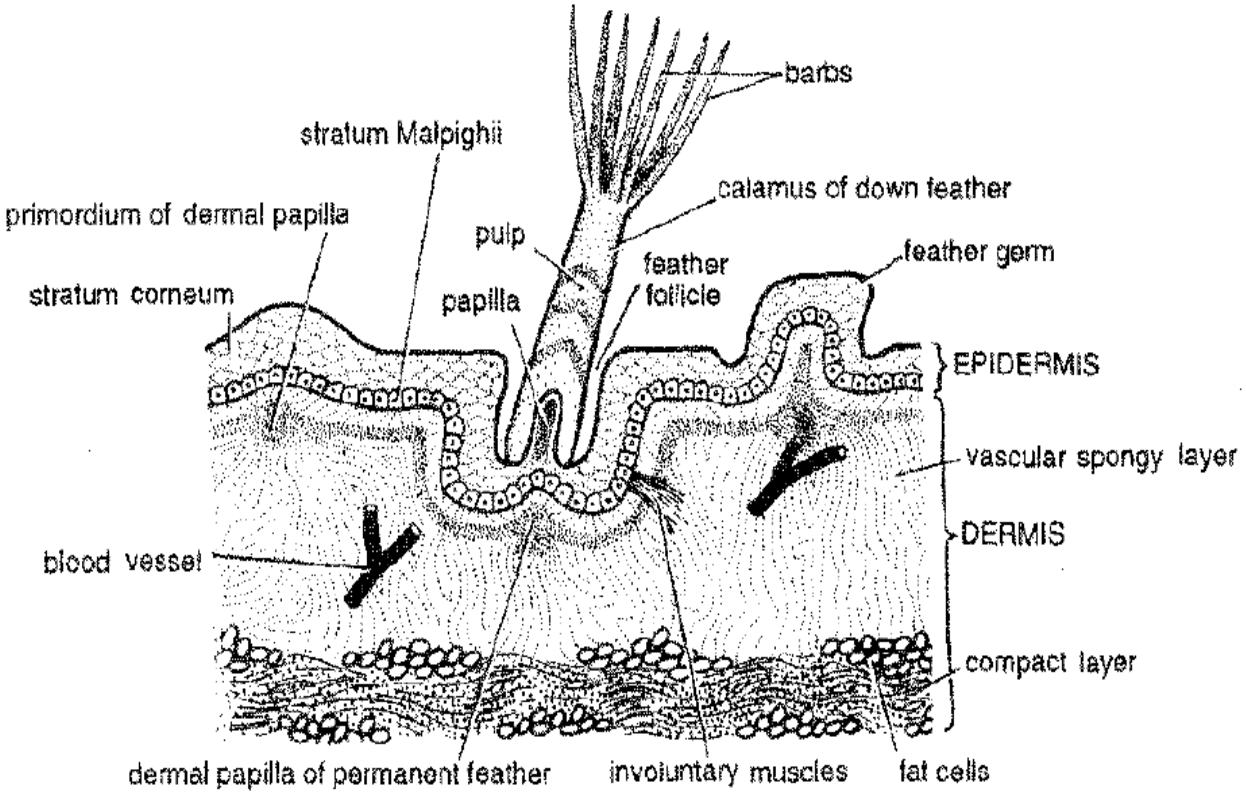


Fig. 4. Pigeon. V.S. of skin.

The Exoskeletal derivatives of the birds skin

- **Horny scales** covering the legs of birds
- **Claws** of fingers
- **Horny beaks** covering the maxilla and mandible

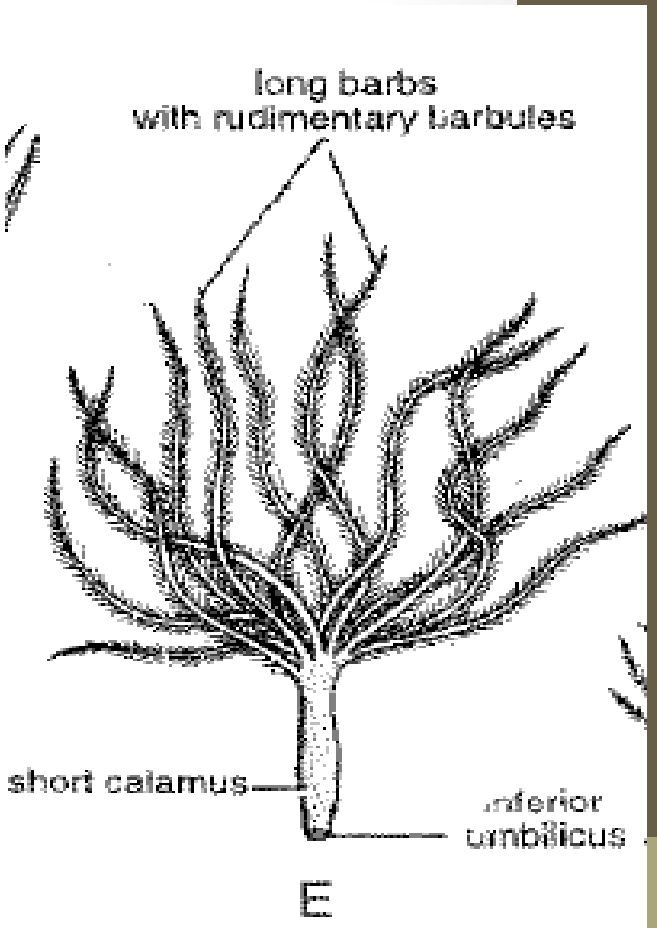
  * all derivatives are originating from the corneal epidermal layer by cornification process

Types of feather

1- Down feather

Covering the young birds and found in adults between the bases of contour feathers

- The down feather consists of a short , thick, hollow stem or quill embedded in the integument, and numerous soft rays or barbs arising in a circle from the top of the quill with minute barbules without hooklets



2- Hair feathers

- They found around the mouth and the face of birds and may be scattered in the surface of the body
- They are composed of along axis or haft that carrying terminal barbs at its end with minute barbules which have no hooklets

3- Contour feathers

- They are found in all parts of the body where they give the general outline or contour to the body

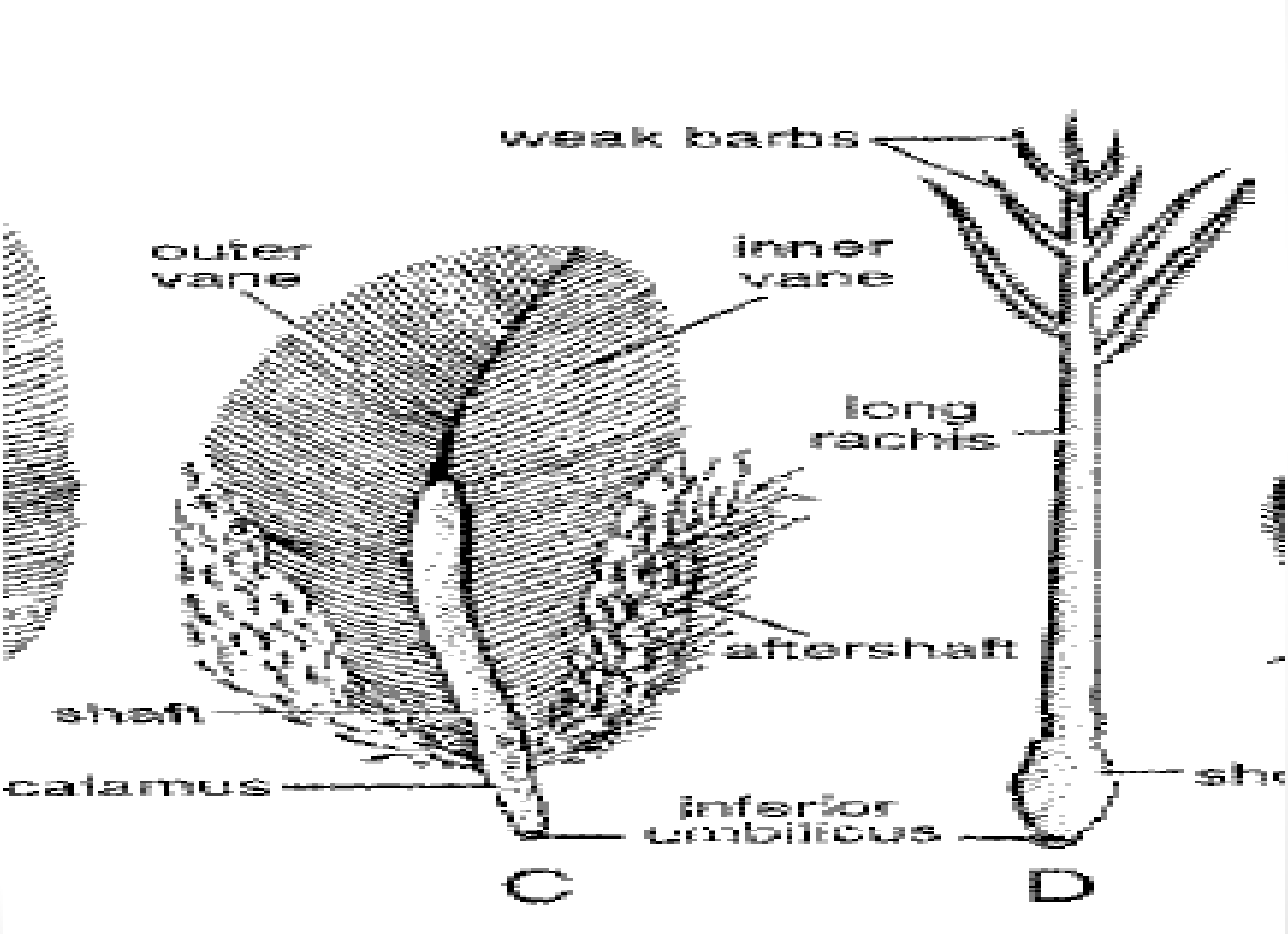
*they are composed of :

that its inner parts is a hallow is embedded in the skin and it has two opening :

a. Inferior umbilicus: that is found in proximal parts of the feather
b. Superior umbilicus: that found on the ventral side of the feather

: it has an umbilical groove and each side of shaft has a vane which it composed of many barbs with minute barbules that have hook lets

- Contour feather (C) and Hair feather (D)



4- quills feathers

These feather similar to the counter feathers but they are large and common type of wings and called flight feathers and of tail which called tail feathers

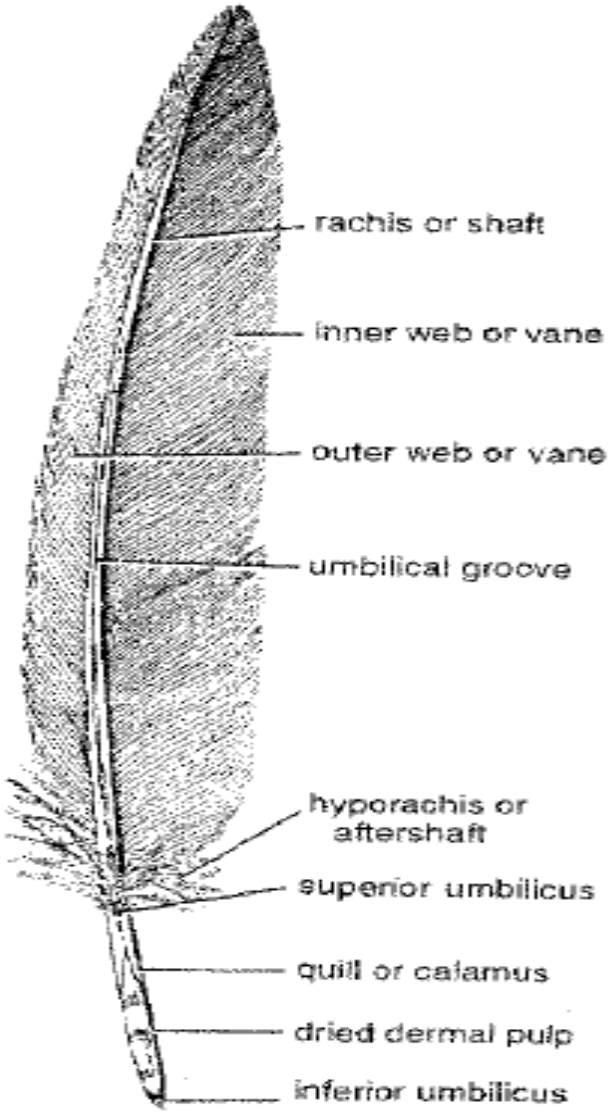
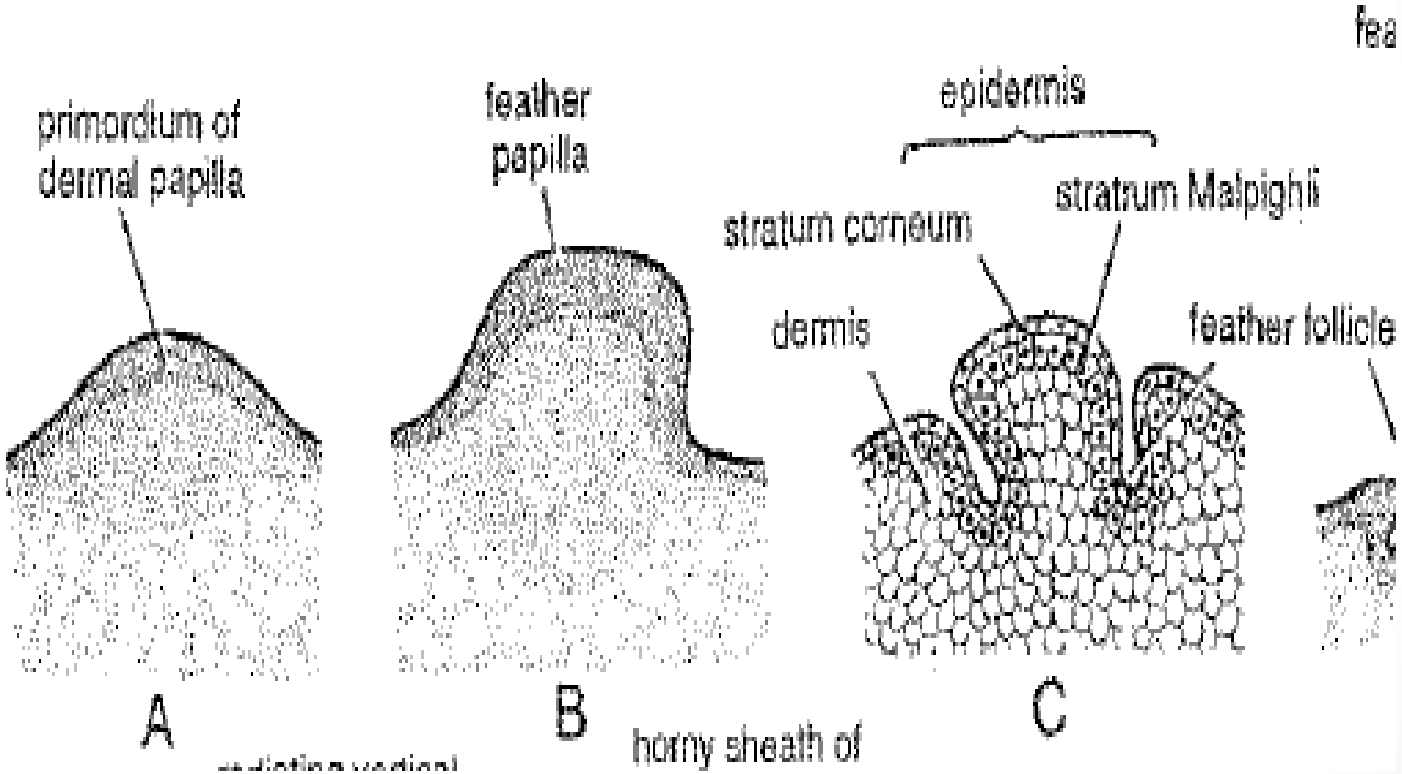


Fig. 7. Pigeon. Structure of a typical flight feather (remex) in ventral view.

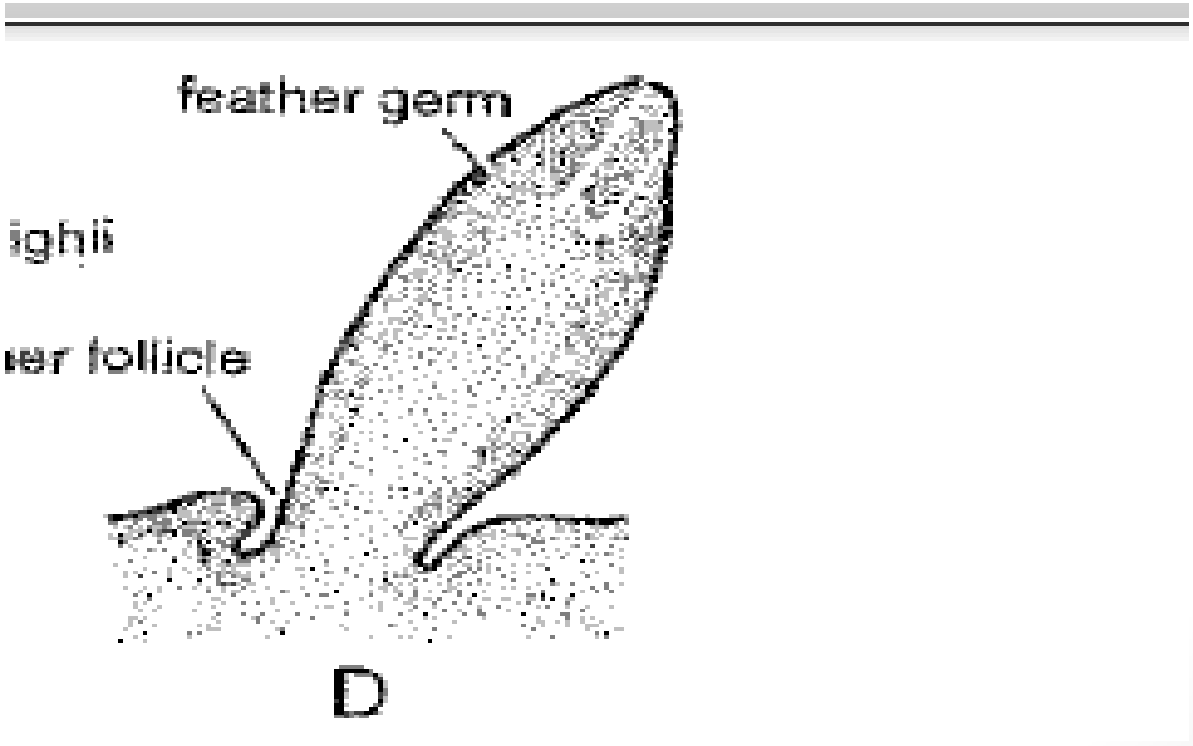
Development of feather in birds

1. An accumulation of mesenchymal cells in the dermis and becomes covered by a cap of epidermis giving the dermal papilla

2. The dermal papilla is supplied by blood from the blood vessels that are found in the dermal pulp, where these papilla grows into (cylinderical cone) above the surface of the epidermis and its base deepens in the dermis to form feather follicle

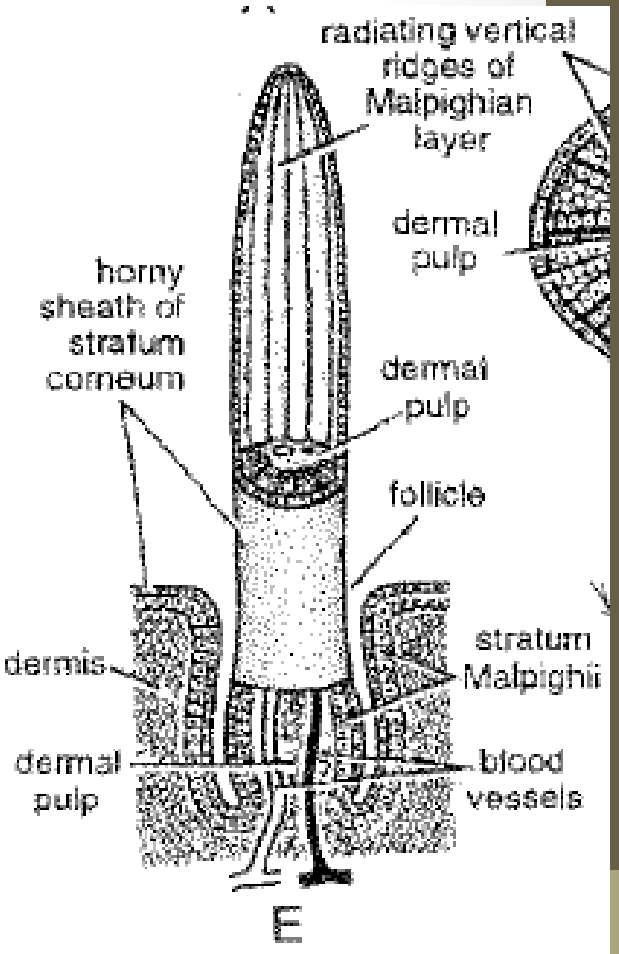

primordium of
dermal papilla
feather
papilla
epidermis
stratum Malpighii
stratum corneum
dermis
feather follicle
A
B
C
horny sheath of

3. **The cells of stratum germinativum become active and divide continously to form several layers that press upon the overlines cells and transformed into horny thin layer that give the outermost layer (feather sheath or periderm) (d)**



Development of feather in birds

- **The cells of stratum germinativum grow and forming series of longitudinal ridges or columns of pigmented cells that extend in the dermis and arranged in dermal pulp**

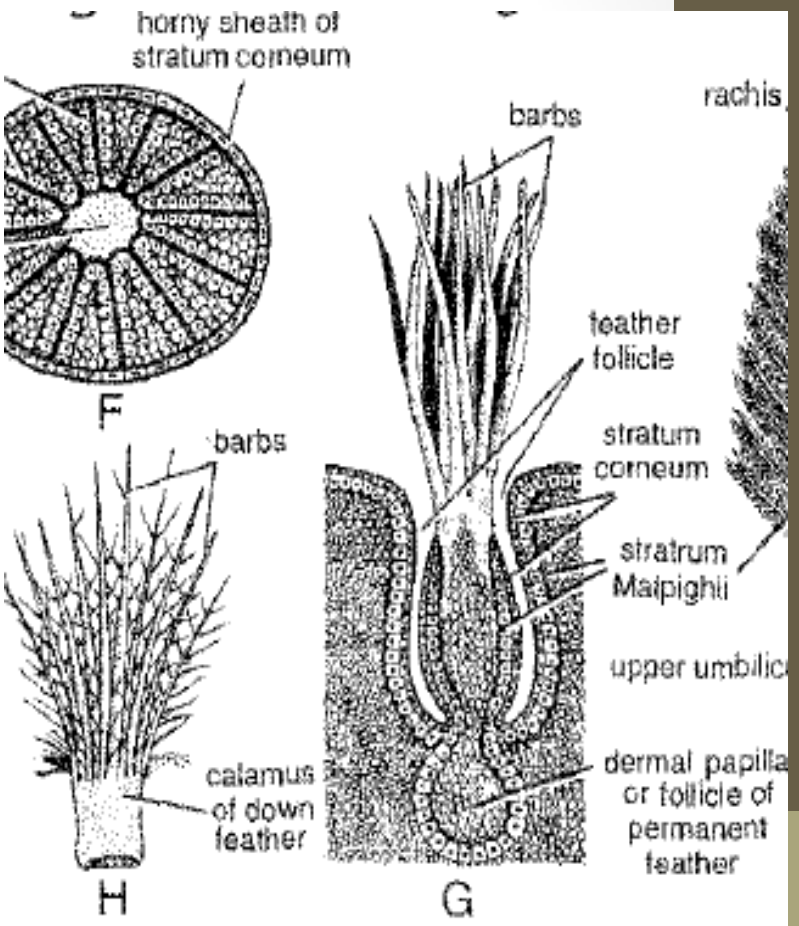


Development of feather in birds

5. The pigment cells will be cornified and separate from each other to form the barbs
6. . the stratum cornium forming a thin sheath (feather sheath) above the barbs.
7. New epidermal cells are modified also into pigmented columns to form the side branches of the barbs (barbules)
8. And the future feather continous in development where the basal part secret a horny layer around it to form the quill that encloses the dermal pulp

If the feather developed into down feather

- The barbs will be separated and pentrate the sheath of the epidermis and arrange themselves on the top of the quill with minute barbules that have no hooklets



If the feather developed into contour feather

- **The shaft will be formed up to the quill. And the fusion of two ridges of barbs , where the barbs spread to give a vane and there are barbules that attached to barbs and containing the hooklets**

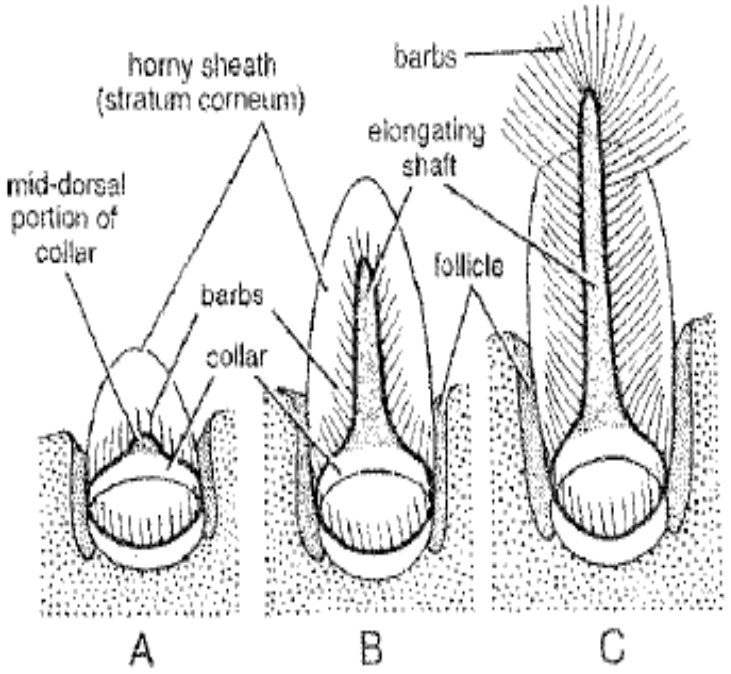


Fig. 12. Schematic development of a contour feather from the down feather stage.

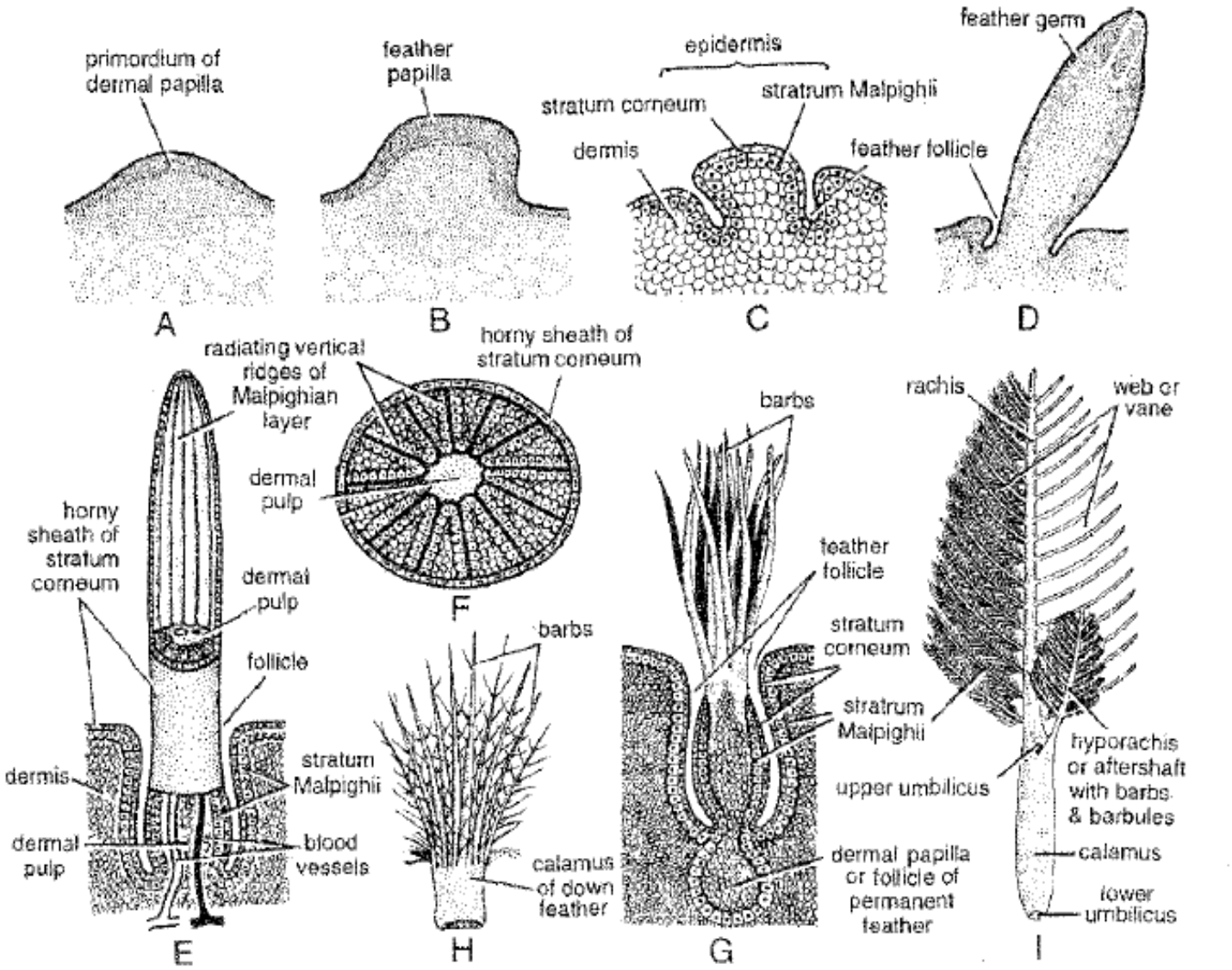


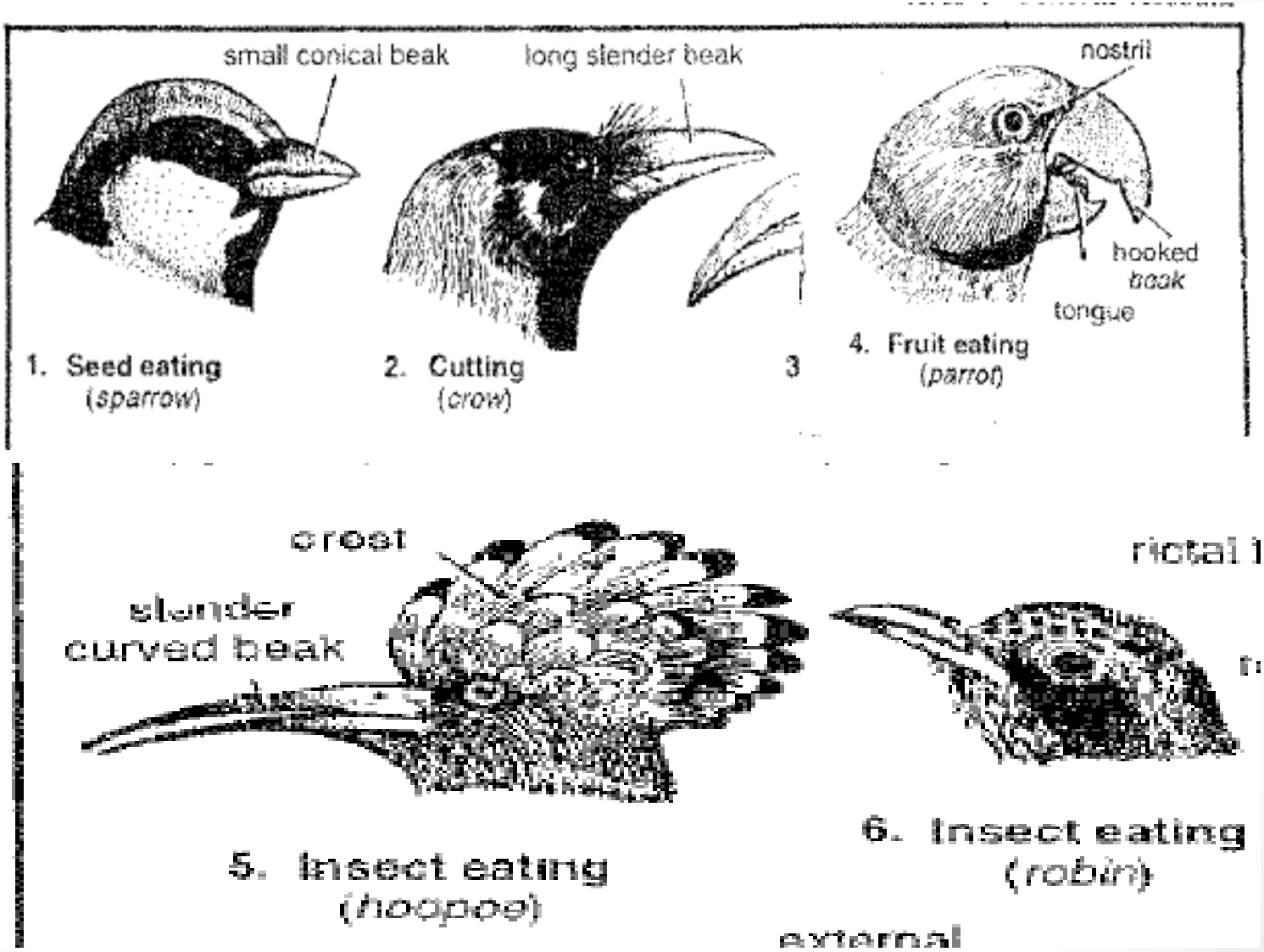
Fig. 11. Stages in the development of a contour feather. A—Dermal papilla. B—Feather papilla rising above skin surface. C—Feather papilla in V.S. D—Feather germ elongates. E—Stereogram of later stage in V.S. F—Feather germ in T.S. G—Down feather in its follicle in V.S. H—Mature down feather of a newly hatched bird. I—Young contour feather.

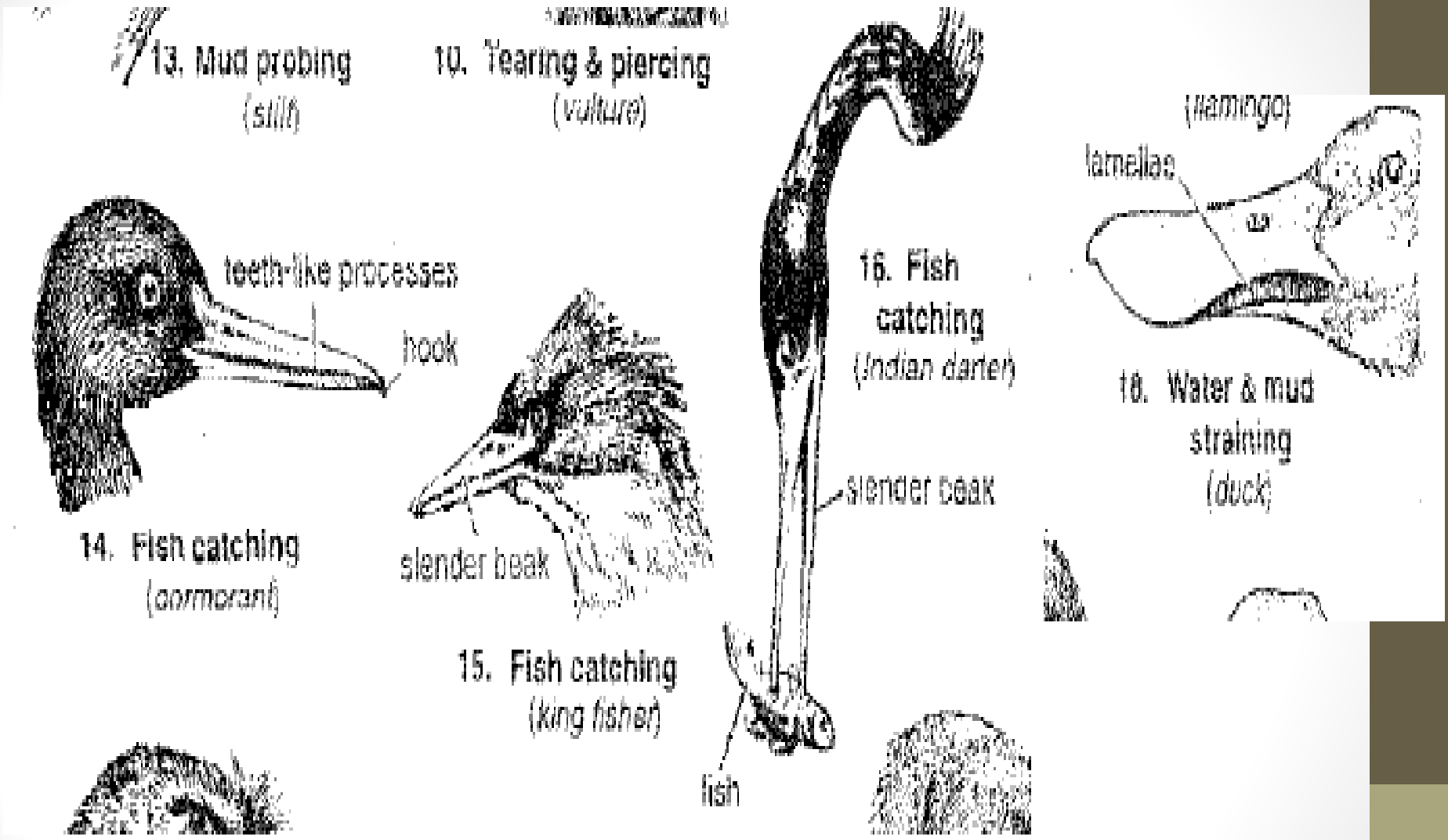
is produced having a number of barbs springing

The horny beaks of birds

- Beaks covers the maxilla and mandible of birds
- It is epidermal in origin
- It differs in size and shape
- Seed eating birds usually have short, strong and blunt beaks
- Insect eaters possess long, weak and narrow beaks

Types of beaks in birds




13. Mud probing
(still)
10. Tearing & piercing
(vulture)
(flamingo)
lamellae
teeth-like processes
hook
16. Fish
catching
(Indian darter)
18. Water & mud
straining
(duck)
14. Fish catching
(cormorant)
slender beak
slender beak
15. Fish catching
(king fisher)
fish

The dermal system of mammals

The skin of mammals composed of two layers

1-the epidermis :composed of stratum germinative layer or called malpighian layer at the base and many layers above it end by stratum corenum at the surface of epidermis

2-the dermis : much thicker than other vertebrates contain a- an outer thin conn. tissue b- deep fibrous conn.tissue c- nerves

d-blood vessels e- melanin granules in basal layer of epidermis .

Below the dermis ,there is fatty layer which thick in some regions than others

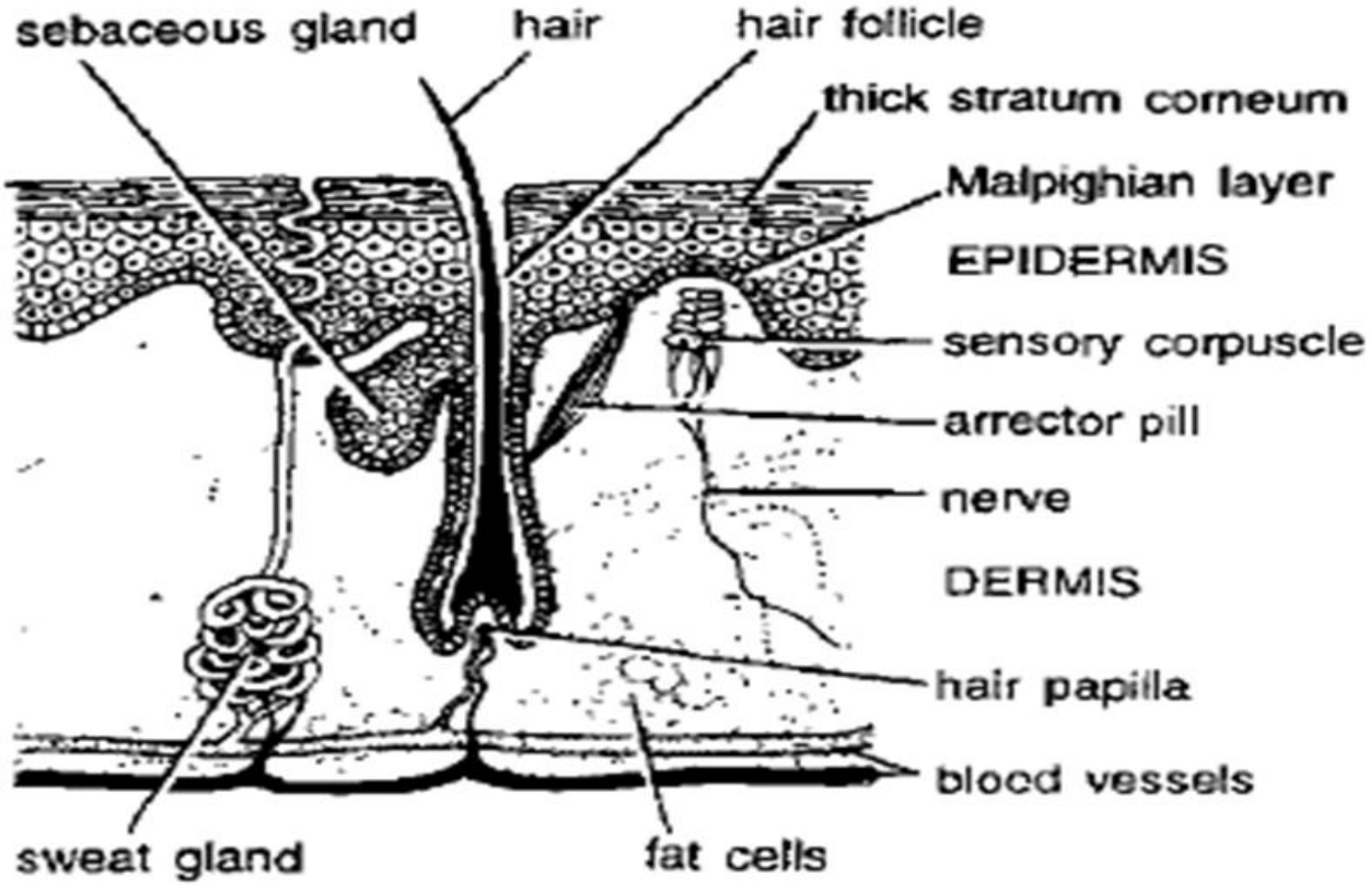


Fig. 13. Skin of a mammal in V. S.

The glands: two types of glands

1-sebaceous gland 2-sweat glands

Also mammals have scent glands and mammary glands which all arise from epidermis and embedded in dermis

The derivatives :the epidermal hair ,claws ,nails ,hoofs and horns

Development of hair

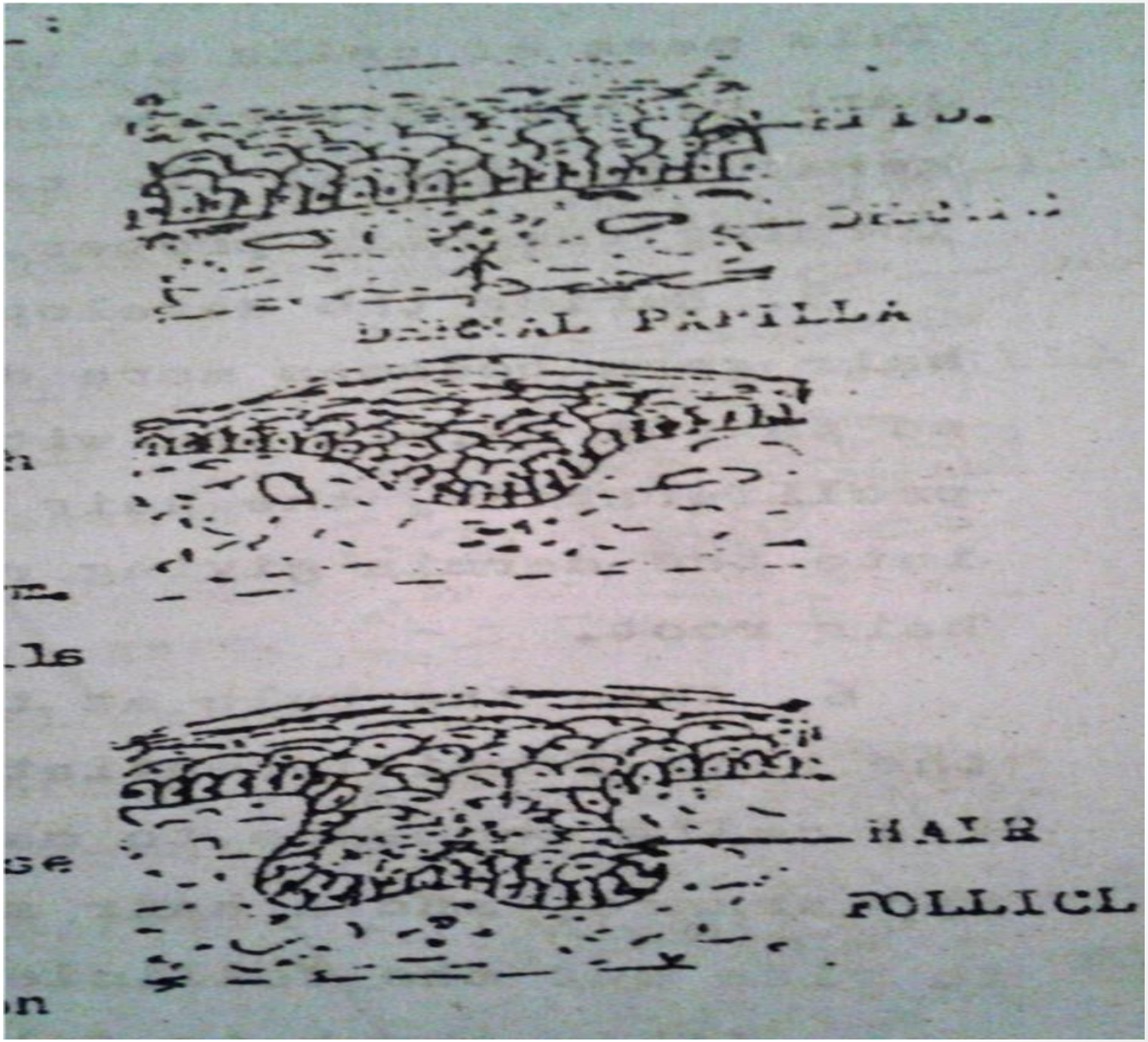
1- the cells of strat. germ at region where the hair will developed become active and invaginate towards the dermis forming a thickened dermal papilla or hair follicle.

2- the mesenchymal cells accumulate forming “dermal papilla” which support the malpighian cells and nourishment it .

3- the invagination of str. germ is followed by other epidermal cells forming hair germ نبت الشعر

4-the mesenchymal cells press upon the inner border of the hair germ and thus forming the hair bulb

5-the cells of hair germ are activated and proliferated to give a small conical mass of cells which form hair rudiment

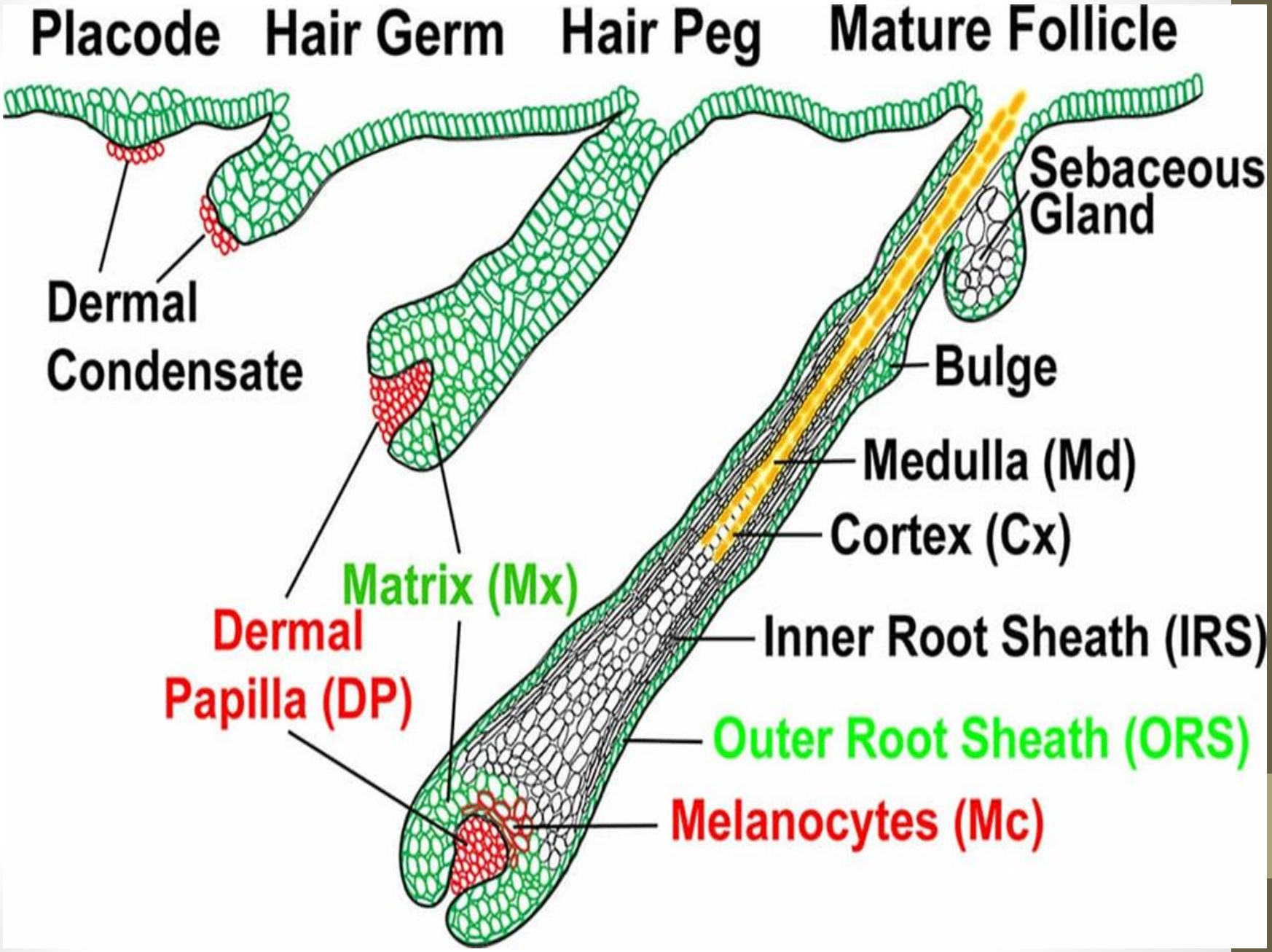

DERMAL PAPILLA
HAIR
FOLLICL

6- the mass of cells of central part of the hair germ Undergo keratinization forming hair properاصل

7- during the development the hair germ become more deeply embedded in the dermis and then give hair root

8- the hair bulb is differentiated ,cornfield cells commenceتبدا to make their appearance and the hair shaft begins to rise out the follicle

9- the hair continuous to be pushed out until it projected from the surface of the skin and becomes visible ,at the same time the sheath of hair root becomes formed


Placode
Hair Germ
Hair Peg
Mature Follicle
Sebaceous Gland
Dermal Condensate
Bulge
Medulla (Md)
Cortex (Cx)
Matrix (Mx)
Dermal Papilla (DP)
Inner Root Sheath (IRS)
Outer Root Sheath (ORS)
Melanocytes (Mc)

The structure of hair

1-The hair lies within a pit in the skin called hair follicle that arise from invagination of malpighian layer in the dermis .

2- the base of follicle the hair expanded to form a bulb like enlargement the root of the hair

3- the hair then extend by addition of cells and projected through the skin

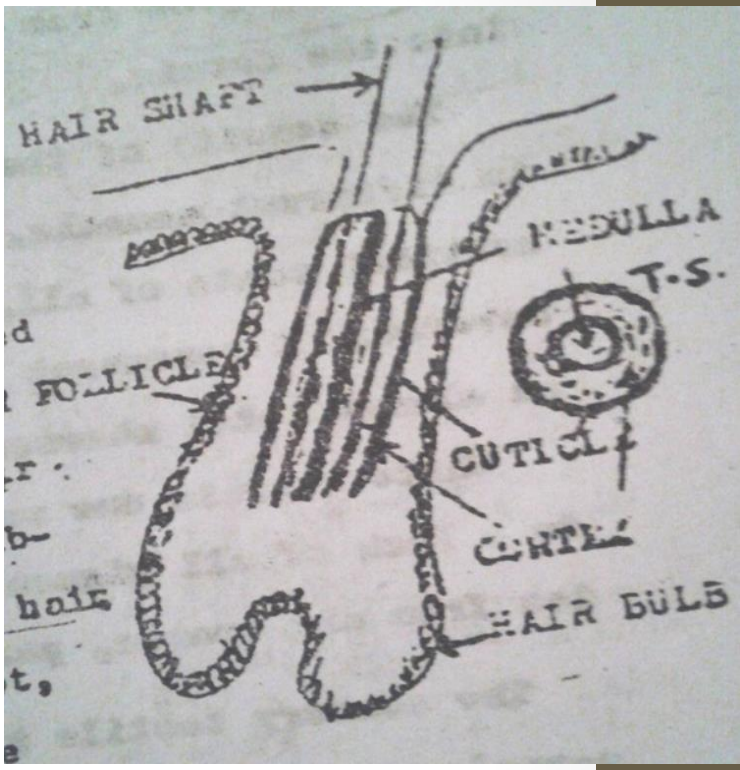
4-only the base (root) of hair is living but the rest is dead or horny .

In across section the hair composed of three regions are

1-outer :cuticle 2-median :cortex 3-inner:medulla

The color of hair produced by pigment that exist in the cortex

Claws : are epidermal origin and in mammals composed of hard horny dorsal plate called unguis and less hard verntal plate called subunguis ,both enclosing the tip of the digit, covering the last tapering phalanx



Nails :are epidermal in origin and in some mammals are claws are modified into nails which are found at the ends of digit and composed of dorsal abroad flattened unguis and the sub unguis is usually reduced or absent .

Hoofs :are epidermal origin and composed of horny unguis which surrounds the front of toe and it pointed and has U or V shape and sub unguis which is greatly enlarged ,thickened and covered the ventral side of the toe and has U shape

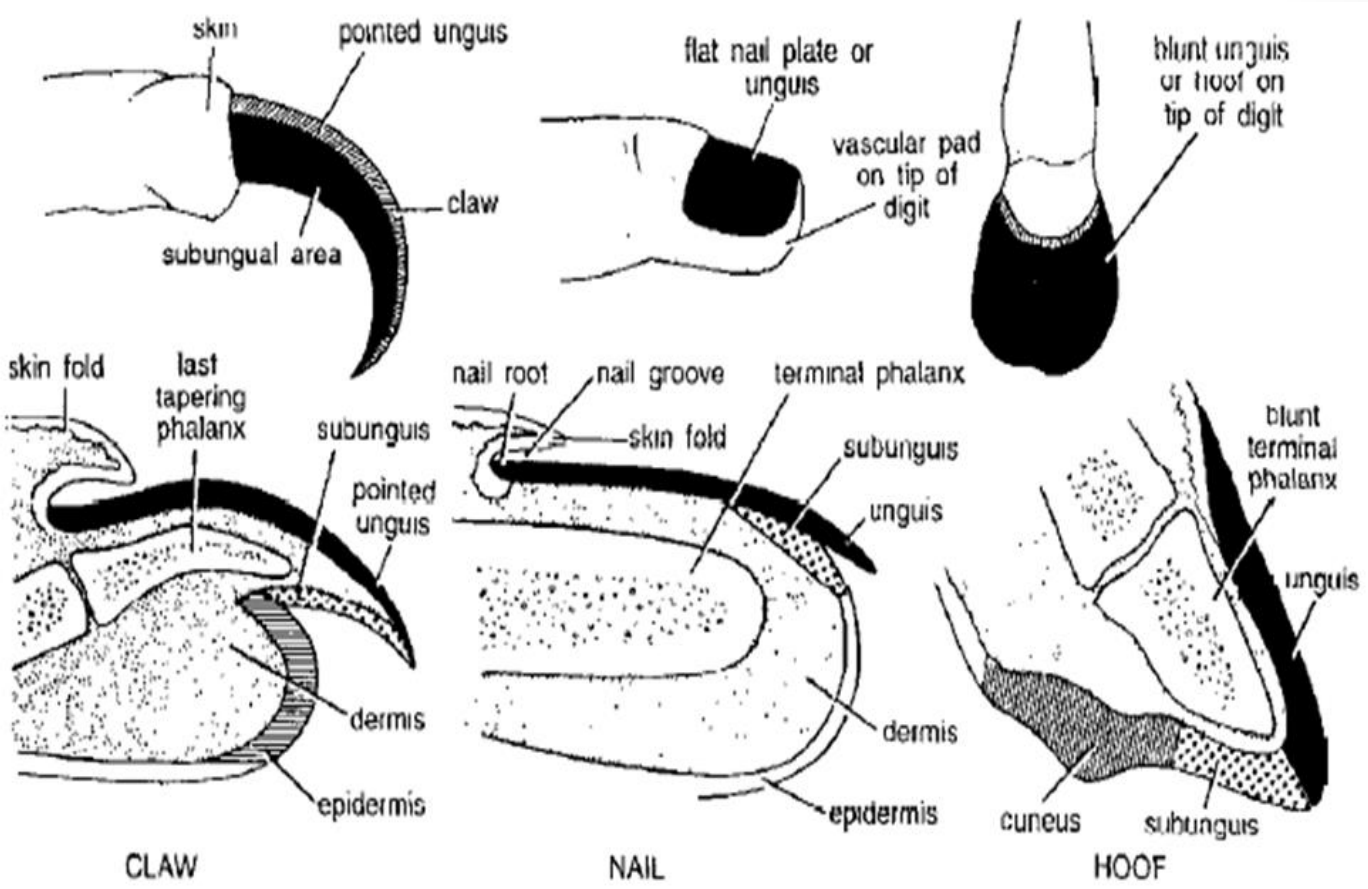
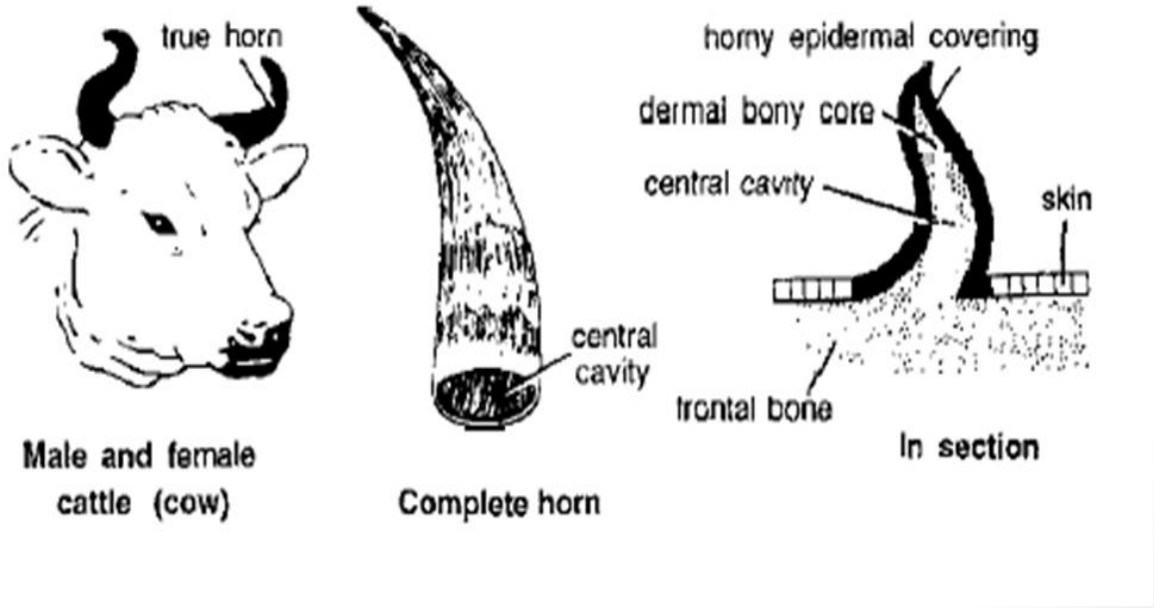


Fig. 2. Relation between claw (eagle), nail (human) and hoof (horse). Digital tips shown complete above and in sagittal sections below

(Z-3)

Horns :are epidermal in origin ,and they are hollow keratin sheath cover hollow bone which out from skull of the animals and they found at hoofed mammals on their head and form organs of defense .



Types of horns

1-true horns :-they are permanent structures that continue to grow throughout life and never shed ,and composed of hollow dermal bony corearising from frontal bone of skull and covered by epidermal horny hollow cap.

2-prong horns شائك القرن:they are also true horns but the horny sheath bears 1 to 3 branches and it shed every year and the permanent bony core becomes the base around which anew horn is developed the following year

3-antlers :they found only on males ,and it is a branching solid out growth of dense conn. tissue

Connected basally to the frontal bone of skull ,it is covered on the surface with hairy and vascular skin and it is also shed and new one develop the following year .

4-Giraffe horns : unbranched and permanent present in both sexes, composed of short dermal core ,projecting from frontal bone and it never shed.

5-Hair horns :composed of thick hairy and keratinized epidermal fibers fused together .these are permanent and if it broken they again grow out

Types of mammlian glands

two essential types of glands from which all the glands are derived

1-sweat glands : simple coiled tubular or simple branched tubular glands that embedded in the dermis and secret the sweat on the skin surface for thermal regulation and removal of salts ,urea and other waste products .they arise as invaginations of epidermis into the dermis and open on the skin surface numerous in primates and absent in rabbits.

2-Sebaceous glands : branched alveolar glands opens in the hair follicle or in skin and they secrete fatty substances

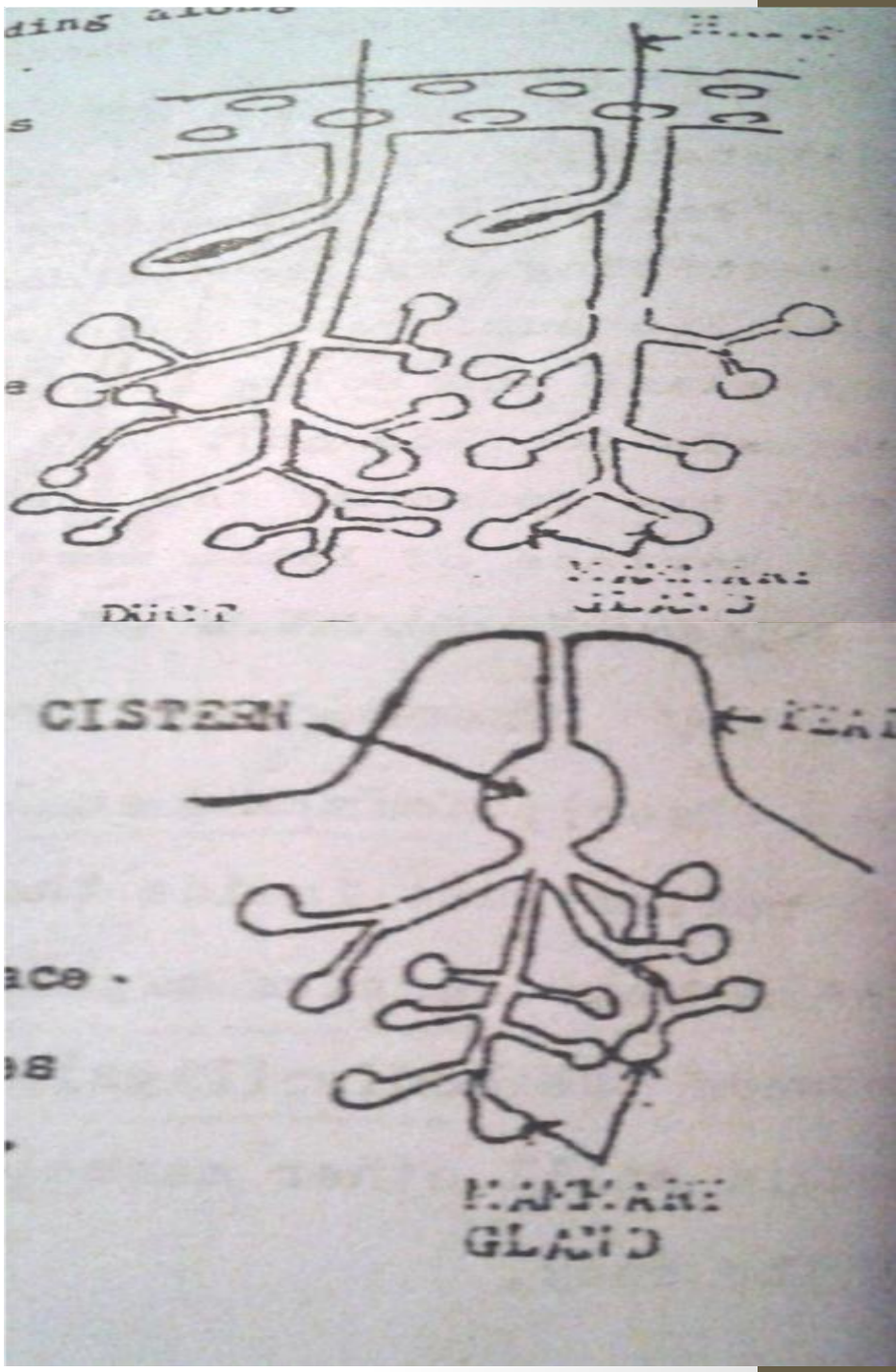
3-Scent glands : modified sweat glands or sebaceous glands, may be useful in attracting members of the same species or the opposite sex or they act as a defense against enemies

4-mammary glands : branched, milk producing glands present in mammals only .

arise usually in the females but are also present on males in monotermes ثدييات اولية,in primates they present in the form of a pair or more of elevated ribbons called milk lines and it active before the young is born and at sucking period

In prototheria :mammary glands are primative and open in depressions on the abdomen , functional in both parents no nipples are present ,the young obtain the milk from hairs

2-in metatheria كيسيةand eutheria :mammary glands are functional in females only ,they open in the surface through nipples or teats which young sucking milk from it .



Dentition in vertebrates

1-Homodont : in vertebrates other than mammals , all teeth present are similar in shape and size.

3-Heterodont:mammalian teeth are characteristically heterodont ,that is different in shape and size ,they are distinguished into several types known as incisors, canines premolars and post molars .they differentiation depends upon the nature of food eaten.

Attachment of teeth

1-acrodont :this condition occurs in most vertebrates in which teeth are attached to the free surface or summit قمة of the jaw bone as in shark ,such teeth are break off easily but are replaced

2-Pleurodont: common in lizard ,teeth are attached to the inner side of jaw bone by their base as well as one side

Acrodont and pleurodont teeth are rootless ,so that nerves and blood vessels enter the pulp cavity along lateral side .

3- Codont : such teeth are characteristic of mammals .teeth have well developed root implanted in deep individual pits or sockets in the jaw bone

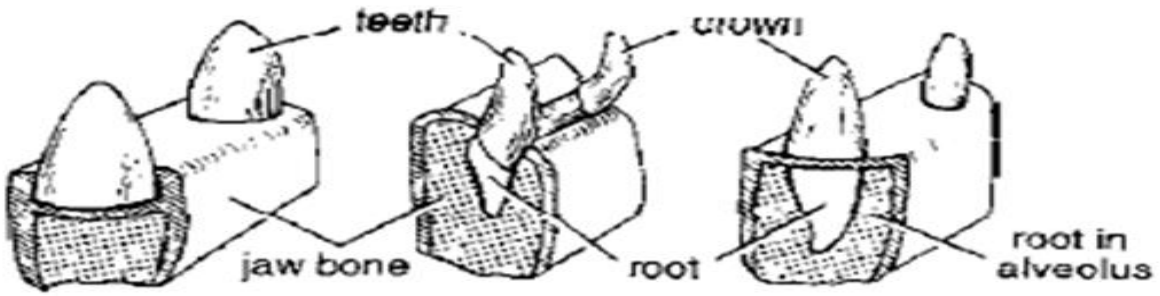


Fig. 1. Three methods of attachment of teeth to jaws.

surface or summit of the jaw bone, as in a shark or frog. Such teeth are apt to break off easily but

Replacement of teeth

According to their development ,teeth fall into 3 categories

1-polyphyodont : in lower vertebrates ,teeth can be replaced an indefinite number of times during life

2-diphyodont :in most mammals teeth develop during life in two successive sets ,the first set are called milk teeth as in human

3-monophyodont :in some mammals such as some rodents only one set of teeth develops known as monophyodont condition

Dental formula

$$D.F = \frac{\text{number of teeth in half of upper jaw}}{\text{number of teeth in half of lower jaw}}$$

For example

	young	adults
Incisors =	8	8
canins =	4	4
Premolars=	8	8
Post molars=	8	12

$$D.F = \frac{\text{Incisors+canins+Premolars+Post molars}}{\text{Incisors+canins+Premolars+Post molars}}$$

$$D.F = \frac{2+1+2+2}{2+1+2+2}$$

The Endoskeleton

Ligaments- cartilages- bones

and it divided into axial (skull, vertebral column, ribs and sternum) and appendicular (limb bones and girdles)

Types of bones

1. Cartilage bones (replacing bones)
2. covering bones

The Skull

- Neurocranium
- splanchnocranium

Skull in cyclostomes

- No roof except in the occipital arch.
- Incomplete floor and side walls formed by combination of anterior and posterior pairs of parachordals and auditory capsules.
- Single anterior olfactory capsule.
- Small pieces of cartilage arise between the gills (7 visceral arches).

Skull in elasmobranch fishes

- Roof is not complete (anterior fontanella)
- Side walls with contains small pores for passage nerves and blood vessels

Development of chondrocranium

1. **At the floor of the brain:**

Mesenchymal cells accumulate in three pairs, these cells transformed into elongate cartilage elements, a pair on both sides of the anterior end of notochord called **parachordals**, a pair anterior to those underlying the anterior end of the brain known as **prechordals** and a pair of small polar cartilages forms between the parachordals and prechordals.

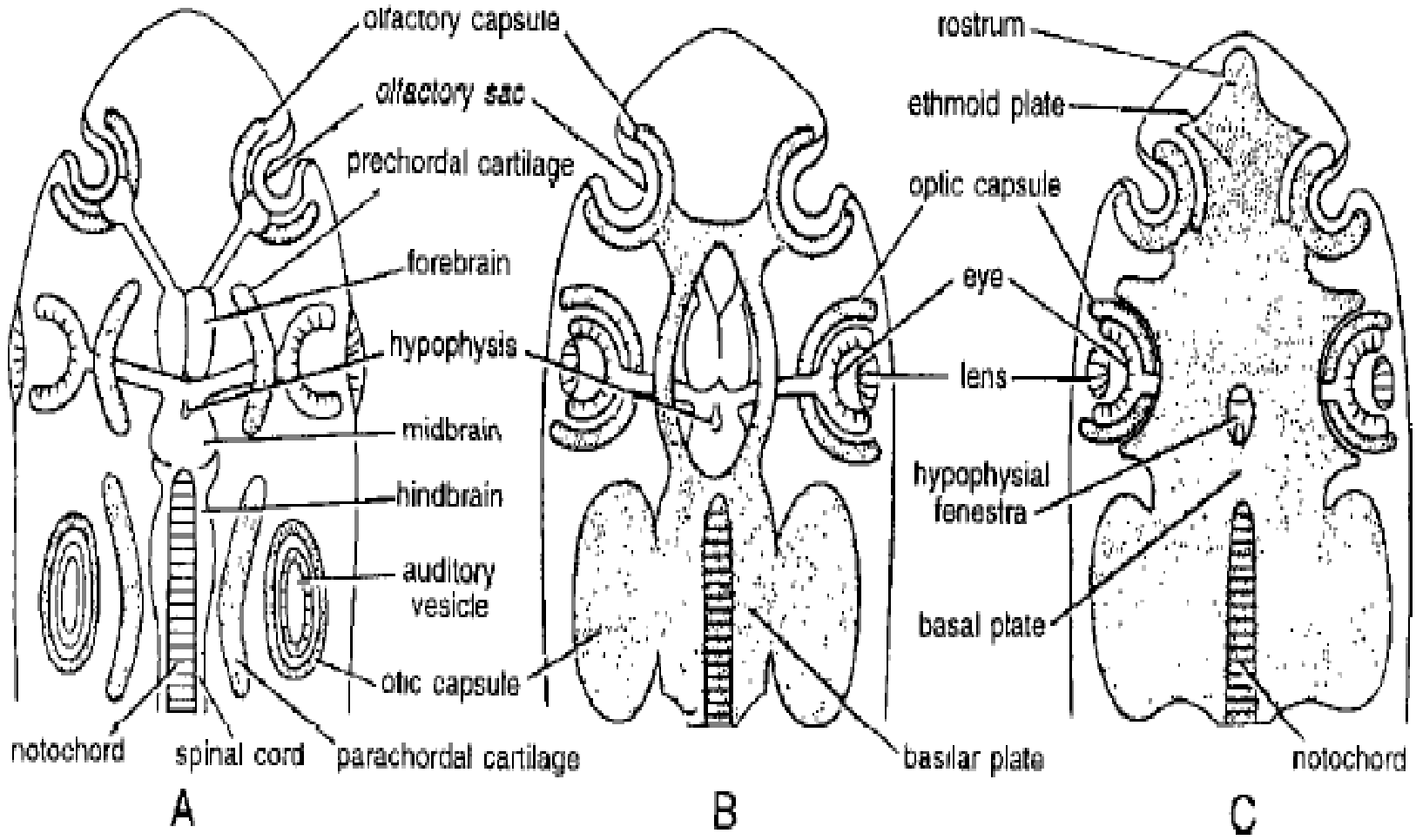


Fig. 1. Stages to show diagrammatic development of chondrocranium or cartilaginous neurocranium in ventral view A—Cartilages appear in head of embryo B—Formation of ethmoid and basilar plates. C—Chondrocranium completed

Development of chondrocranium

- At the same time, cartilaginous sense capsules appear around the sense organs(olfactory, optic and otic capsules)
- Then the occipital arch appears at the posterior end of the parachordals
- The parachordals fuse together forming a basal plate which extend laterally to unite with the auditory capsules, the anterior ends of the parachordals connected by a transverse bar called acrochordal leaving an opening behind called basicranial fenestra.

Development of chondrocranium

- Anteriorly, the trabiculae and the polar cartilages if present fuse with the parachordals, fuse together forming ethmoid plate (intertrabicular plate)and leaving a hypophyseal fenestra behind. The ethmoid plate do not reach the optic capsules so that the optic capsules region free, however extends anteriorly to reach the olfactory capsules and fuse with them and extend anterior between the nasal capsules called internasal septum

2. The side walls of the chondrocranium

- The auditory capsules form the side walls of the posterior part of the chondrocranium
- In the eye region, two separate plates of cartilage which are formed from accumulation of mesenchymal cells between each eye and the corresponding side of the brain giving the orbital cartilages which fused ventrally with the polar cartilages and trabeculae, and posteriorly with the auditory capsules forming the postorbital process.
- Lateral to the orbital cartilage formed the supraorbital

3- The roof of chondrocranium

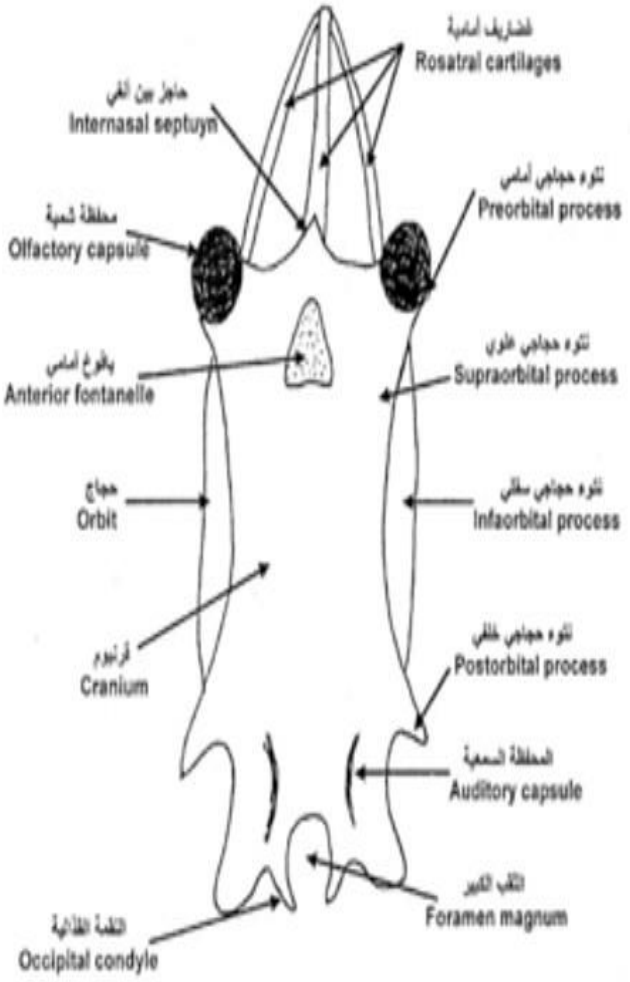
- Posteriorly in the region of the auditory capsules, two cartilage plates grow from the dorsal edges of the otic capsules towards the middle line and fuse together to form a complete roof, known as tectum synoticum.
- In the orbital region, two plates grow from the orbital cartilages and extend medially to form a complete roof in the eye region called (dorsalis crania)
- In the olfactory region , no roof is formed and a large gap called the anterior fontanelle between the two olfactory capsules.

4- the occipital arch

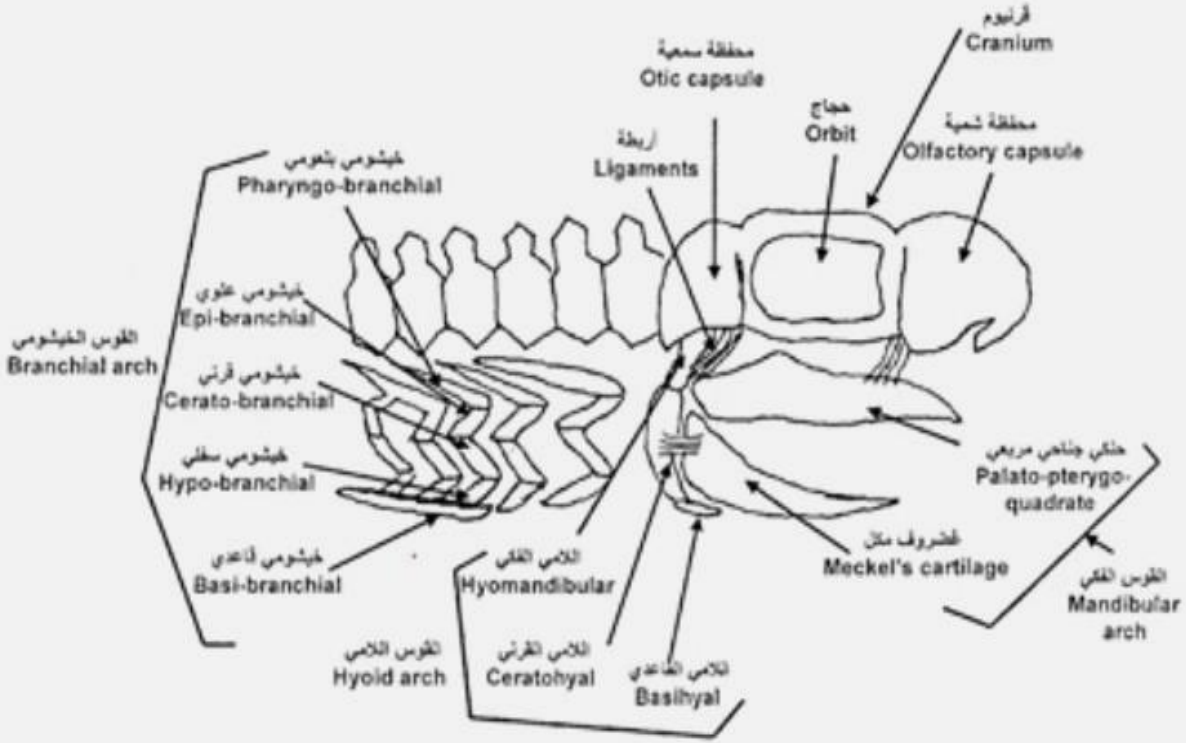
- Posterior to the otic capsules, the region of the parachordals is segmented in nature, the segment of the region form upward projections on both sides.
- The last segment may be called occipital arch and the segments in front are preoccipital arches.
- Certain vertebrae may be added from behind, and these are called occipitospinal arches
- These three arches with their roof and the tectum synoticum form the occipital arch of the adult skull, bounding a large foramen magnum through which the spinal cord passes.

5- The visceral arches or the splanchnocranium

- Visceral skeleton supports the gills and consists of a number of cartilagenous pairs developing in the mesoderm between the gill slites. In dog fish (7 pairs), the first pair called the mandibular arch (upper and lower jaw), the second arch called hyoid arch, the remaining (3-7) known the gill arches.



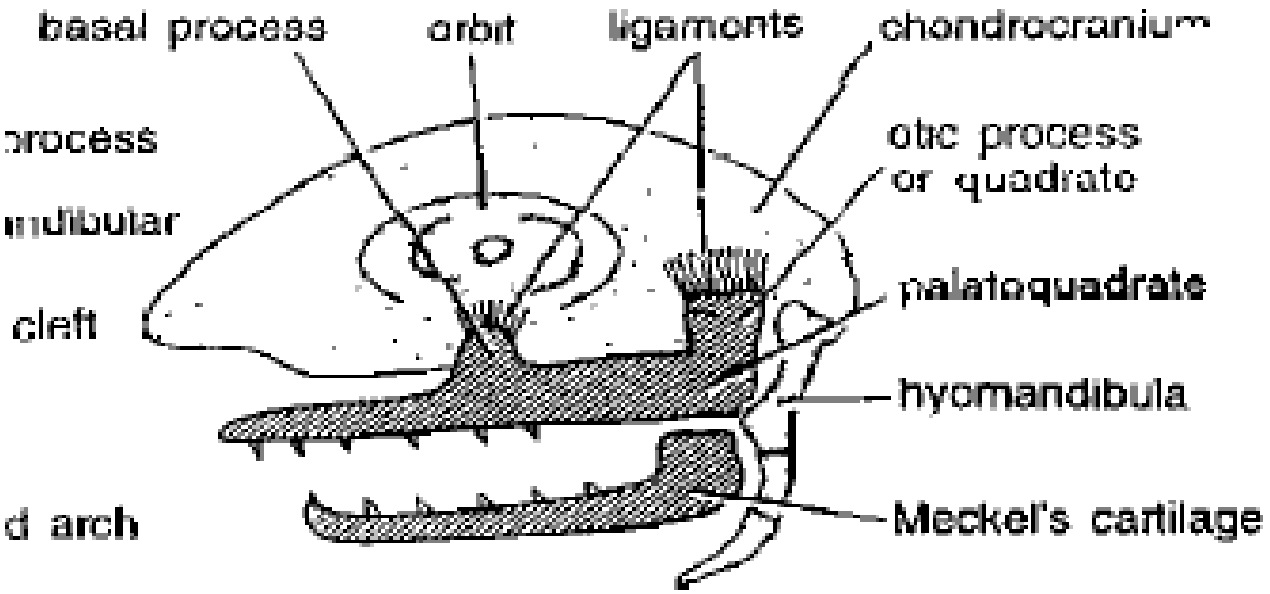
Splanchnocranium



تركيب الأقواس الحشوية في كلب السمك

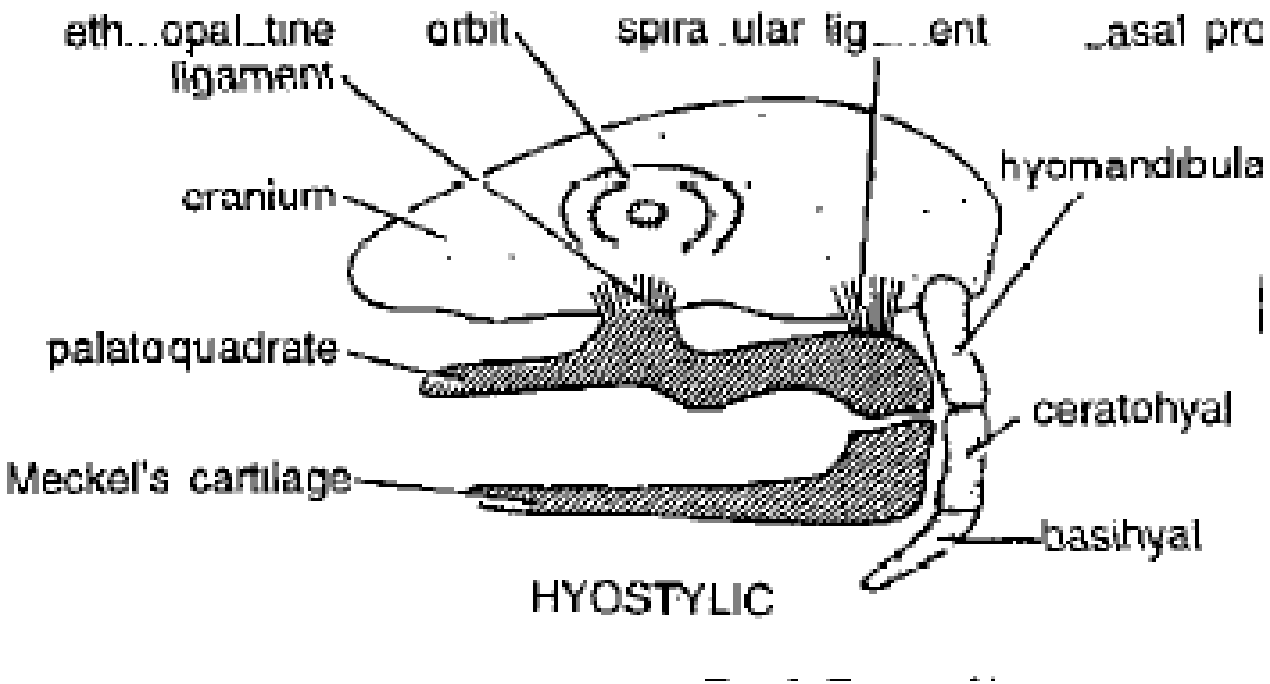
Structure of Visceral arches in Dog Fish

Jaw suspensions



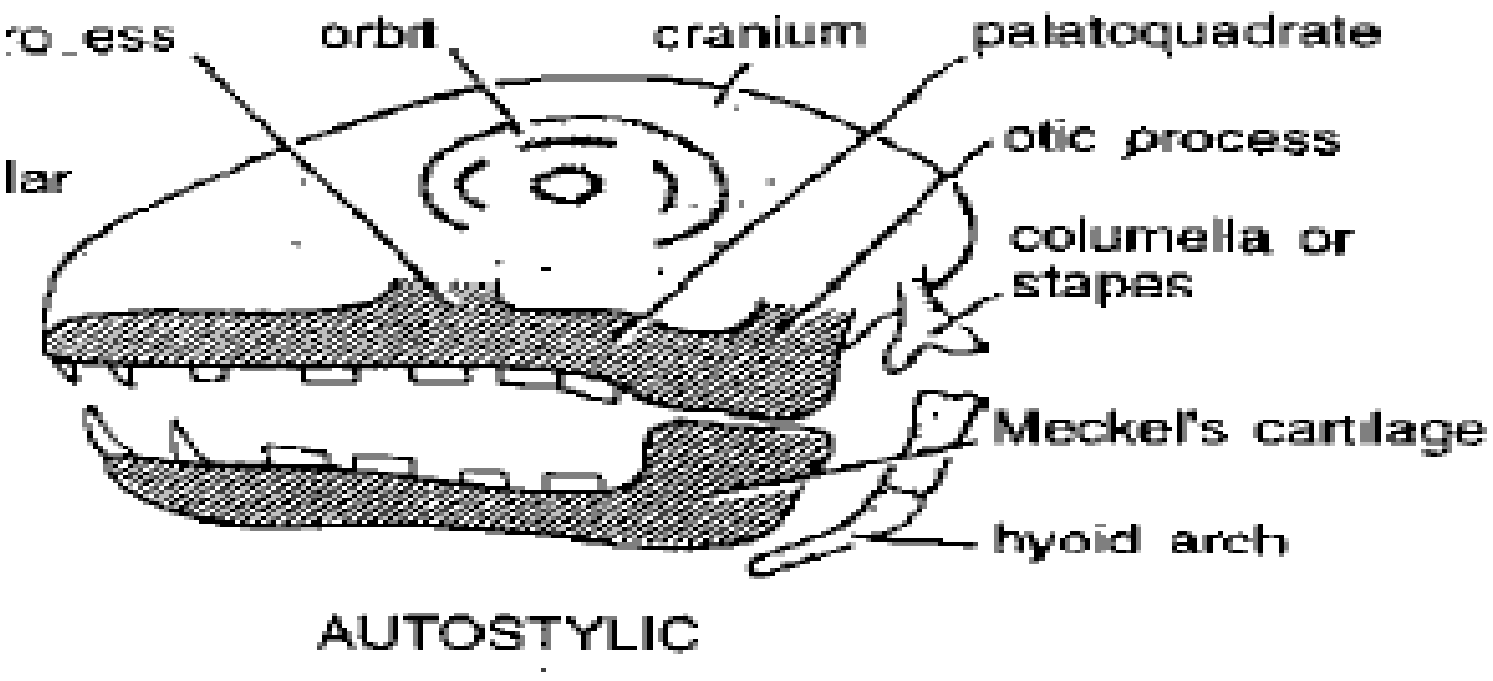
As in primitive elasmobranches

Jaw suspensions



As in most elasmobranches and in all teleostomes

Jaw suspensions



thmoid As in most vertebrates(some fishes and amphibia,ascending in tetrapodes, basal in elasmobranches and primitive teleostomes, otic in tetrapodes.

Development of the osteocranium

1) replacing bones in cranium

a. **occipital bones:**

In the occipital region of skull, four bones ossify and surround the foramen magnum, these are:

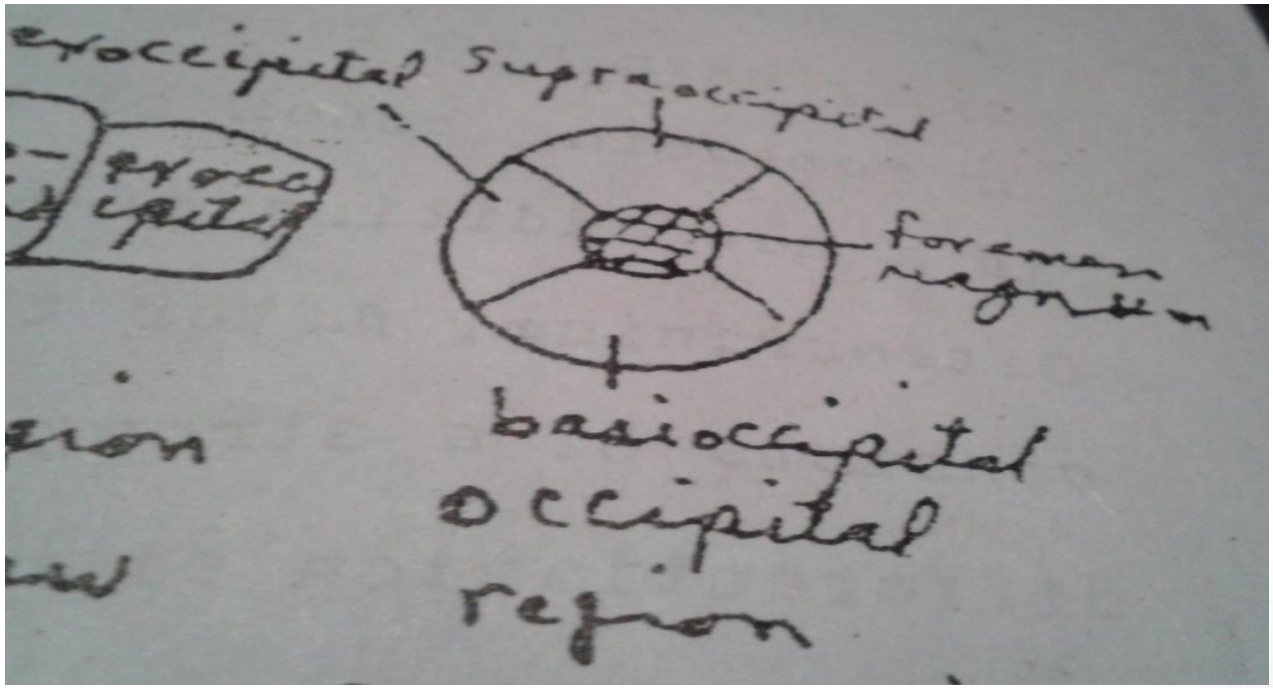
1- Supraoccipital: single bone above the foramen and arise from ossification of tectum synoticum.

2- Basioccipital: It is also a single bone found below the foramen magnum, and arise from the ossification of the posterior part of the parachordal plate.

3- Exoccipitals:

the foramen magnum and formed by ossification of the occipital arch

Modern Amphibia contains only exoccipitals



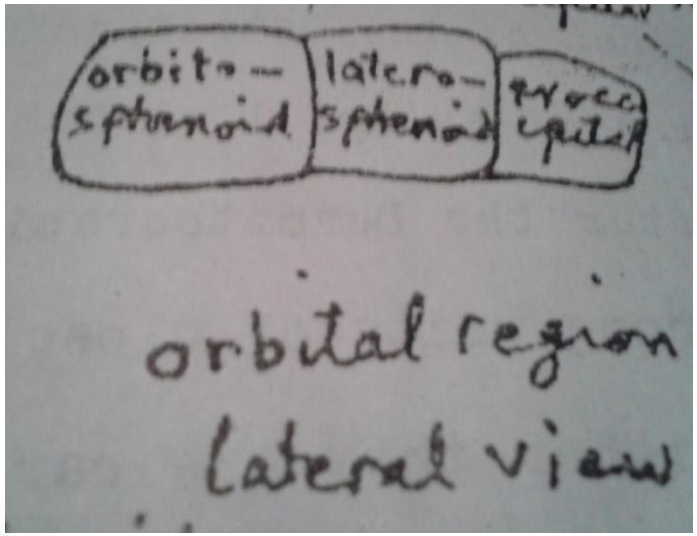
Occipital condyles

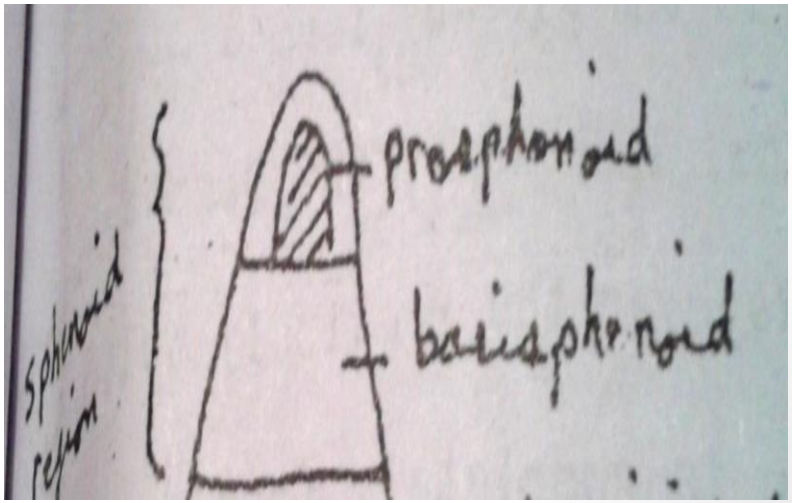
A processes appear in the occipital region, by which the skull articulates with the first vertebra of the vertebral column

In fishes, reptiles and birds, there is a single occipital condyle, but in modern amphibia and mammals there are two occipital condyles.

b.Sphenoid bones:

- Orbitosphenoid bone arise from ossification of anterior part of orbital cartilage
- Laterosphenoid bone arise from ossification of posterior part of orbital cartilage
- Basisphenoid bone arise from the ossification of the anterior part of parachodal plate
- Presphenoid bone arise from the ossification of trabicular plate.





C. Ethmoid bones:

- Mesehmoid bone (Turbinals in mammals) arise from ossification of the internasal septum

- In modern amphibia there are sphenethmoid bone that arise from a single ossification in orbitosphenoid region

2) replacing bones in the sense capsules

- **Otic or Auditory capsules:**

- In teleosts are: prootic, epiotic, opisthotic, pterotic and sphenotic

- In higher vertebrates there are only the first three bones

- In Aves the otic bones are fused together forming periotic
- **Olfactory capsules:**

Ossification in the walls of the nasal capsules give the ectothmoid

- **Optic capsules:**

- The optic capsules do not fuse with the cranium to allow free movement of the eye

- In reptiles and birds ossification occurs forming a ring of sclerotic bones

3) replacing bones in the jaws

a) **The upper jaw:**

- Most of the palatoquadrate cartilage degenerates

- Ossificatin of the ascending process forming the epipterygoid bone

Ossification of otic process form the quadrate bone

b) The lower jaw:

An articular bone ossifies from the posterior end of the lower jaw cartilage while the rest of the cartilage disappears or remains as a cartilage

4) replacing bones in the hyoid arch and gill arches

In tetrapodes, the hyomandibular part of the hyoid arch ossifies to form the columella of the middle ear

Development of dermatocranium

- The dermal bones in the primitive tetrapod skull can be classified into six group:

1. **median dorsal group:**
   they are from anterior back words, nasals, frontals, parietals and post parietals

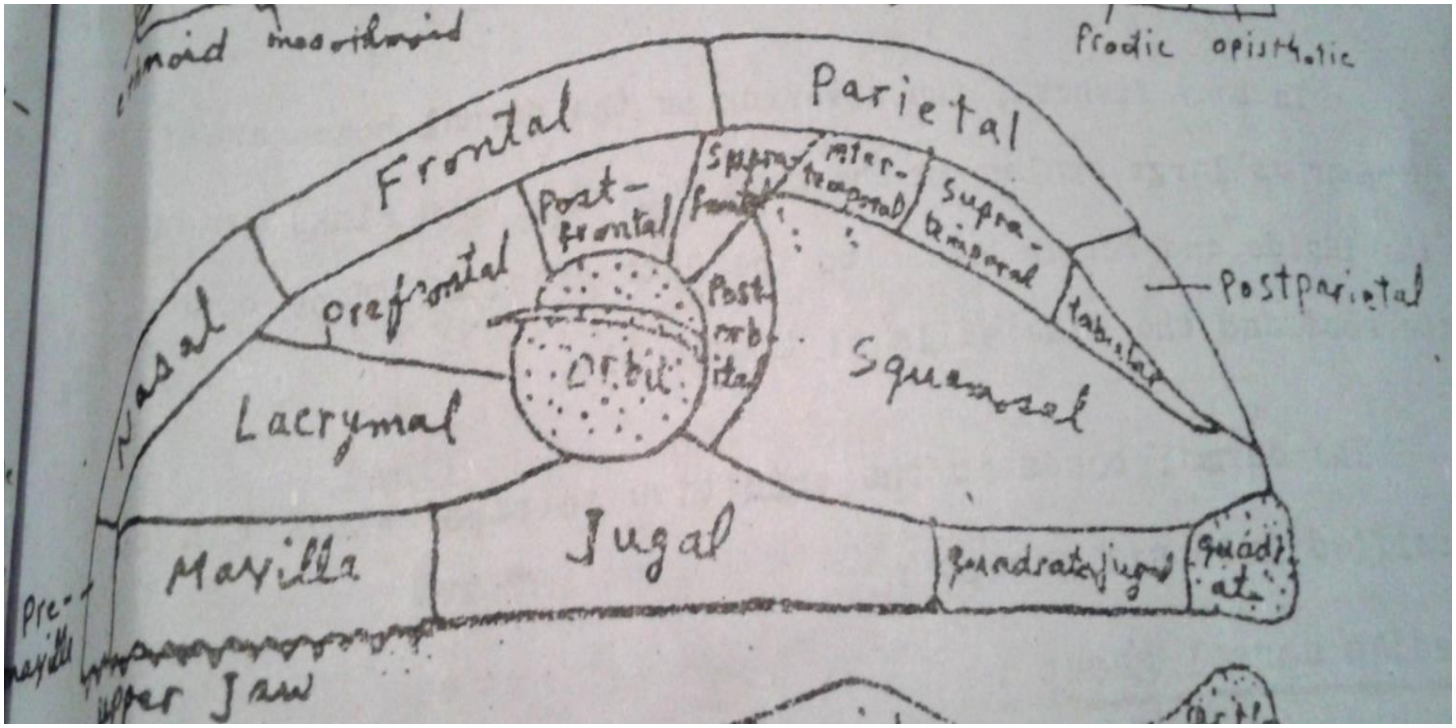
2. **2. Circum orbital group:**

Formed around the orbit, lacrymal, prefrontal, post frontal and post orbital

3. Temporal group

These dermal bones formed behind the orbits: intertemporal, supratemporal, tabular and squamosal

- 4. Maxillary group
- The dermal bones of the upper jaw: premaxillae, maxillae, jugals and quadratojugal



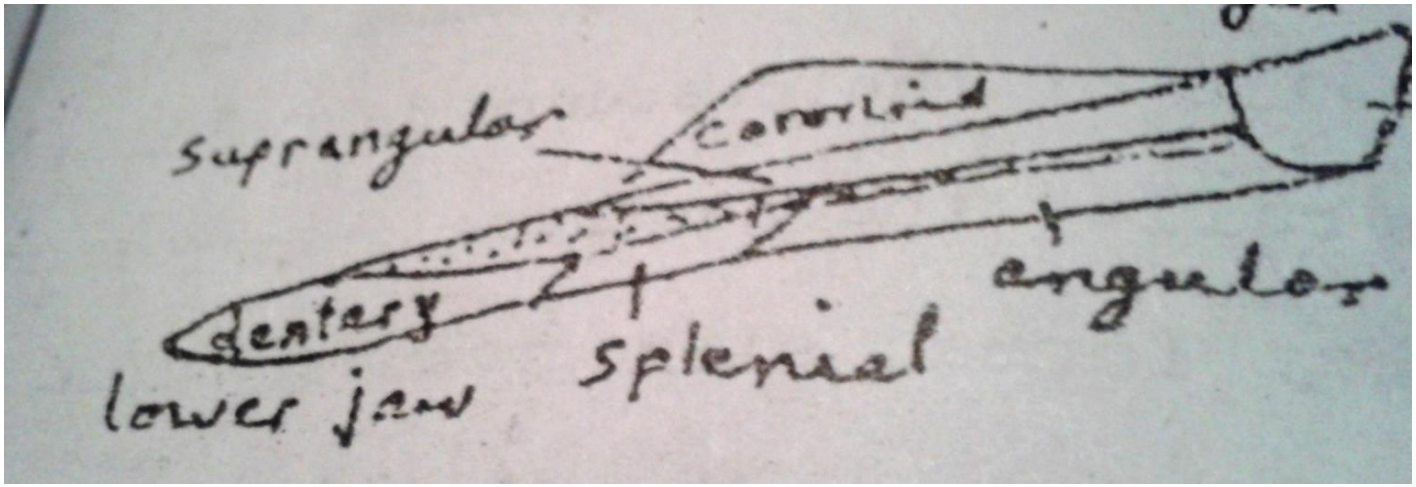
5. Palatal group (the roof of the mouth cavity)

- Prevomers, vomers, pterygoids, and a single median parasphenoid

Laterally there are palatines and ectopterygoids.

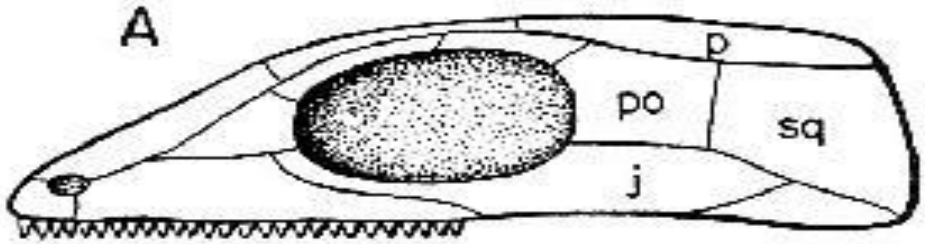
6. Mandibular group

- On the outer side of the lower jaw:
  dentary, splenial, postsplenial, Angular and suprangular



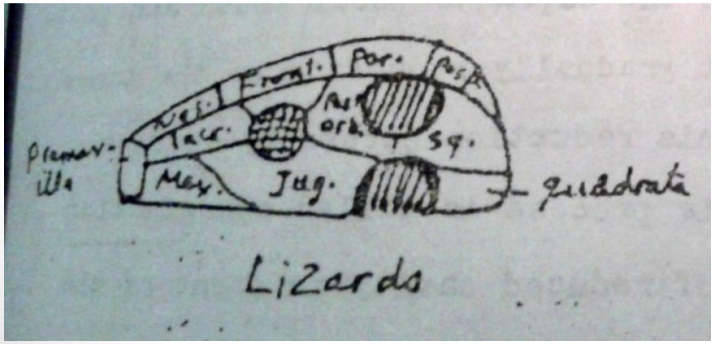
Skull of primitive reptilia

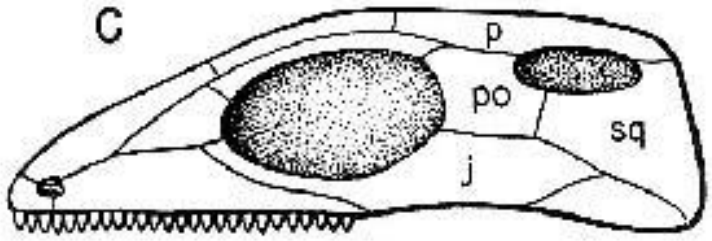
- **(anapsidian skull)**
- **The openings in it are the nostrils, the orbits and the foramen magnum**



- **Parapsidian skull (in extinct reptiles, modern lizard fenestration occurred in the temporal region which found just behind the orbit.**

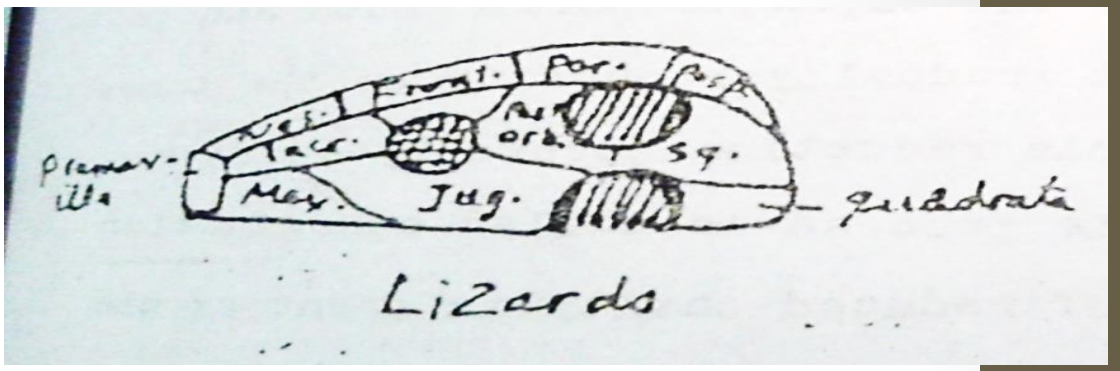
Forming an upper temporal fossa or the supra temporal fossa





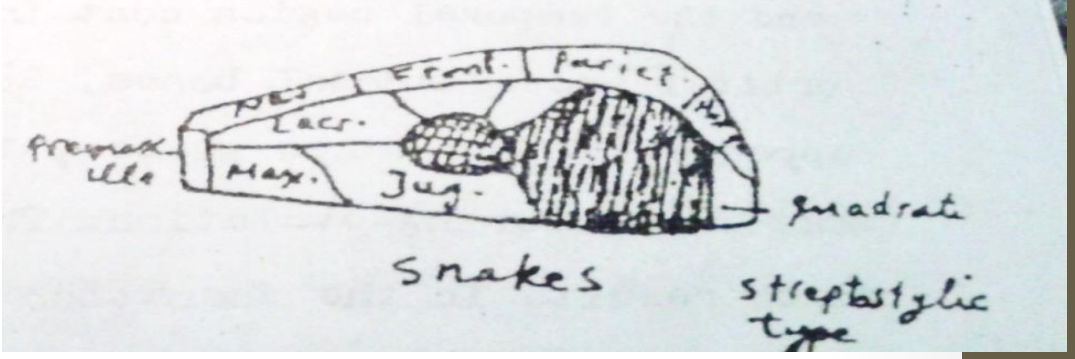
Evolution of modern lizard and snakes skull from parapsidian type:

In lizard:



- In which there are complete cercum orbital group
- the temporal group: contains (upper temporal fossa.
- jaw group: reduction of bones of upper jaw group and complete disappearance of quadratojugal during evolution, its enable the quadrate to move freely when the mouth open, the quadrate is now attached only to the squamosal. **.(streptostylic skull)**

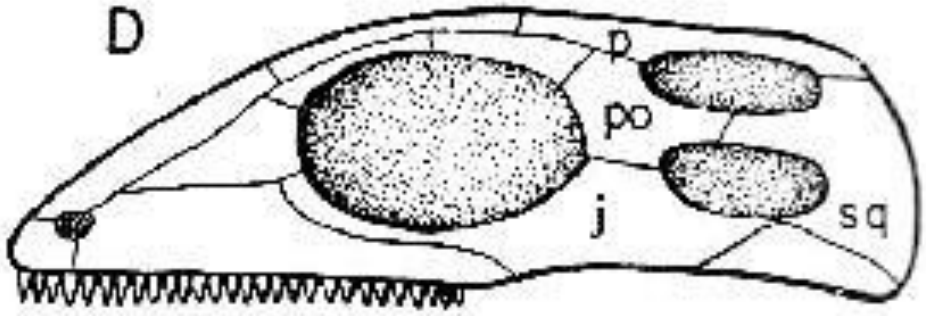
In snakes



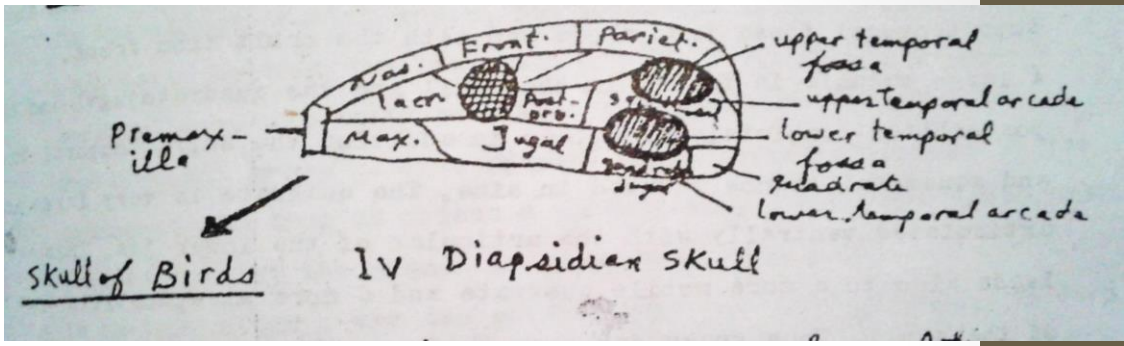
- Degeneration of quadratojugal occurs and also extend upward and forward as become continous with the supra temporal fossa above and with the orbit from front
- Large vacuole is formed where the quadratojugal and post orbital completely disappear. In addition the supra temporal bones and squamosal become reduced in size.
- The quadrate is very large and articulate with the articular bone of the lower jaw
- This lead more mobile quadrate, so the snake can open their mouth very widely**.(more streptostylic skull)**

Diapsidian skull
in extinct reptiles, Avian skull

- Possesses two temporal fossa, the supra and the infra temporal fossa, between the upper and lower fossa, there are the postorbital and squamosal bones.



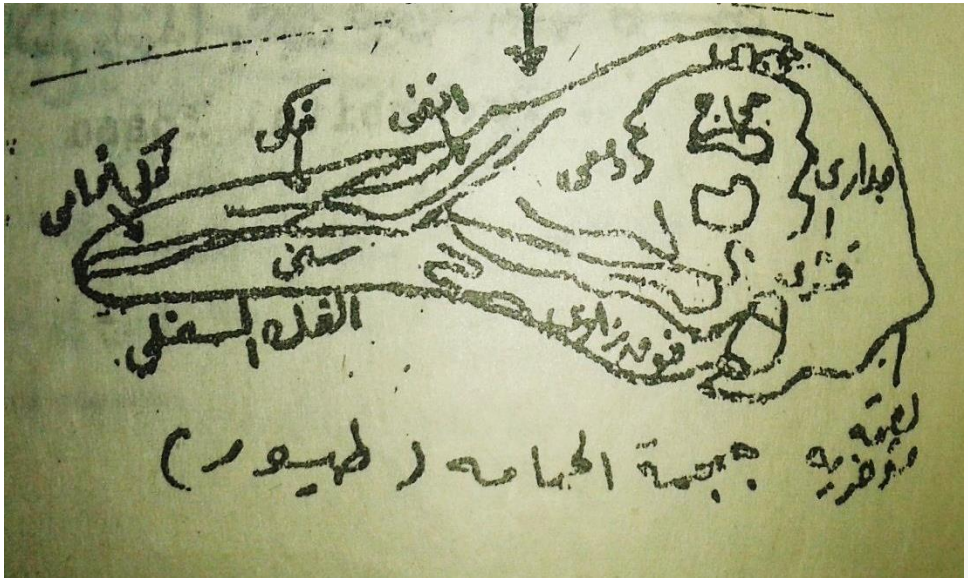
Evolution of skull of bird from the Diapsidian type



- **The post orbital** **disappears.**
- and thus the upper temporal fossa becomes contineous with the lower temporal fossa ventrally and with the orbit anteriorly
- **The anterior part of the skull** becomes elongated to form the beak, due to elongated, the nostrils shefted anteriorly and thus a new cavity formed between the nostrile and orbit called **preorbital fossa**
- **The dorsomedian group** consists of the nasals which lie between the nostrils in front and preorbital fossa behind. Then frontal and parietal behind
- **The cercum orbital group** bones are highly reduced except lacrymal bone.

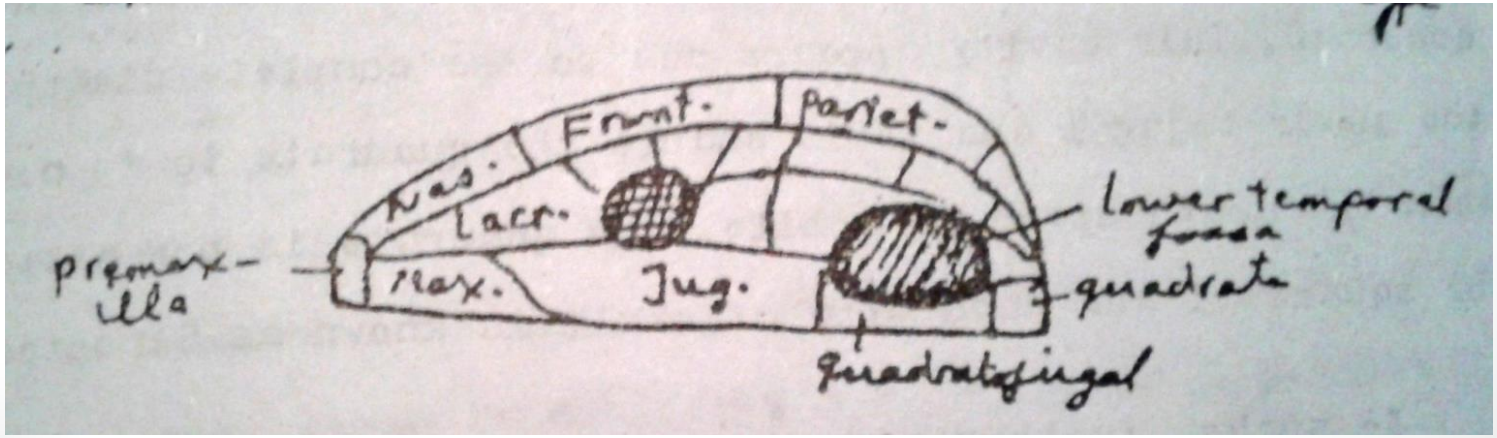
•**In the upper jaw**: the two premaxillae are fused together forming a single elongated beak. The maxilla, jugal and quadratojugal form a slender rod of bone that bounds the orbit ventrally.

•**The quadrate** has three process: orbital process towards the optic region, otic process towards the otic region and articular process articulated with the lower jaw.



Synapsidian skull in extinct reptiles, mammals

- It contains only the lower fossa
- It consists of complete upper jaw group except that the quadratojugal and quadrate are reduced
- The temporal group is represented only by the squamosal
- The jaw articulation take place between the quadrate and the articular.

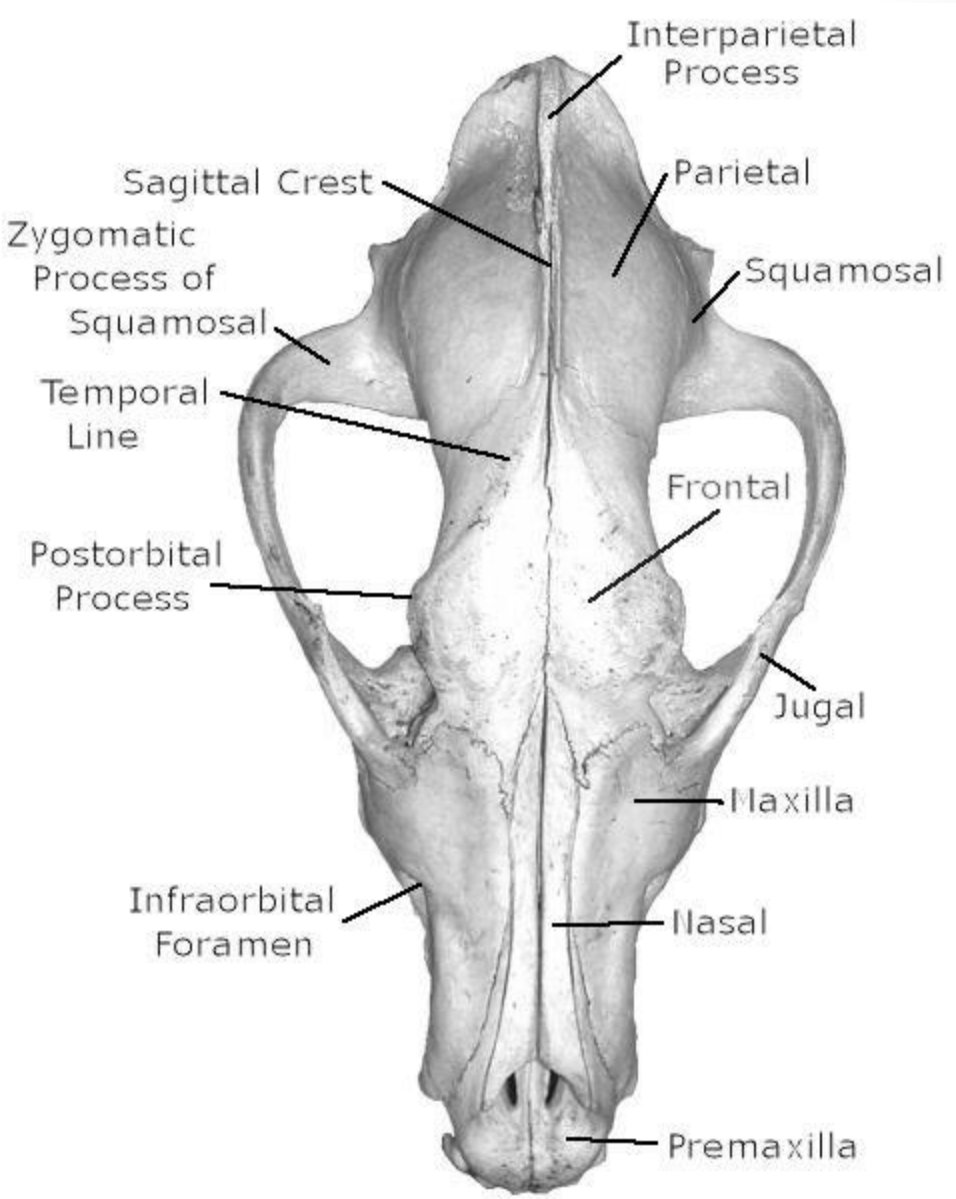


Evolution of skull of mammals from the synapsidian type

During evolution to form the skull some modification such as reduction, fusion and translocation take place:

1. the anterior part of the skull is prolonged forward to form the snout.
2. Post orbital and supra temporal disappear thus the orbit becomes confluent with the infra temporal fossa
3. In the dorsomedian group of bones :

   - a new bone called inter-parietal is developed.
4. The quadrato-jugal completely disappears and the quadrate become separated from the posterior region of the skull
5. The articulation between the jaws occurs by the squamosal of the skull and the dentary of lower jaw


Interparietal Process
Sagittal Crest
Parietal
Zygomatic Process of Squamosal
Squamosal
Temporal Line
Frontal
Postorbital Process
Jugal
Maxilla
Infraorbital Foramen
Nasal
Premaxilla

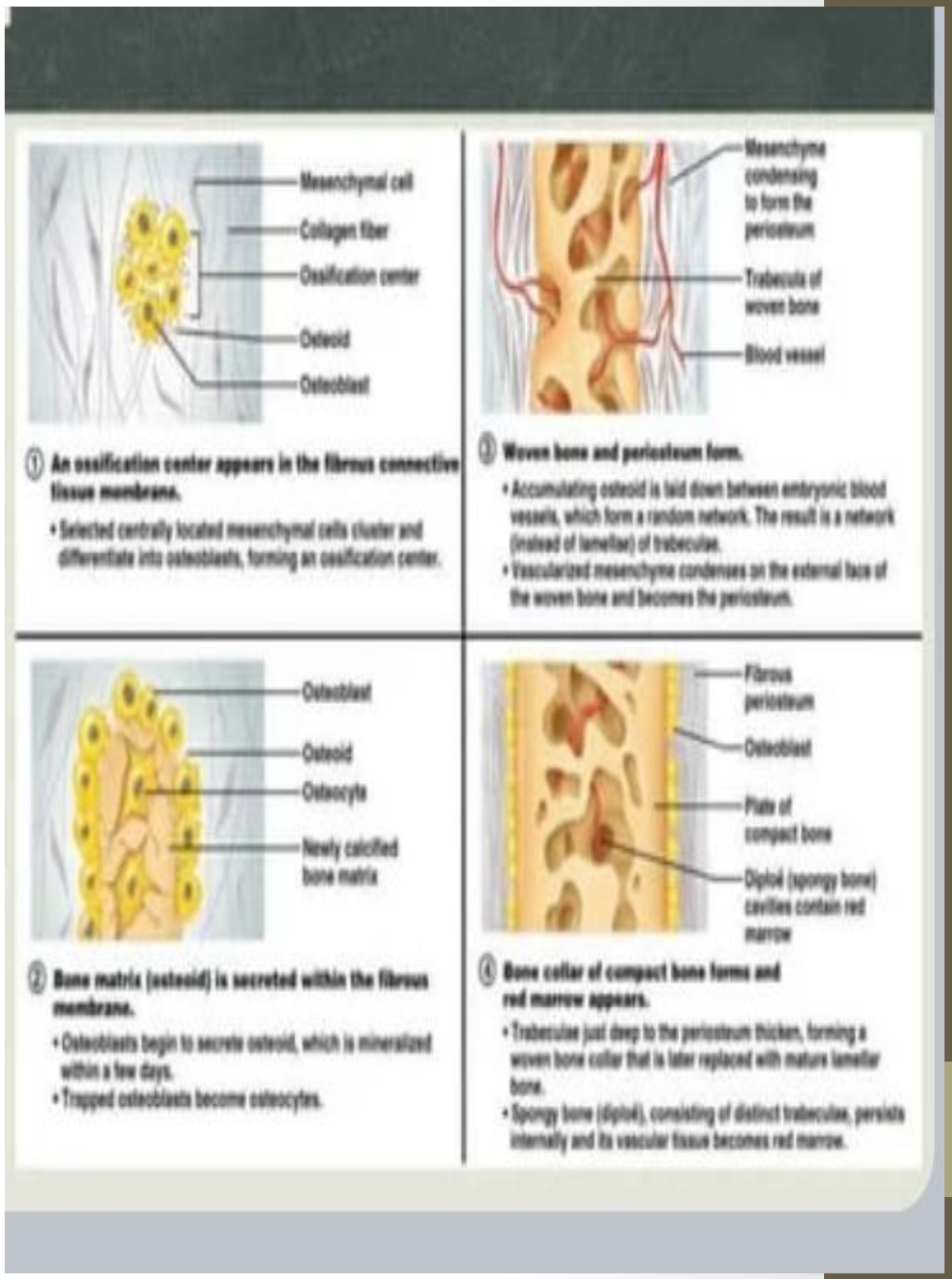
Postcranial skeleton

- **Axial**
- **Appendicular**
- **Function of body skeleton includes:**

- **Protects the viscera**
- **Contributes to ventilation of the lungs**
- **Store for various minerals**
- **Provides rigidity to the body**
- **Provides series of firm and hinged segments needed for locomotion in conjunction with the muscles.**

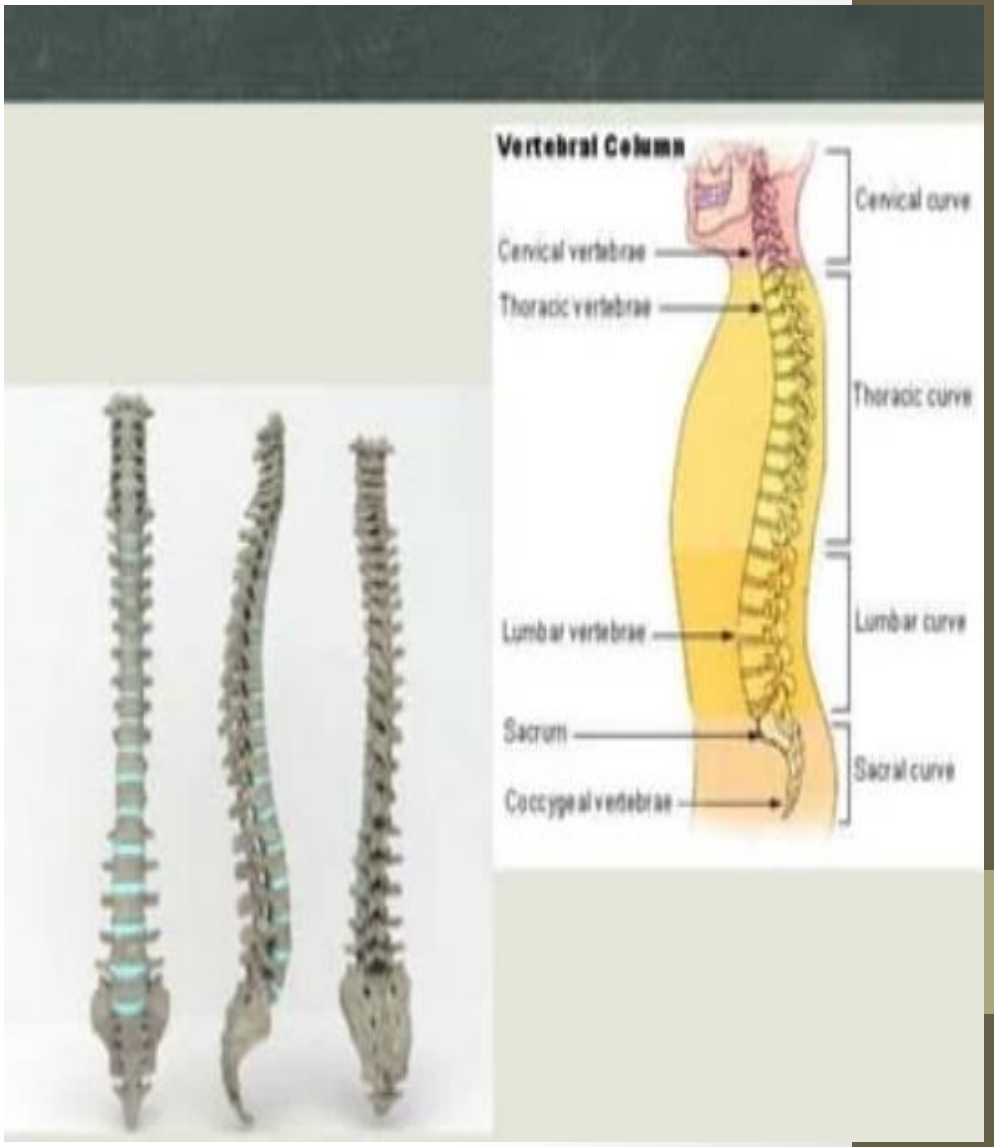
Notochord

- ✓ The primitive axial skeleton, replaced by the vertebral column.
- ✓ Unsegmented and composed of dense fibrous connective tissue .
- ✓ The first skeletal element to appear in the embryo of chordates.



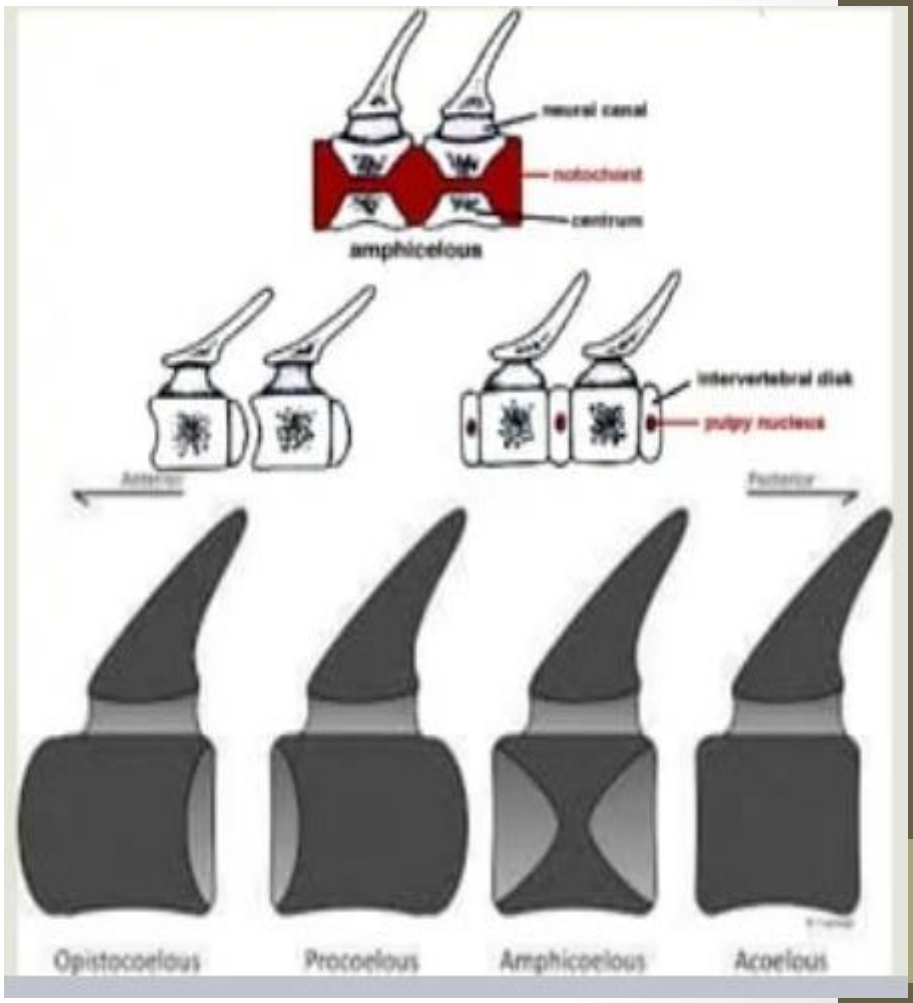
Structure and development of vertebral column

- The vertebral column is the main axial support of vertebrates.
- A vertebra is composed of a centrum, one or two arches, and various processes.
- It protects the spinal cord and provides rigidity to the body.



Types of centra based on shapes

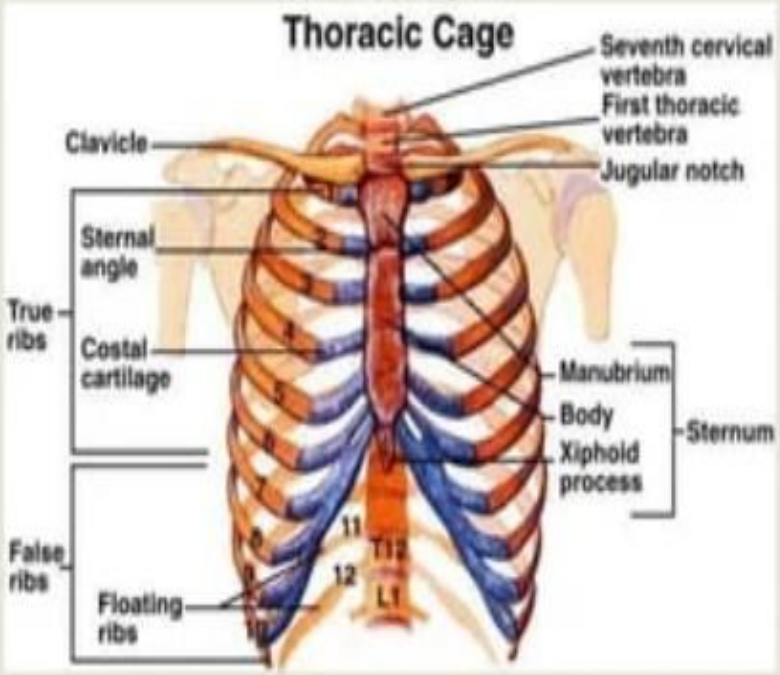
1. Amphicoelous
2. Procoelous
3. Opisthocoelous
4. Acoelous



Structure and Function of Ribs

- Series of cartilaginous or elongated bony structures served as attachment for the vertebrae extending into the body wall
- Provide sites for secure muscle attachment and help suspend the body
- Form a protective case (rib cage) around viscera
- In Amniotes, contributes to the breathing mechanism

Types of Ribs



1. True ribs – meet ventrally with the sternum, consist of two jointed segments
   - Vertebral or costal rib (proximal segment)
   - Sternal rib (distal segment)
   - Joint between costal and sternal ribs allows changes in chest shape during respiration
2. False ribs – articulate with each other but not with the sternum
3. Floating ribs – do not articulate ventrally

Structure and Function of Sternum

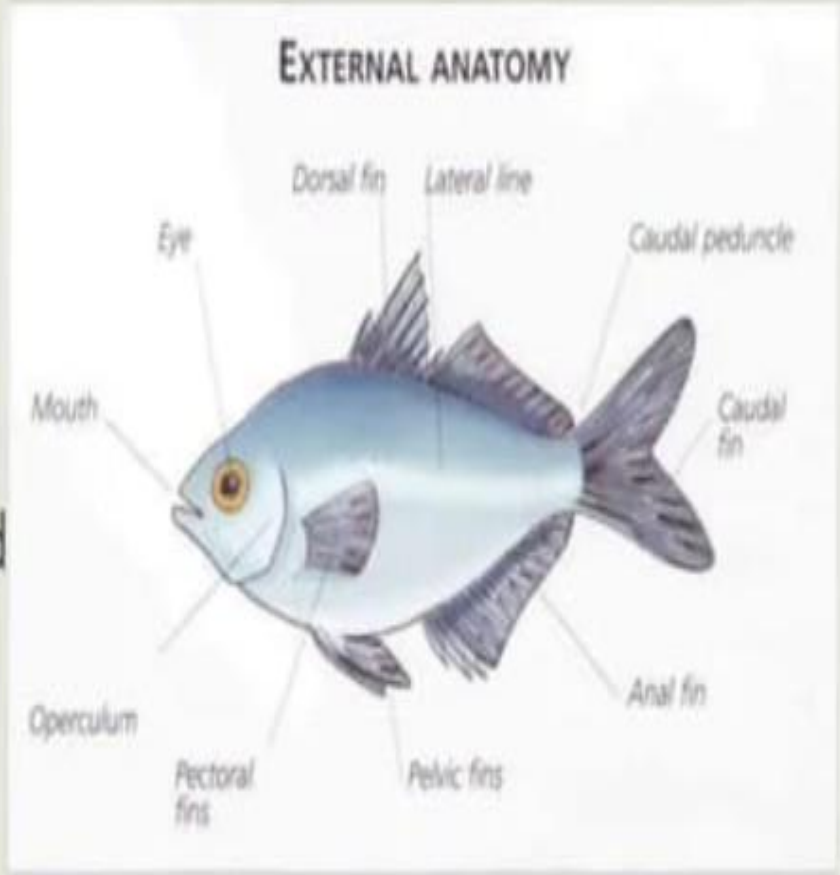
- A midventral skeletal element that usually articulates with the more anterior thoracic ribs and with the pectoral girdle
- Strictly a tetrapod structure and primarily, and amniote characteristic
- Strengthen the anterior part of the trunk and body wall
- Helps protect the thoracic viscera
- Accommodates muscles of the pectoral limbs
- In amniotes, helps in ventilating the lungs
- The sternum forms either paired or midventral primodia that are regarded as new structures not derived from the pectoral girdle or ribs

Appendicular Skeleton

Structure and Evolution of Median Fins

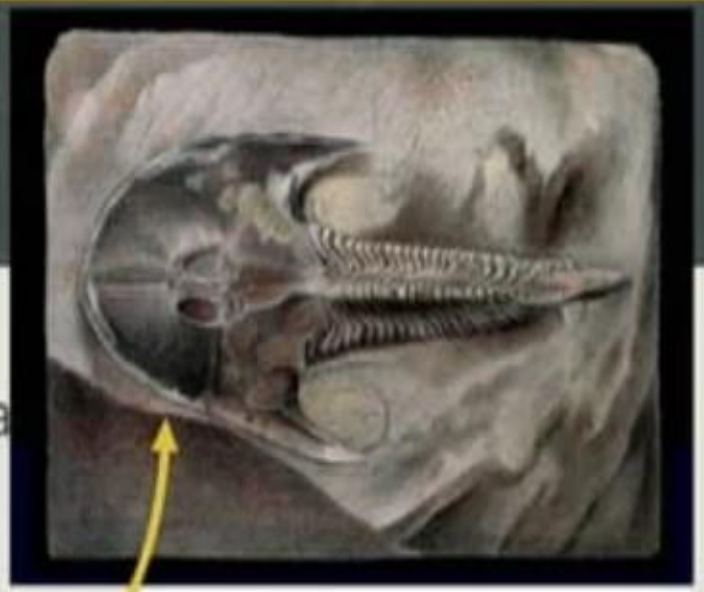
Occur in all jawless vertebrates and fishes:

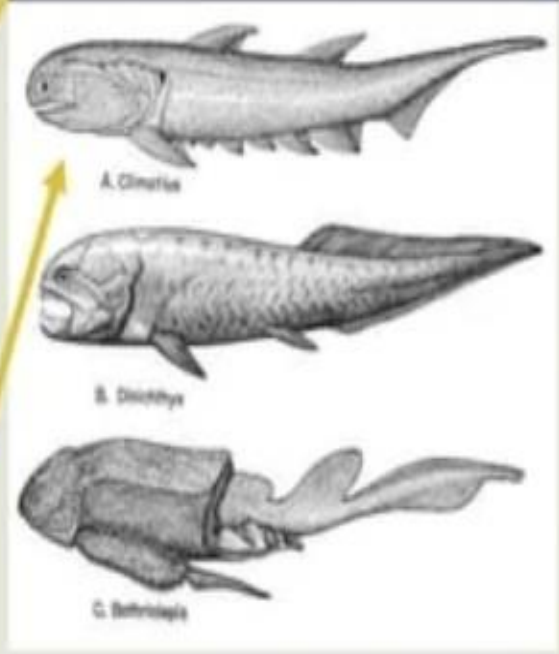
- Dorsal fins - located along the middorsal line.
- Anal fins - located between anus and tail
- Caudal Fin



DORSAL and ANAL FINS

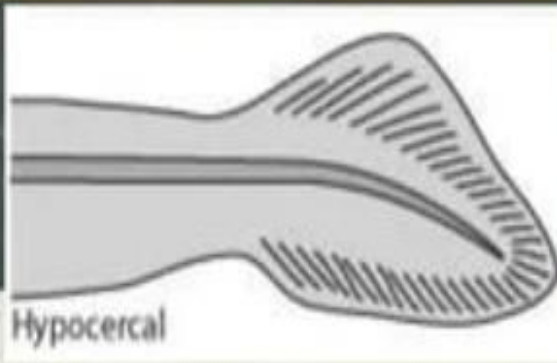
- Prevent the body from turning around the vertical axis (yawing) and around the longitudina axis (rolling).
- In primitive vertebrates, each fin is supported within the contour of the body by a series of rod-like radials or pterygiophores.
- The exposed membrane of fins of CEPHALASPIDS and some PLACODERMS are supported only by dorsal scales.



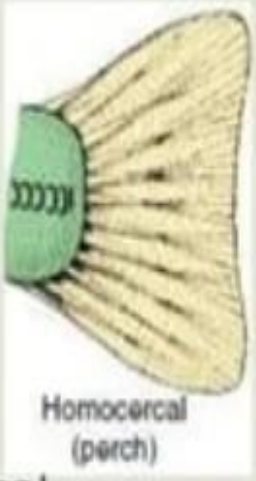


CAUDAL FIN

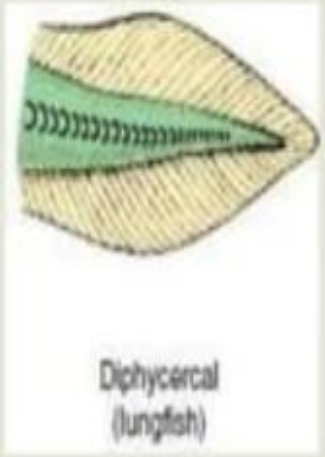
Classified into four types depending on size and shape of the spine.



1. Diphycercal – if the spine is straight to the tip of the tail with equal dorsal and ventral lobe of the tail. (ex. Cyclostomes, pleuracanths, and some sarcopterygians)
2. Hypocercal – if the spine tilts downward with longer ventral lobe than dorsal lobe.(ex.anaspids)



3. Heterocercal – if the spine tilts upward with longer dorsal lobe than ventral lobe.(ex.cephalaspids, placoderms, most chondrichthyes, and primitive osteichthyes)
4. Homocercal - if all the fin membrane is posterior to the spine with equal dorsal and ventral lobe.(ex.all teleosts)



Structures and Evolution of Girdles

1. Ceratotrichia
2. Scapulocoracoid Bar
3. Propterygium
4. Mesopterygium
5. Metapterygium

A. Basal Pterygiophores

Girdles of fishes

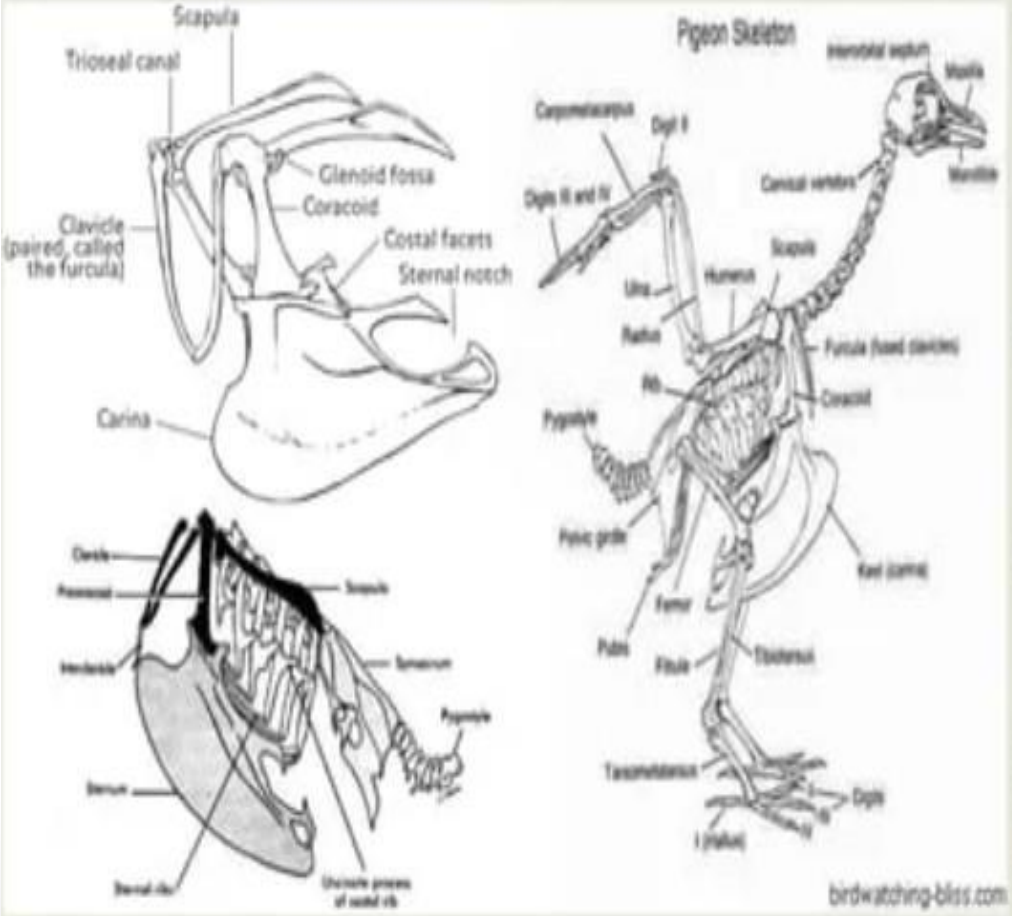
- the pectoral girdle is older, larger and more complicated than pelvic girdle.

-It includes one or more cartilage or replacement bones and several dermal bones derived from ancestral scales and armour plates.

- Placoderms cartilaginous fins was related to overlying plates of dermal skeleton.
- Cartiliginous fishes has no dermal elements

Scapulocoracoid – the right and left halves fused in the midline forming a U-shaped girdle

Girdle and Tetrapod



- BIRDS have a bladelike scapula that is oriented parallel to the spine.

  - with large anterior coracoid that is articulated with the sternum

  - the posterior coracoid has been lost

  - two clavicles fuse ventrally forming the furcula or absent in some birds.

Girdle and Tetrapod

- the only membrane bone retained Therian Mammals is the clavicle

- The anterior coracoid is completely lost.

- the posterior coracoid fuses to the scapula forming the coracoid process of the scapula

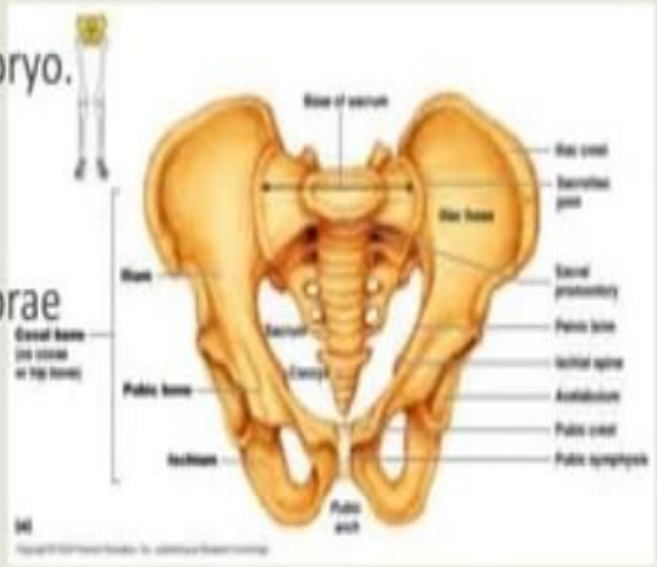
- the scapula is unique in having spine which represents its anterior border

- the ventral end of the spine is continued as the acromion process to articulate with the clavicle.

Girdle and Tetrapod

- the pelvic girdle of Tetrapods is much enlarged over that of fishes and is relatively uniform in basic structure.

-each half of the pelvic girdle is a single cartilaginous unit in the embryo.



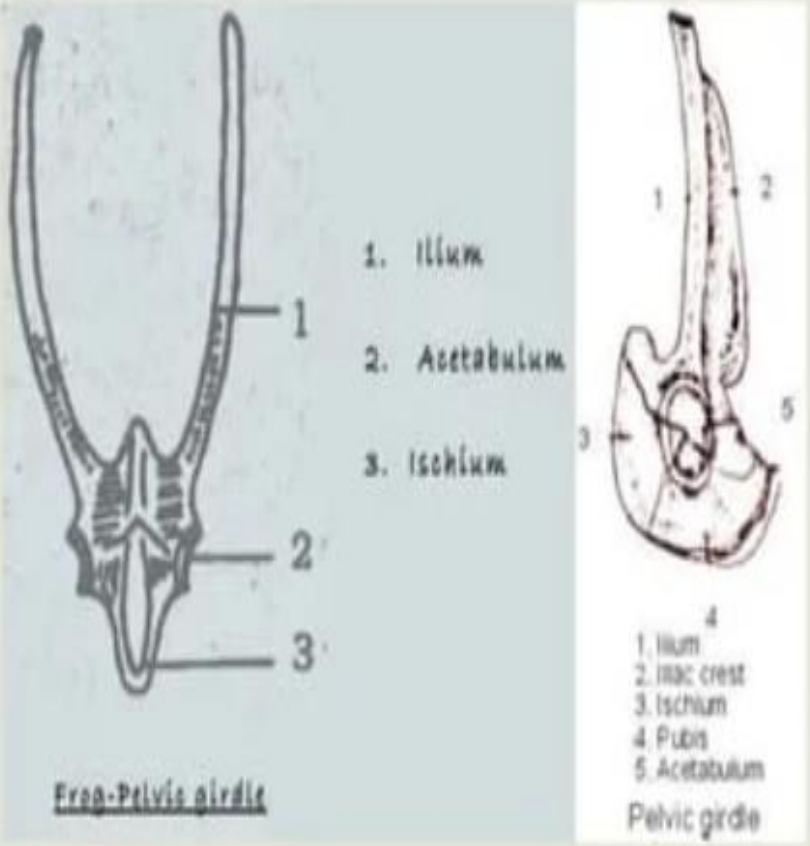
-three bones are constant in the adult:

- a dorsal ilium, which articulates with one or more sacral vertebrae
- an anterior pubis
- A posterior ischium

-the bones of one side usually fuse in the adult forming the innominate bone

-one or both of the ventral bones of the two sides usually articulates of fuse across the midventral line, the contact is called pelvic symphysis

Girdle and tetrapod

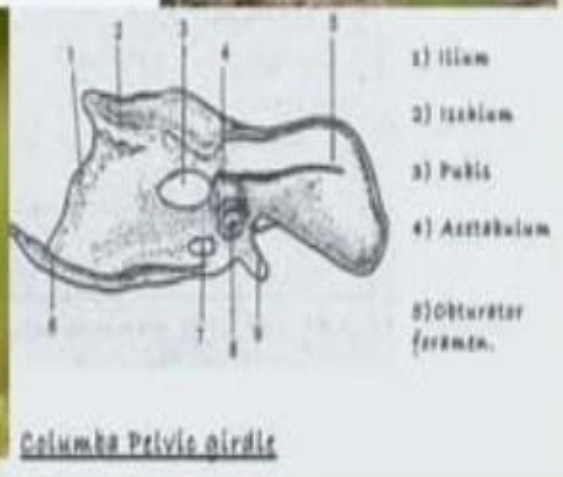


- Primitive amphibians had a solid, triangular shaped pelvic girdle with the ilium forming the apex

  - the pubis can be distinguished from the ischium by having a obturator foramen that accommodates a nerve.

- In FROG, the girdle has a long, anteriorly inclined ilium and cartilaginous pubis.

Girdle and Tetrapod



Columba Pelvic girdle

- REPTILES has various shapes patterned after the basic plan of LABYRINTHODONTS

-the contact with the spine is firmer

-the large pubo-ischiadic fenestrum is present between the two ventral bones

- Birds have a large pelvic girdle that is firmly attached to the synsacrum

-the long ilium extends both anterior and posterior to the socket for the femur or acetabulum: The pubis is turned backward below the ischium and there is no symphysis

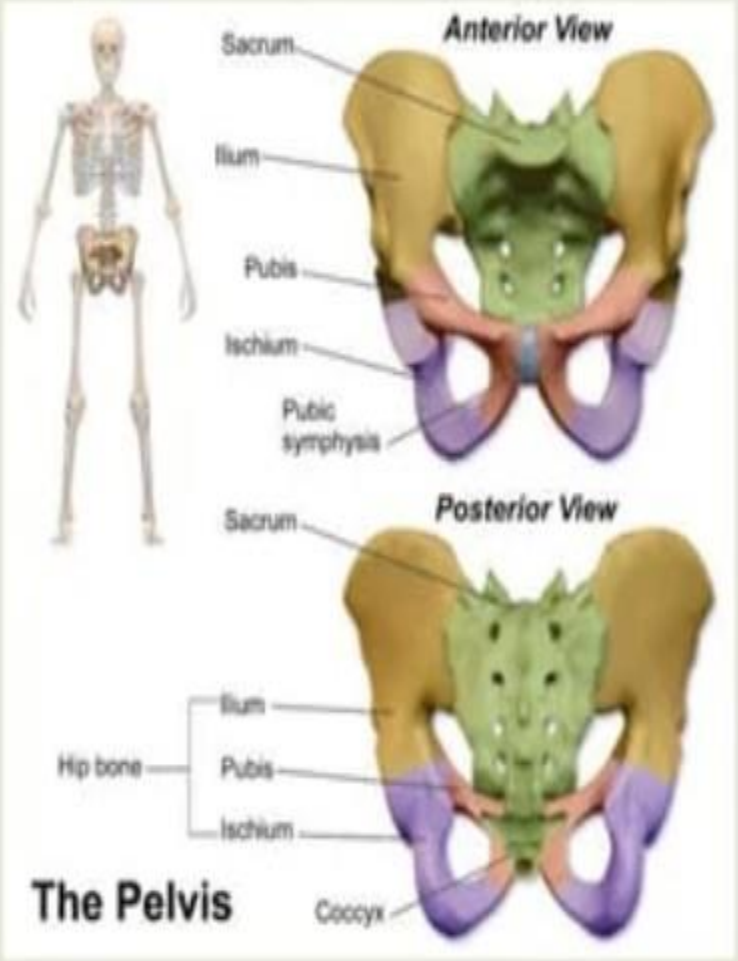
Girdle and Tetrapod

- Mammals have a long and expanded ilium extending only forward from the acetabulum

- the large obturator fenestrum represents both the obturator foramen and the pbo-isichiadic fenestrum of the ancestor.

- a symphysis is always present

- MONOTREMES and MARSUPIALS have epipubic bones that articulate with the pubic bones extending forward in the ventral body wall.



EVOLUTION COURSE

محتوي مقرر التطور
Evolution

- **Historical concepts of evolution.**
- **The evidence for evolution.**
- **Theories of organic evolution.**
- **The Darwin-Wallace theory of natural selection.**
- **Appraisal of theory of natural selection.**
- **Mutation (Types, nature, frequency and causes of mutations).**

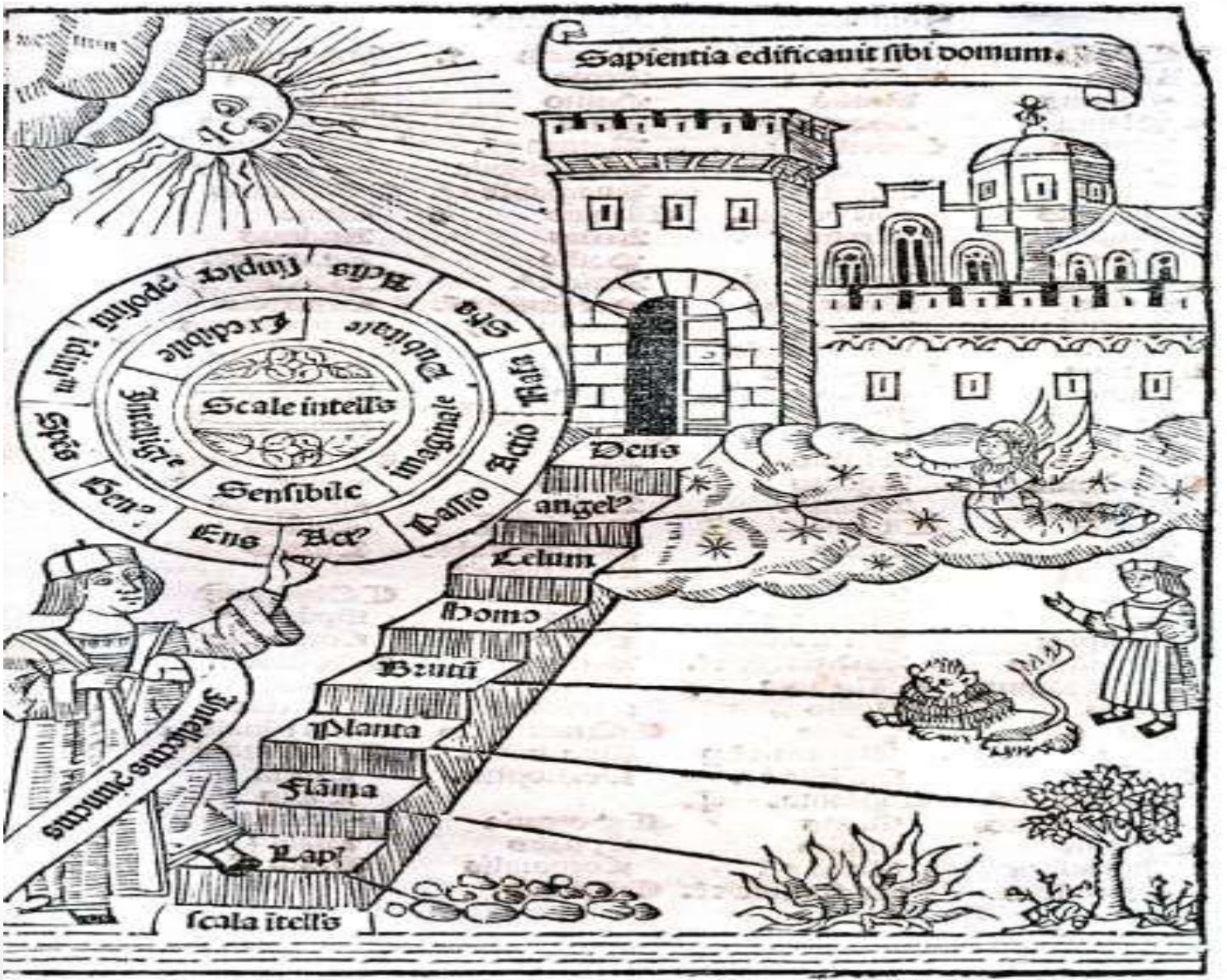
Modern synthesis of evolution.
Natural selection.
Present of concepts of evolution.
The origin of life
Origin of living system.
Principles of evolution.

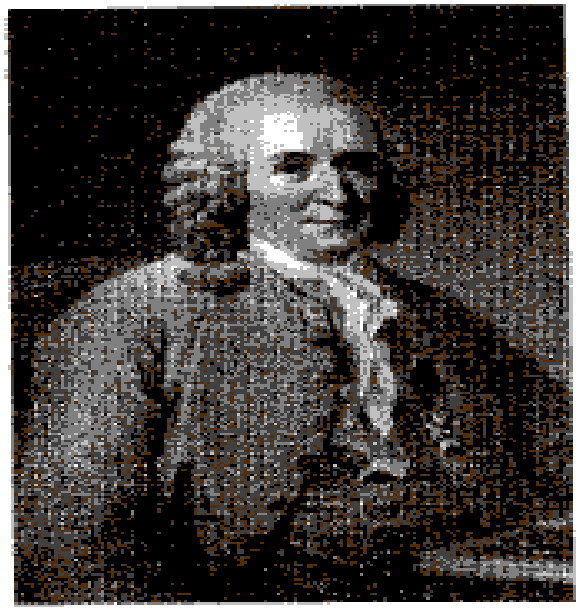
Historical Background

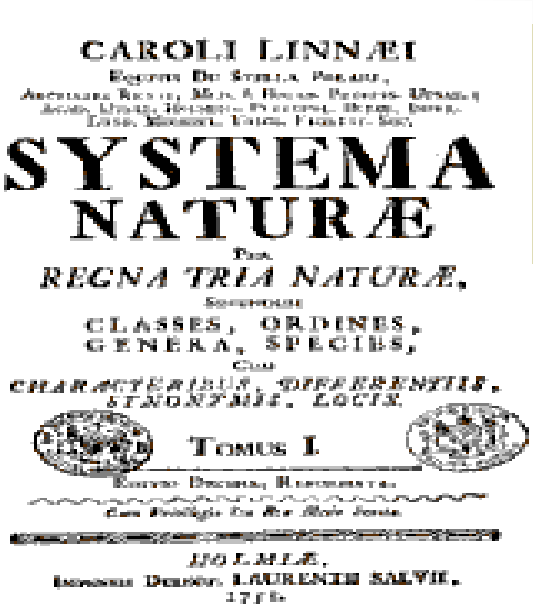
- **Plato (427-347 BC) – Believed in 2 worlds: the real world**
- **(ideal and eternal), and an illusionary world (imperfect and**
- **perceived through the senses).**
- **Typological view of nature– individual variation as the imperfect manifestation of ethos.**

- **Aristotle (384-322 BC) – Believed that all living organisms**
- **could be arranged in a "scale of nature" or Great Chain of**
- **Being.**
- **The ladder of nature consists of graduation from inanimate material through plants, through lower animals and humans to other spiritual beings.**

The Great Chain of Being







Carolus Linnaeus (1707-1778) – Established the modern system of taxonomy in an attempt to discover order in the diversity of life “for the greater glory of God”.

- Groupings based on similarity
- Hierarchal relationships of organisms

Early Ideas About Evolution

- **Earth formed according to laws**
- **of physics and chemistry**

Older than previously thought

- **Life emerged as distinct types**

Transformed when environment Changed

Georges Buffon

(1707-88)

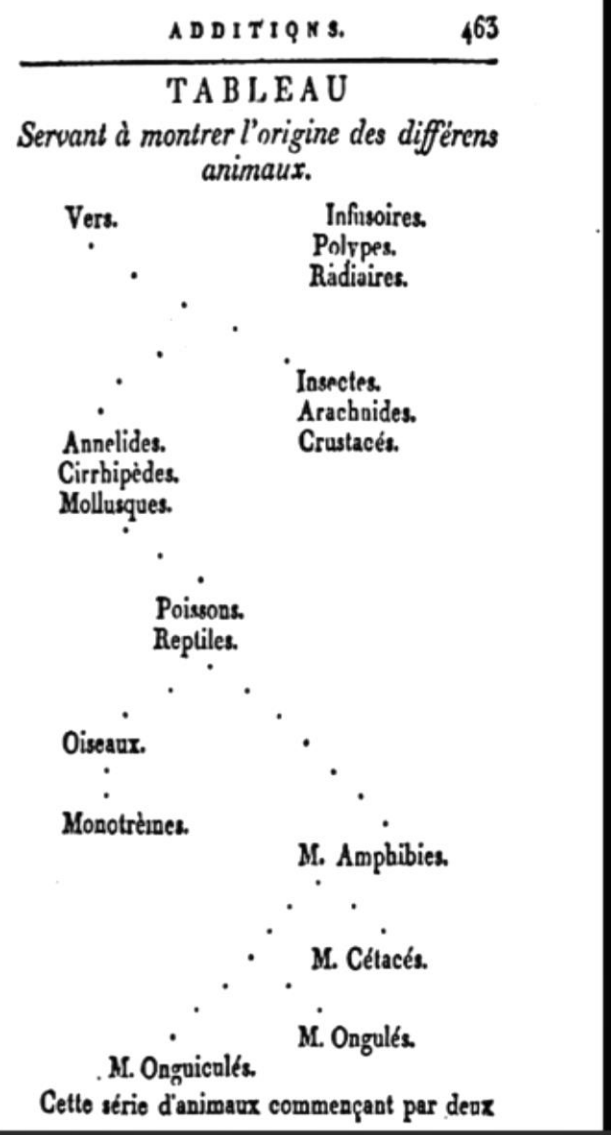
Jean-Baptiste Pierre Antoine de Monet, Chevalier de Lamarck

- **1809 Philosophie Zoologique.**

First articulated theory of evolution:

- **Organisms continually arise by spontaneous generation.**
- **“Nervous fluid” acts to move each species up the “great**
- **chain of being”.**
- **Organisms develop adaptations to changing environment**
- **through the use and disuse of organs. (Heavy use attracts**
- **more “nervous fluid”.)**
- **Acquired characteristics are inherited.**

LAMARCKIAN EVOLUTION



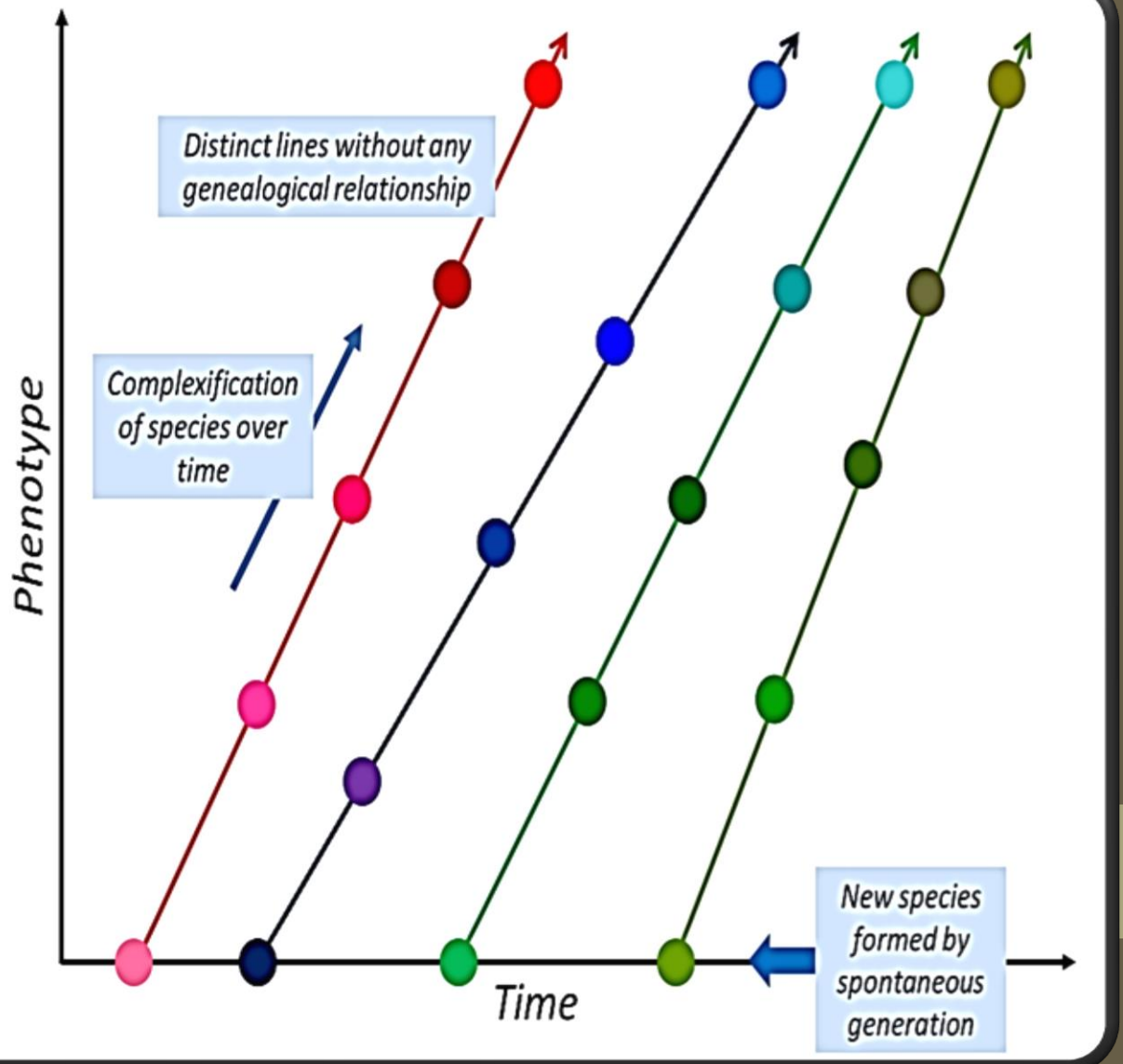
ADDITIONS. 463

TABLEAU

Servant à montrer l'origine des différens animaux.

Vers.
Infusoires.
Polypes.
Radiaires.
Insectes.
Arachnides.
Crustacés.
Annelides.
Cirrhipèdes.
Mollusques.
Poissons.
Reptiles.
Oiseaux.
Monotrèmes.
M. Amphibies.
M. Cétacés.
M. Ongulés.
M. Onguiculés.

Cette série d'animaux commençant par deux



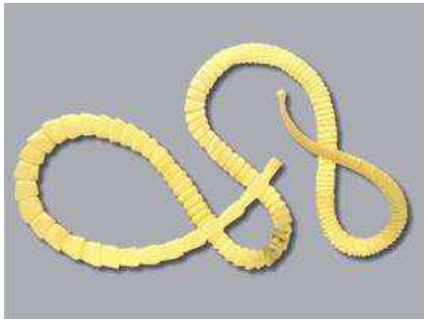
Problems with Lamarck's ideas

1) There is no evidence of spontaneous generation.

2) There is no evidence of an innate drive toward complexity.

E. coli organisms

Parasites



Cave dwelling

3) There is no evidence of inheritance of acquired characteristics. (BUT…..epigenetics???)

How Old is the World?

Archbishop James Ussher

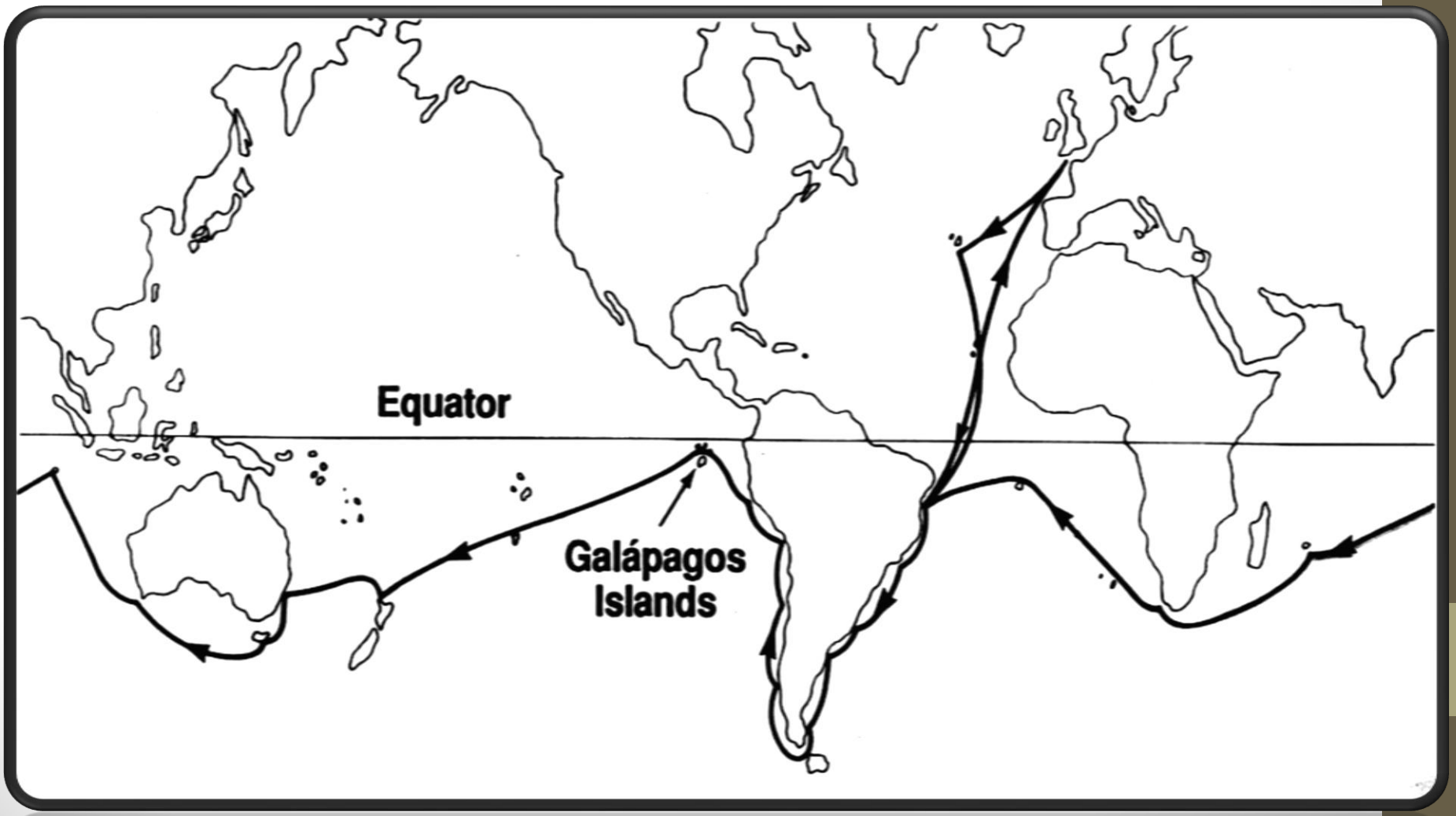
Calculated in 1664 that the Earth was precisely **5,668** years old.

"Heaven and Earth, Centre and substance were made in the same instant of time and clouds full of water and man were created by the Trinity on the 26th of October 4004 B.C., at 9:00 in the Morning."

Record of Historical Change

Nicolas Steno (1638-86): Father of geology and stratigraphy

The Voyage of the Beagle (12/27/1831 to 10/2/1836)



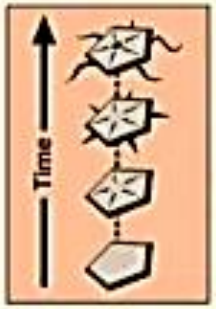
EVIDENCE OF EVOLUTION

BYJU'S
The Learning App

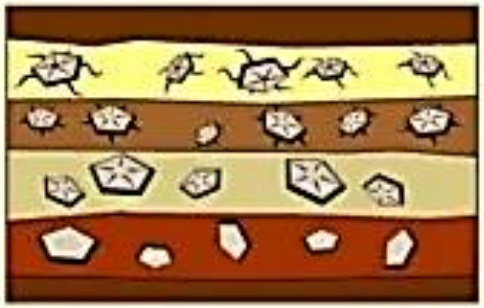
1 Fossils | 2 Comparative Anatomy | 3 Embryo Development

Evidence for Evolution

Fossil record

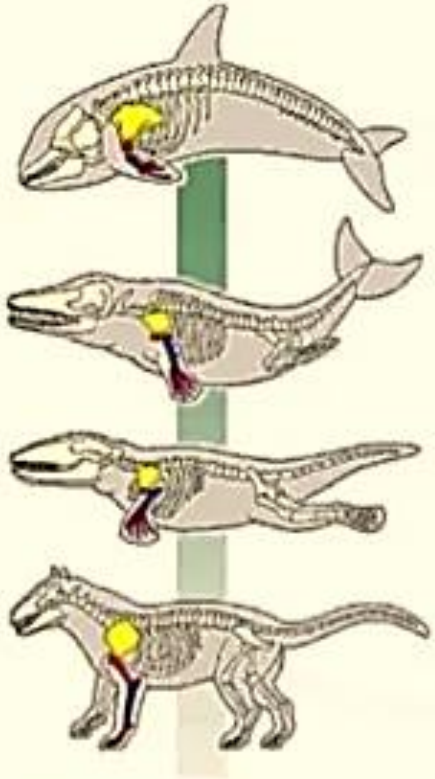


Gradual lineage evolution



Rock strata with fossils

Homologous structures

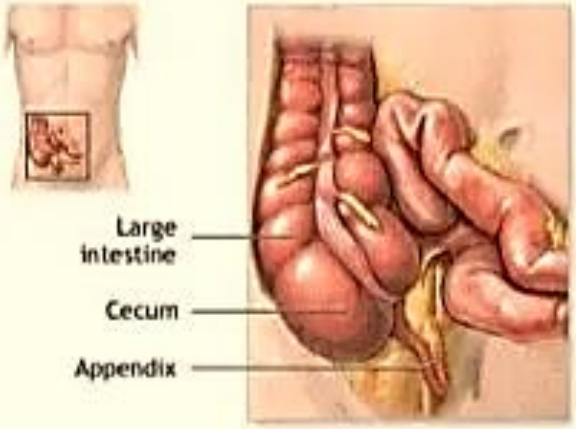


http://evolution.berkeley.edu/evosite/evo101/VIIAPacecevolution.shtml

Selective breeding

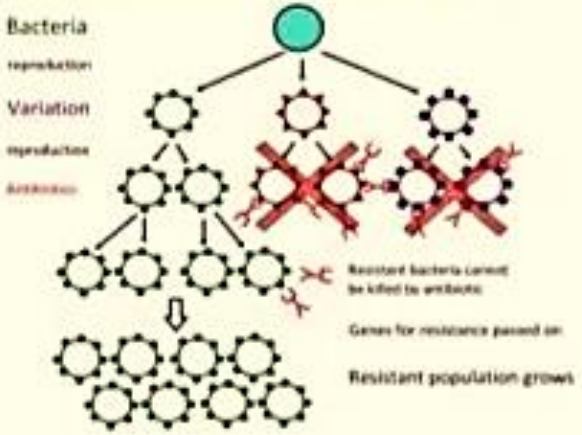
http://www.bbc.co.uk/schools/ks3bitesize/science/images/bio_dogs.gif

Vestigial structures



http://www.nlm.nih.gov/MEDLINEPLUS/ency/imagepages/1128.htm

Observable changes



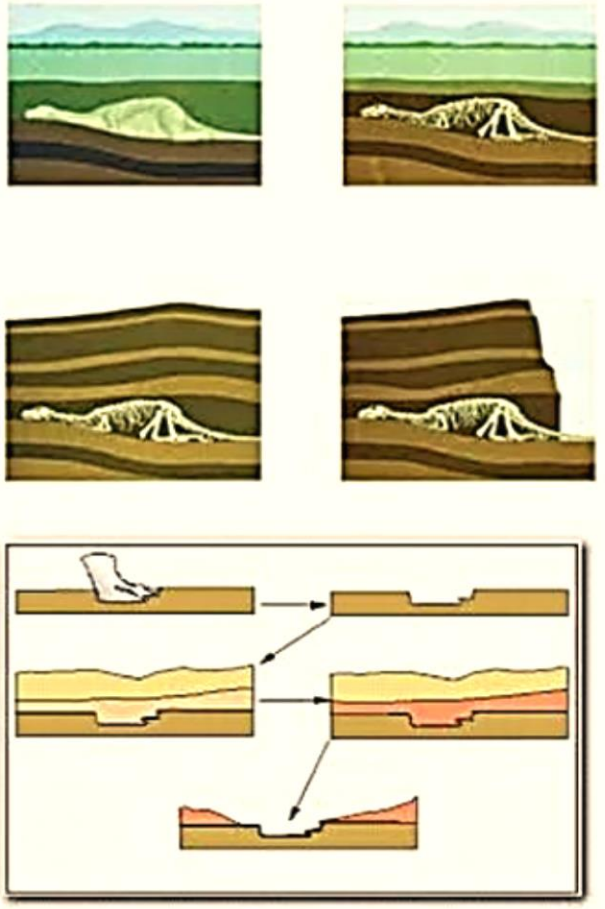
i-Biology

The Fossil Record

- Paleontology is the study of the fossil record to document life's early history
  - Documents patterns within species living at a specific time and area
  - Documents extinctions and new arrivals
  - Documents evolution of life as the environment of Earth changed
- Index (Key) Fossils are those found in similar strata over a wide area… used for relative dating

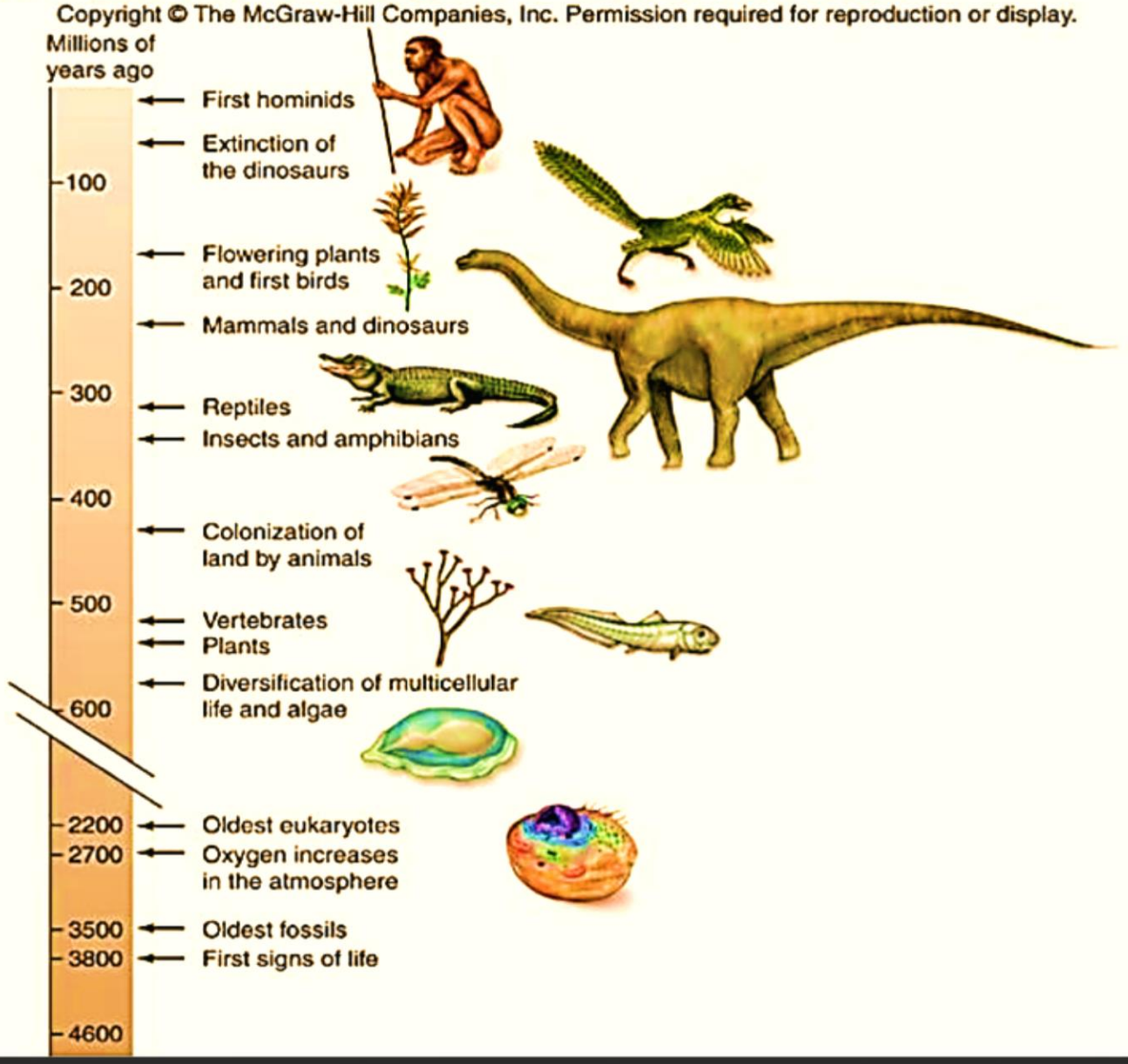
Formation of Fossils

- Whole remains…
  - Requires a soft substrate (sand, snow, riverbed, tar pit,…)
  - Organism must be buried and protected for the elements
- Fossils can be evidence of life
  - Footprints, tunnels and burrows



Fossil Evidence of Evolution

Fossil records document the course of life through time

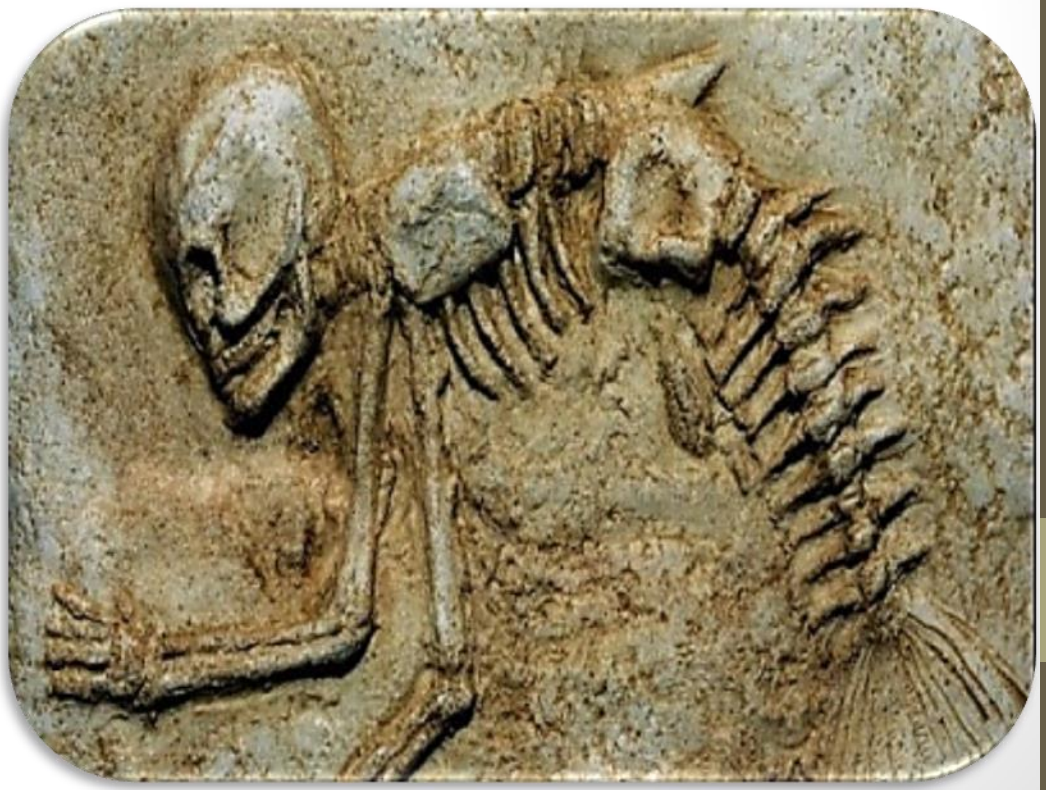


Methods of fossilization
1- imprisonment in ice

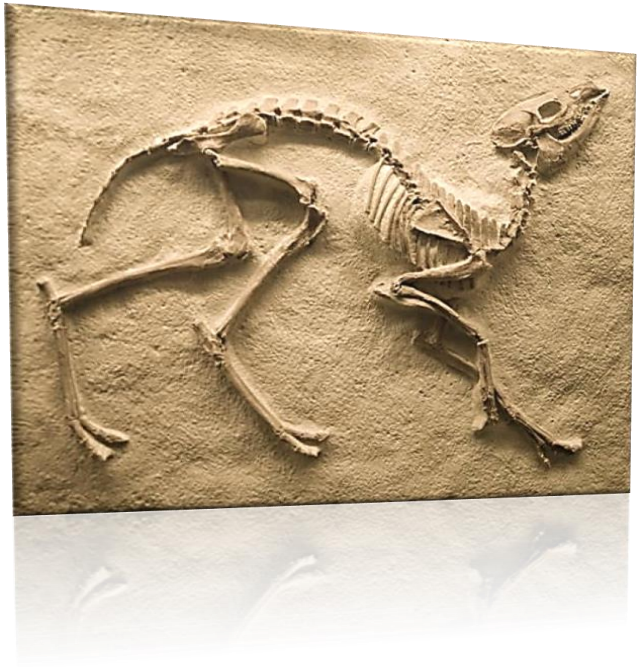
2- Preservation in Amber

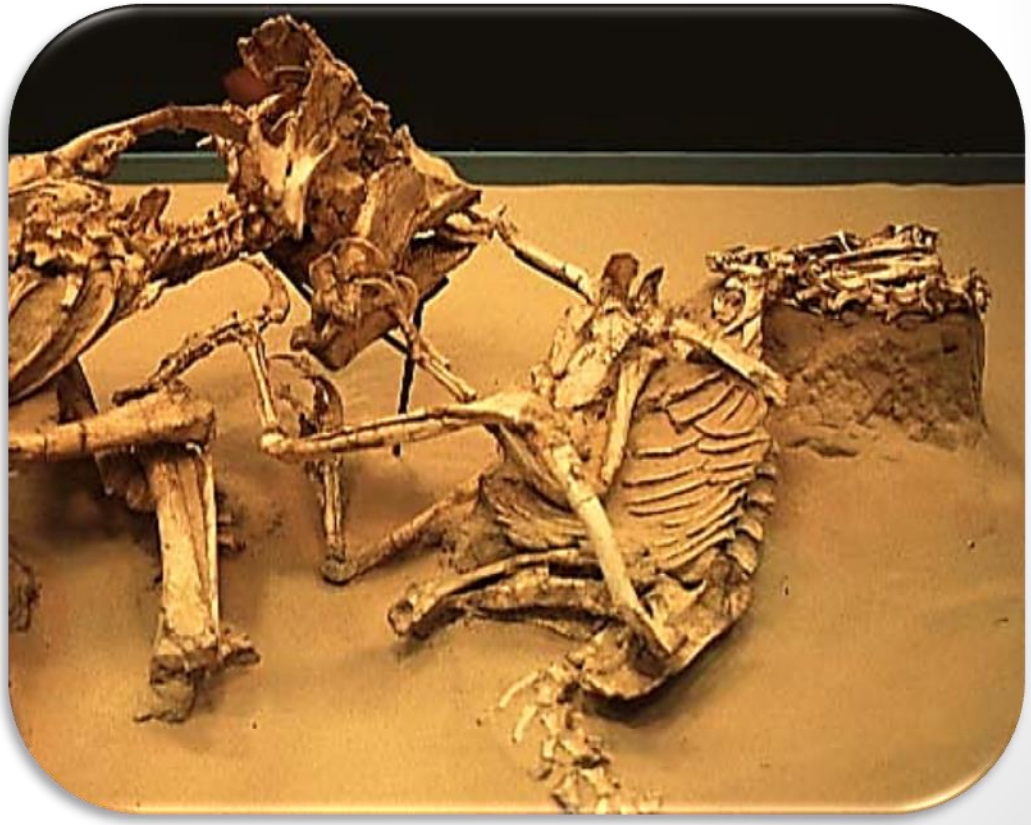
3- Preservation in oil and tarry substances

4- Preservation in acid Bogs

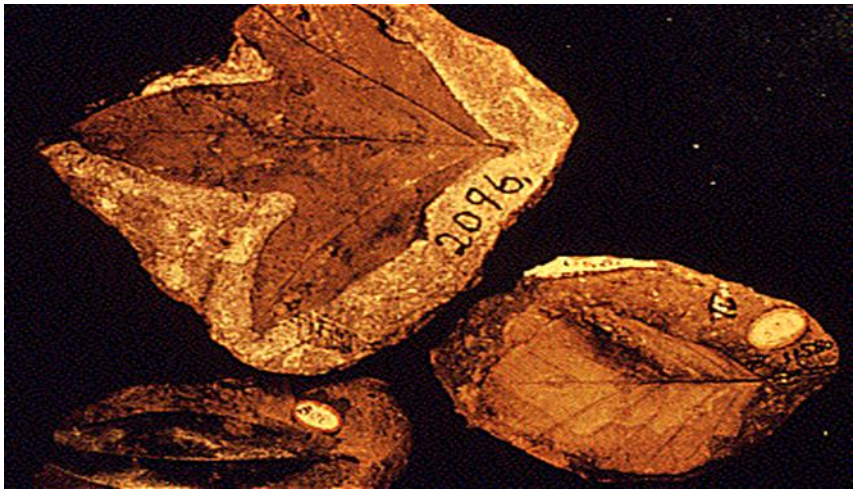


5- Preservation by dehydration

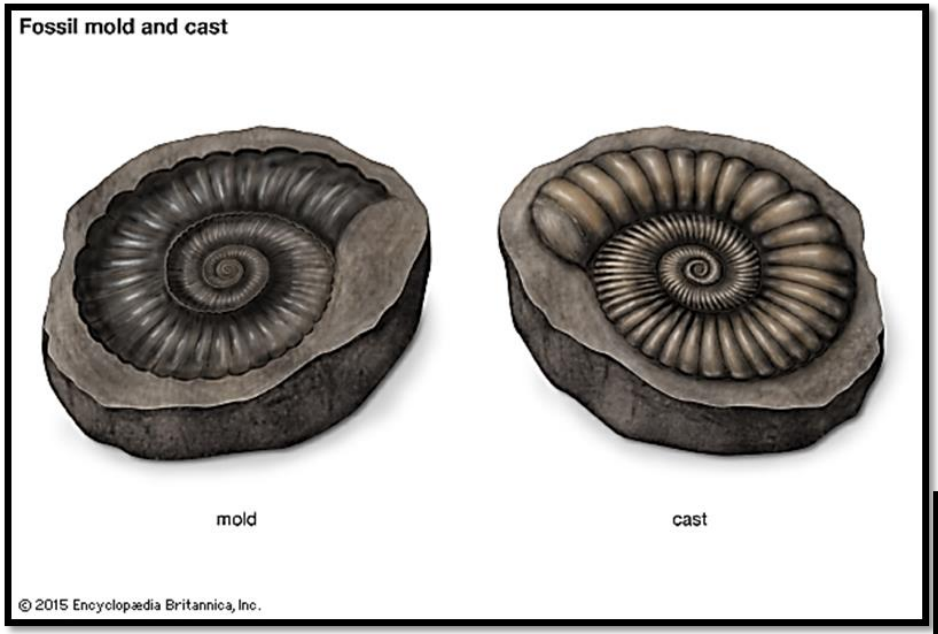


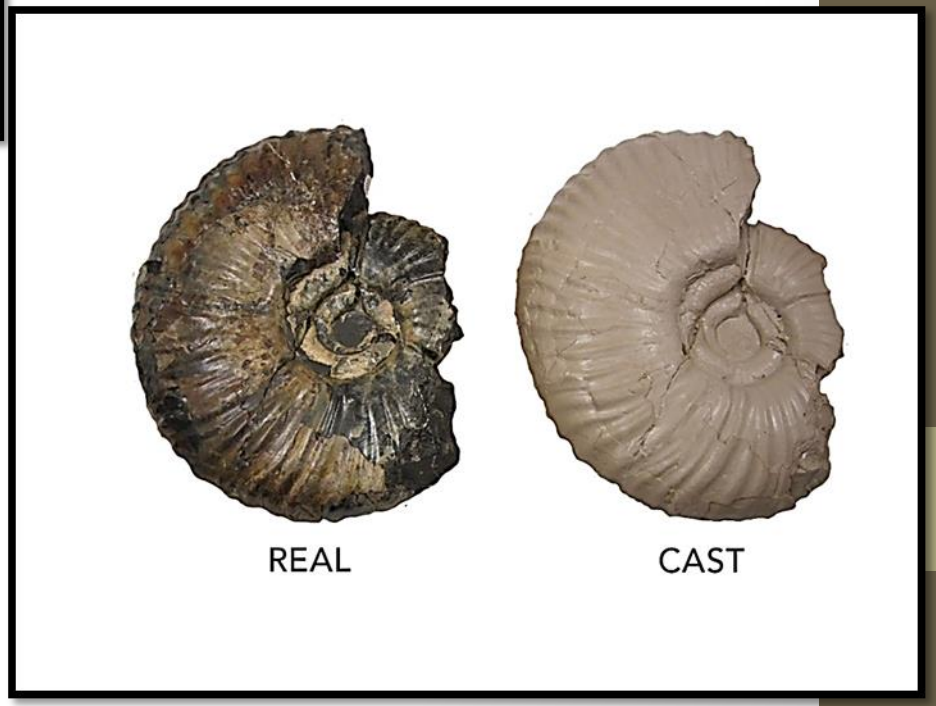


6- Formation of impressions



7- Formation of Cast

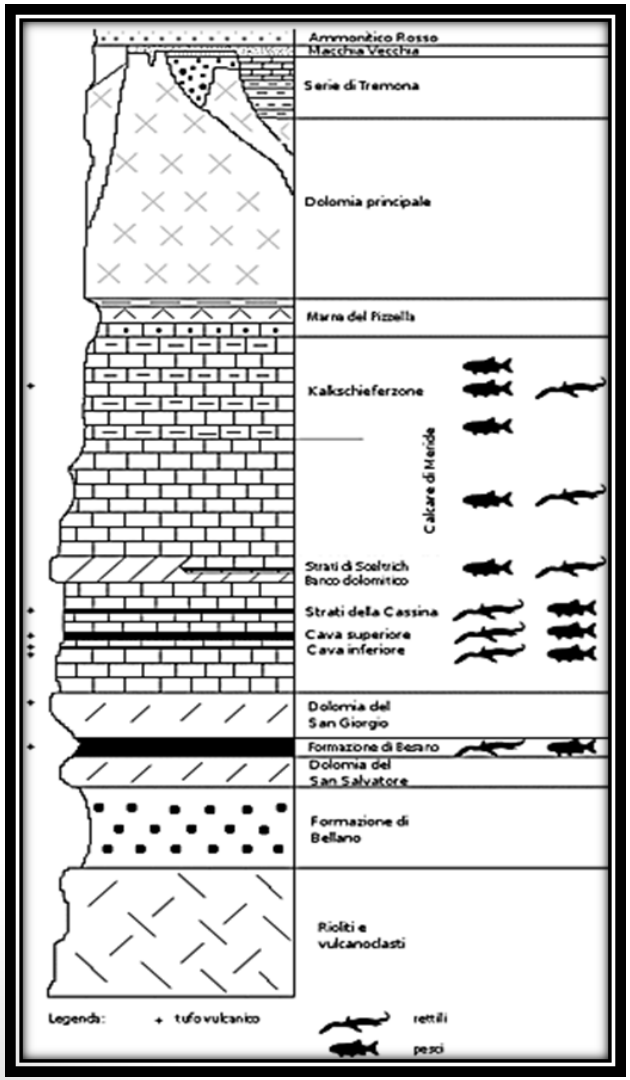




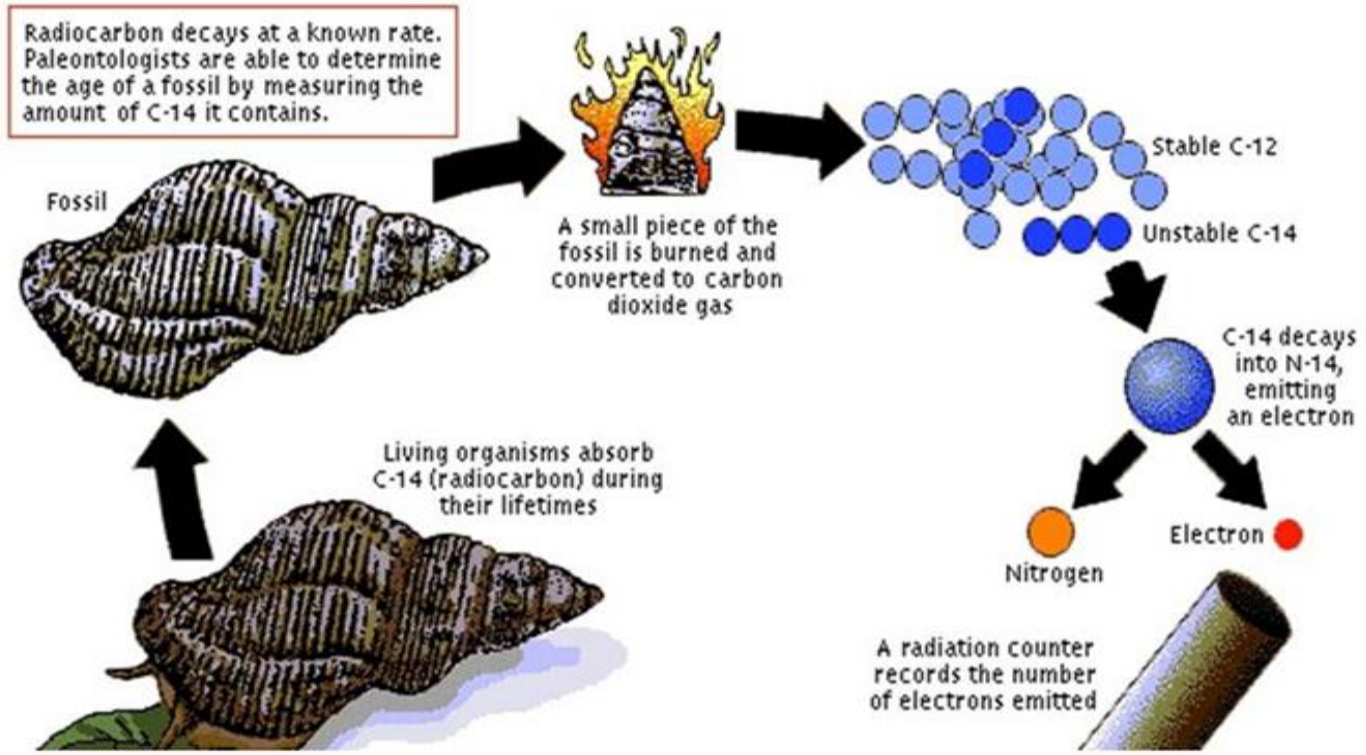
8- Petrifaction

Dating of fossils

Comparing the age of the fossil with the geographical patterns which found in.

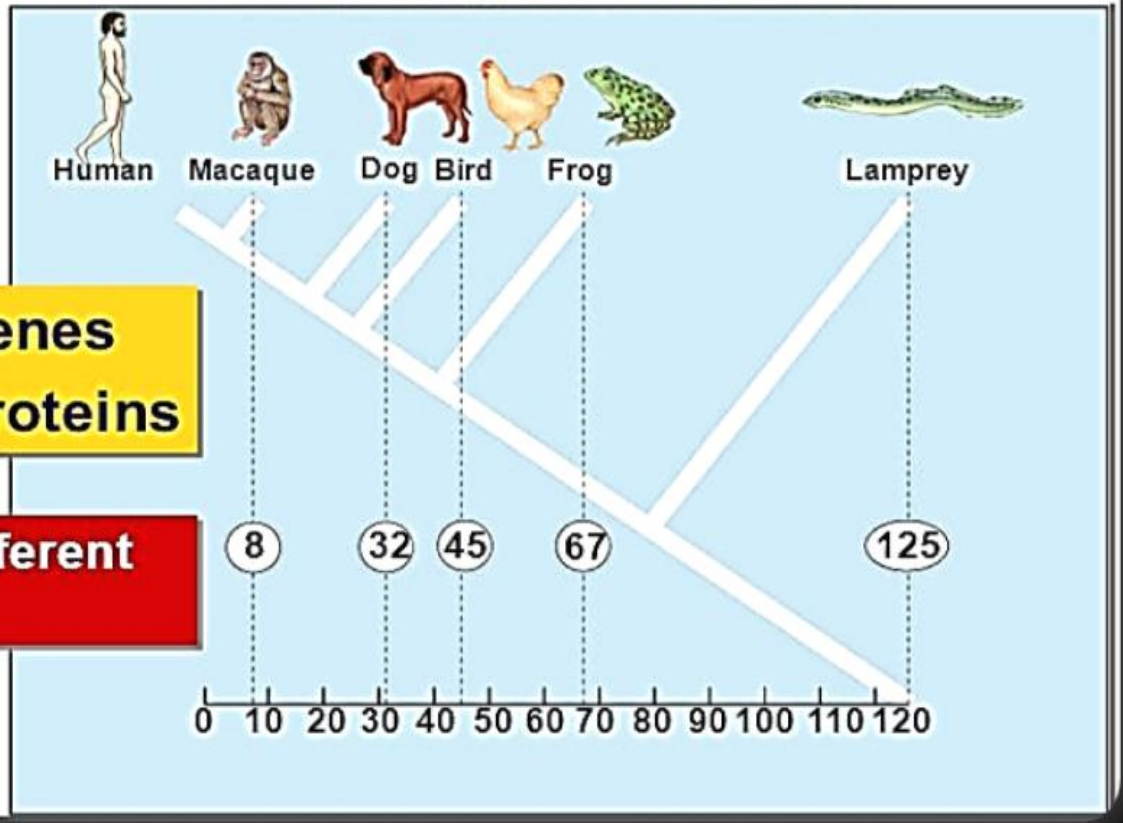


Radioactive dating



3. Molecular record

- Comparing DNA & protein structure
  - everyone uses the same genetic code!
    - DNA



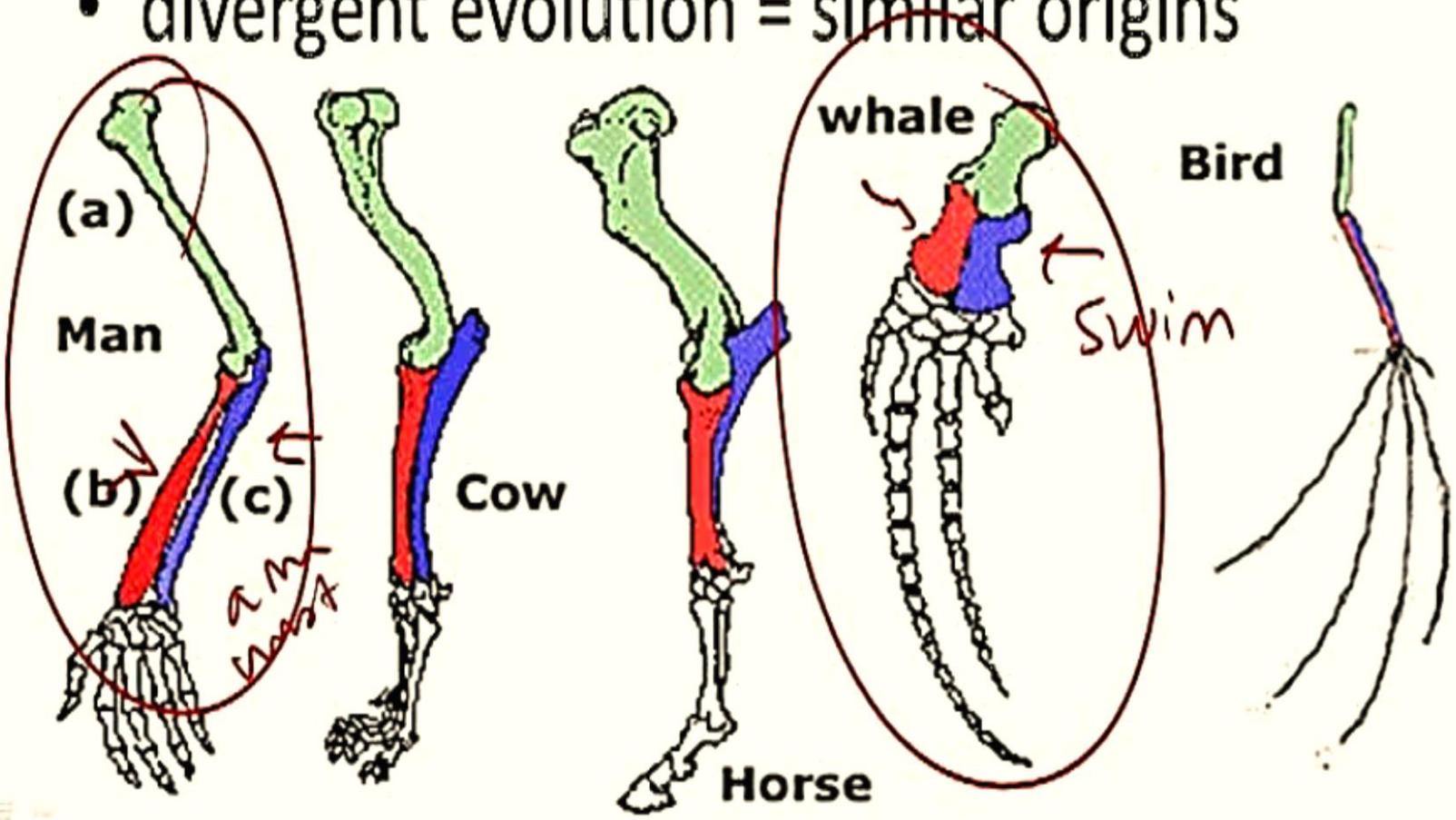
- compare common genes
- compare common proteins

number of amino acids different from human hemoglobin

Homologous Structures

Diverge

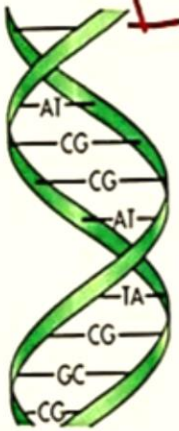
- anatomically similar; different functions.
- divergent evolution = similar origins

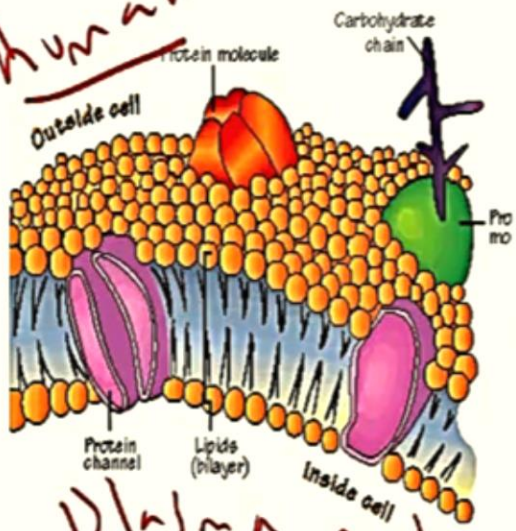


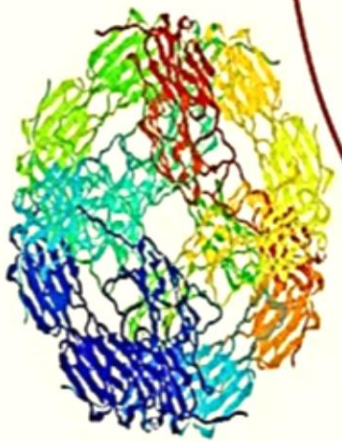
Molecular Evidence for Evolution

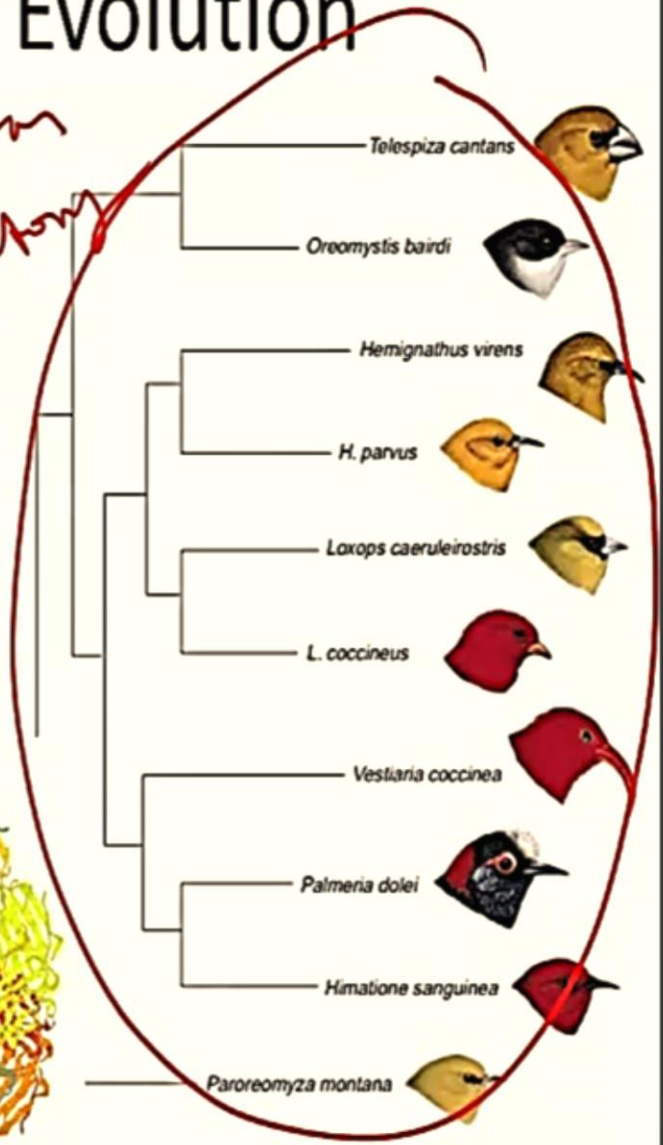
Molecular biologists:

- compare genes and proteins of different organisms
- help determine evolutionary relationships



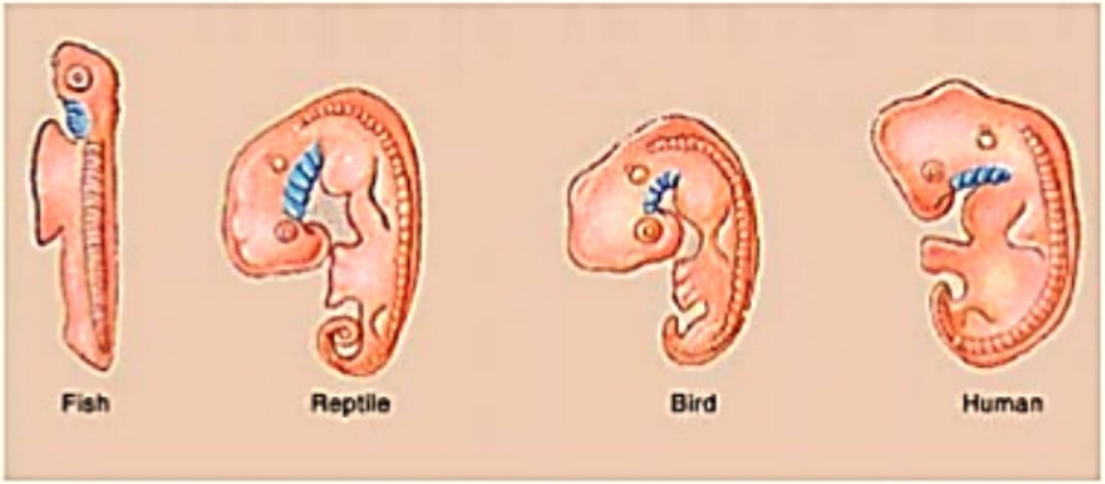






Comparative Embryology

Closely related species have similar embryological development.



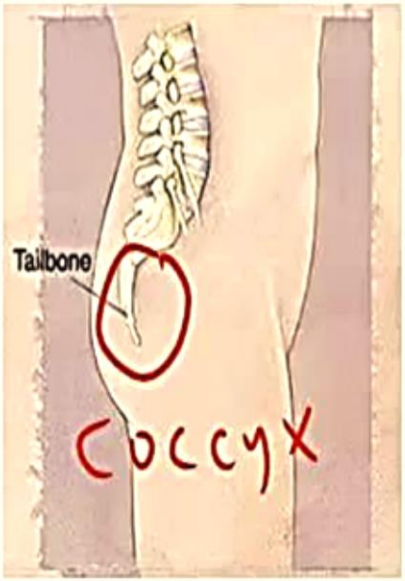
Structures appear in the embryonic stages that serve no purpose and are not present in the adult.

Vestigial Structures

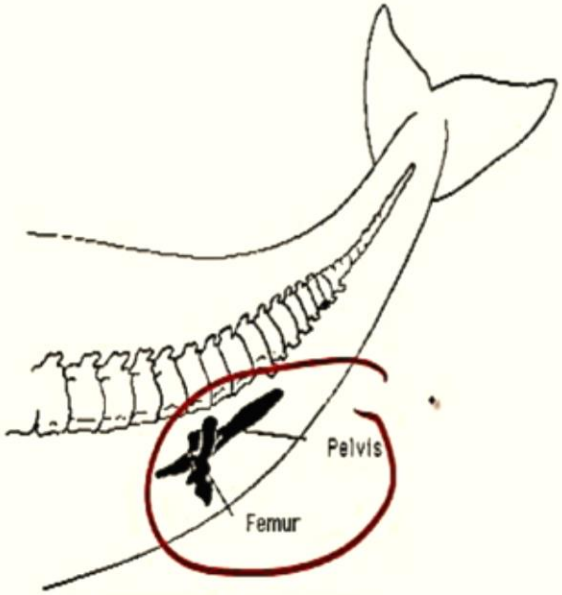
- features present in modern animals that are no longer in use
- give hints as to the evolution of organisms

Ex: human tailbone, whale pelvis, appendix

organs
behaviors



wisdom teeth



appendix

braingenie

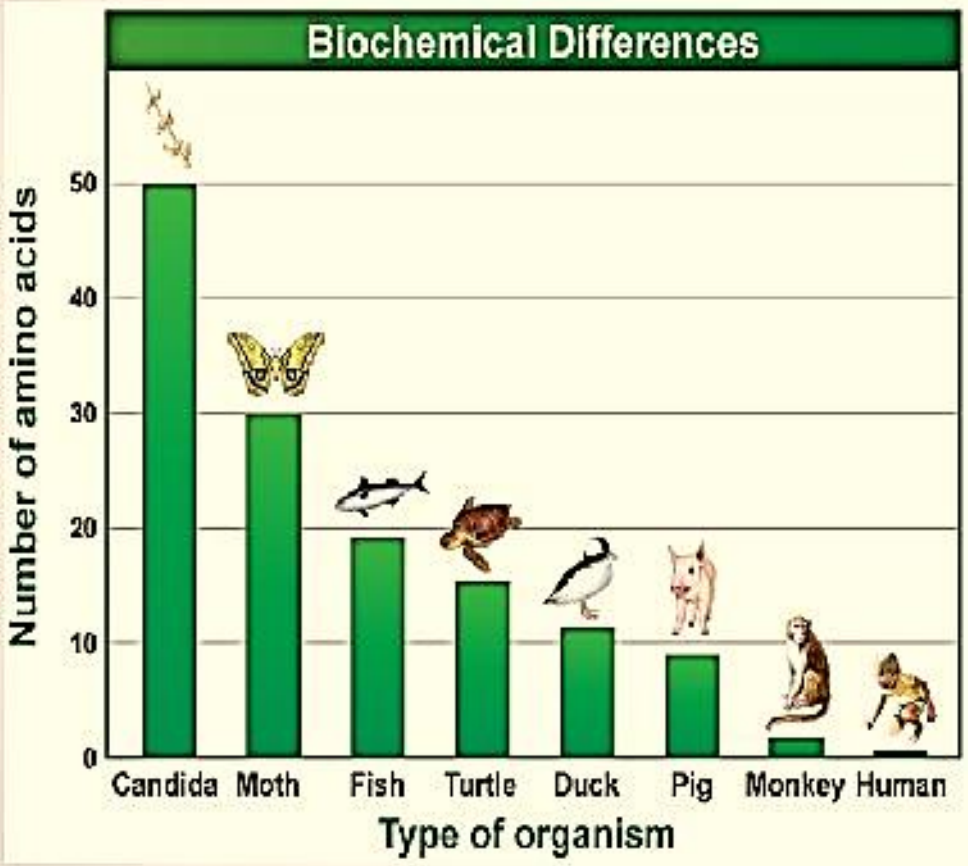
Biogeographical Evidence:

- Biogeography is the study of the geographic distribution of life forms on earth
- Physical factors, such as the location of continents, determine where a population can spread
- Example: Placental mammals arose after Australia separated from the other continents, so only marsupials diversified in Australia

KOALA

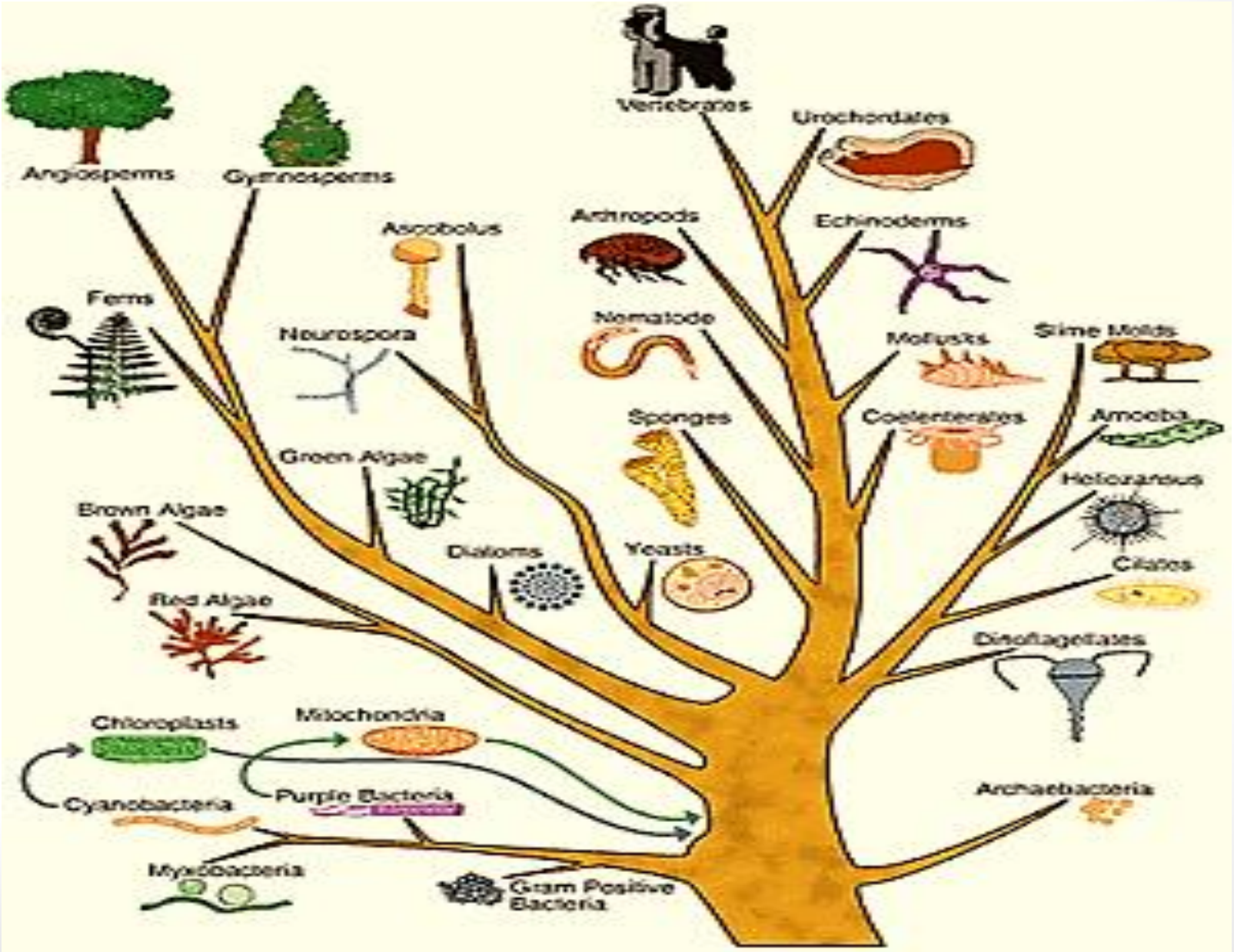
KANGAROO

Biochemical Evidence

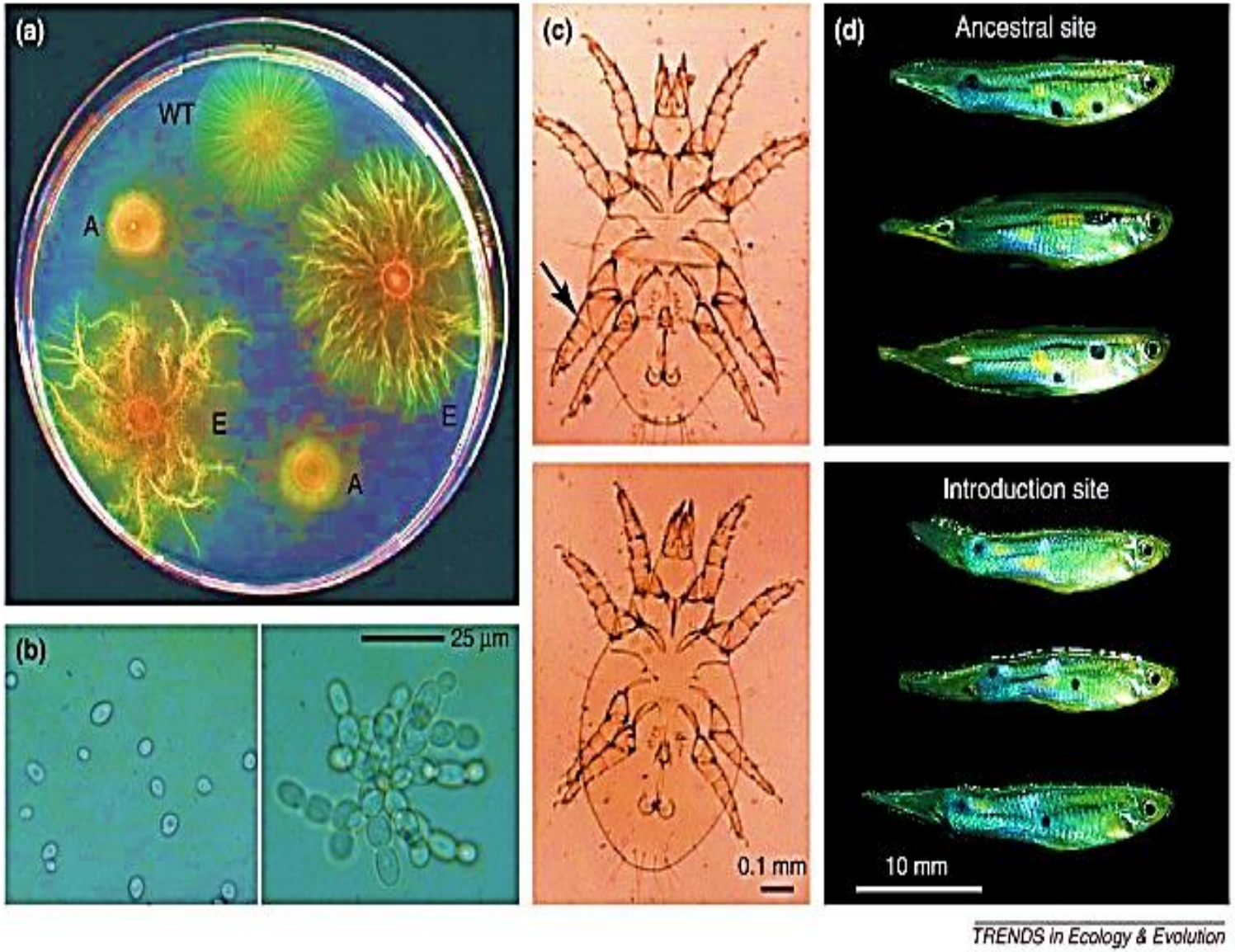


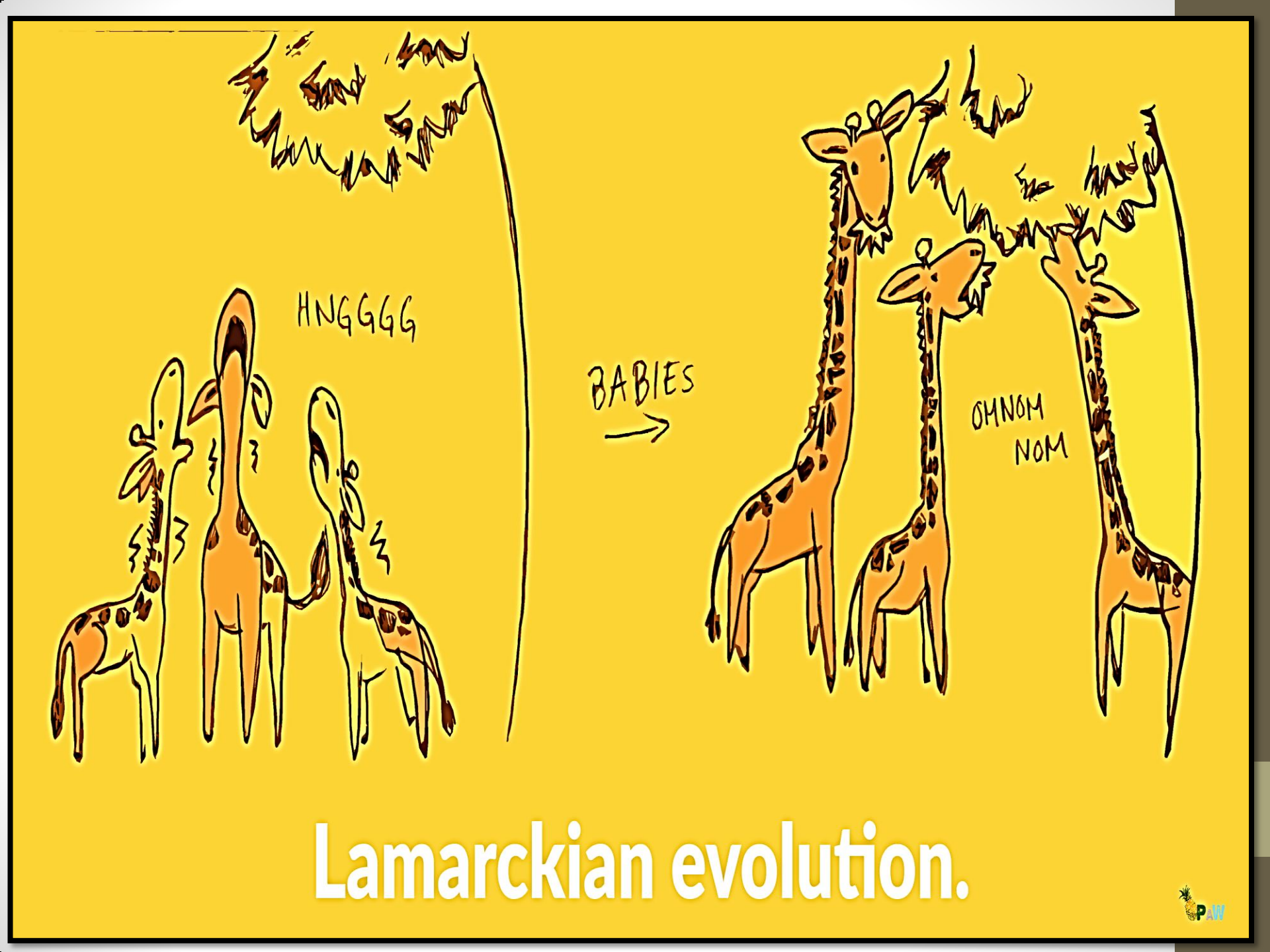
- Common ancestry can be seen in the complex metabolic molecules that many different organisms share.
- Comparison of the DNA or RNA of different species produce biochemical evidence for evolution

Taxonomy


Vertebrates
Urochordates
Angiosperms
Gymnosperms
Ascobolus
Arthropods
Echinoderms
Ferns
Nematode
Neurospora
Molluscs
Slime Molds
Sponges
Coelenterates
Amoeba
Green Algae
Heterokaryon
Brown Algae
Diatoms
Yeasts
Ciliates
Red Algae
Dinoflagellates
Chloroplasts
Mitochondria
Cyanobacteria
Purple Bacteria
Archaebacteria
Myxobacteria
Gram Positive Bacteria

Experimental biology



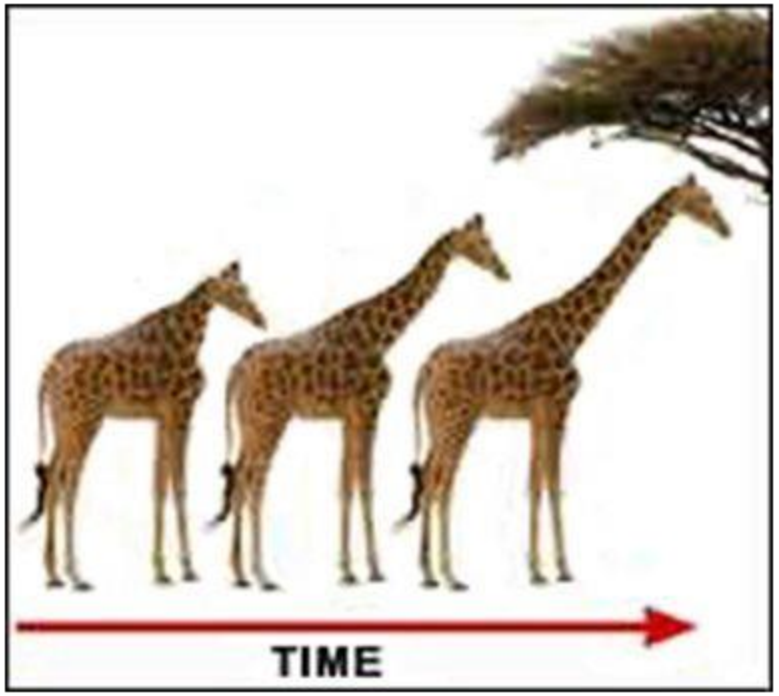


Lamarckian evolution.

Jean-Baptiste Lamarck

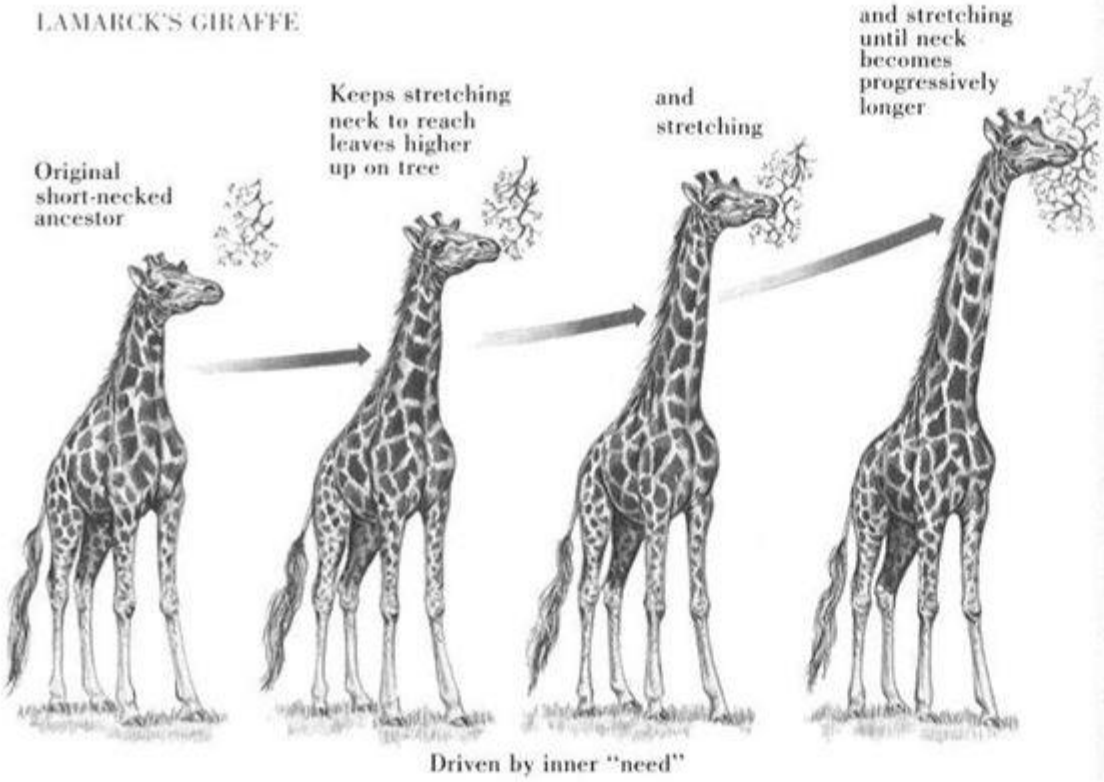
(1744-1829)

- First scientist to propose a mechanism for how organisms change (1809)
- Theory of change through use and disuse
  - Through time, a generation would use an organ more than previously, and would pass those traits on to their offspring



Lamarck's Theory

- Pre-Darwin scientist
- Inheritance of acquired traits
- Organs used a lot could grow and change shape
- Organs not used would shrivel and disappear
- Theory was incorrect but significant because he was the first scientist to recognize that organisms had changed over time

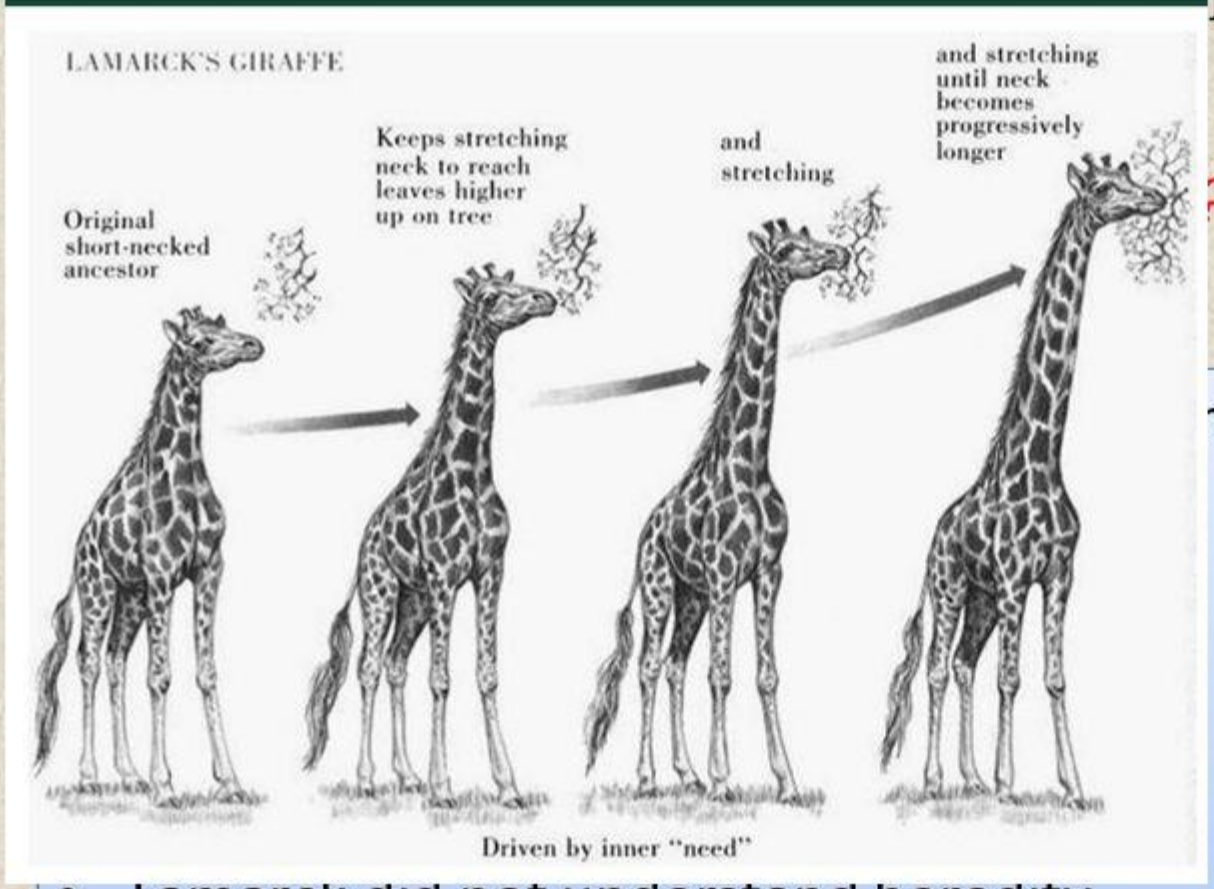


Importance of Lamarck's Theory

- Recognized that life forms were connected
- Recognized that there is variation in traits
- Recognized that evolution requires time (Earth is Old).
- Recognized that inheritance is an important aspect of adaptation

First Theory of Evolution

- Lamarck's theory is **not accepted**. It was replaced by Darwin's theory.



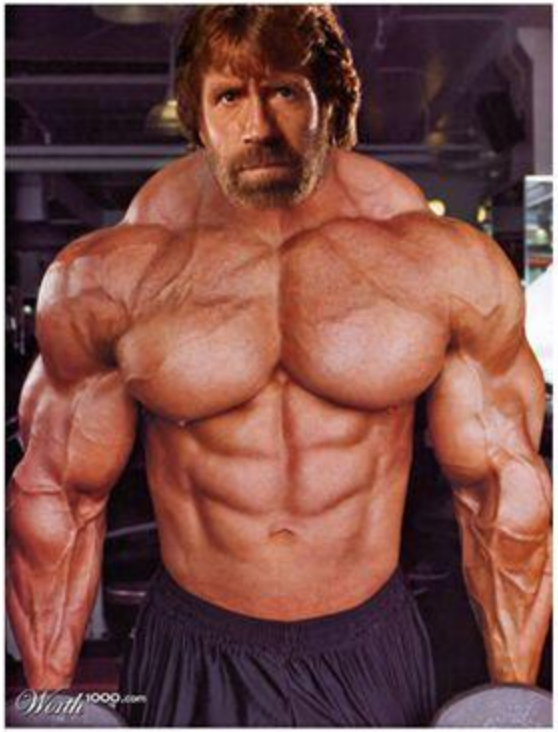
? What's

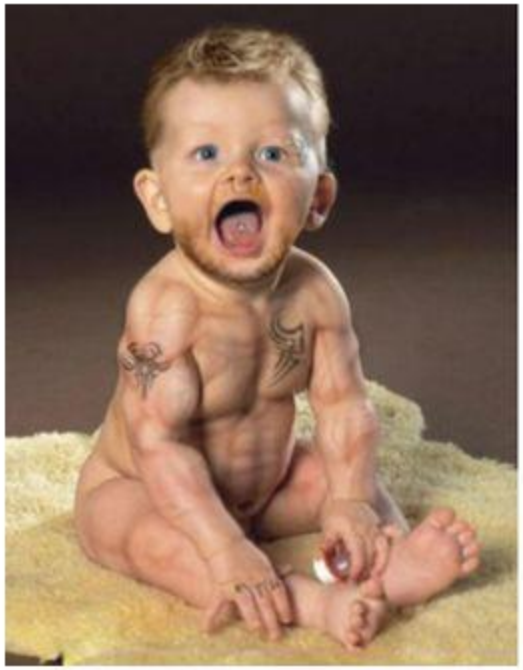
- Lamarck did not understand heredity (genes)

Why was Lamarck Wrong?

1. Acquired traits are not inherited

   (Only traits in DNA are inherited)



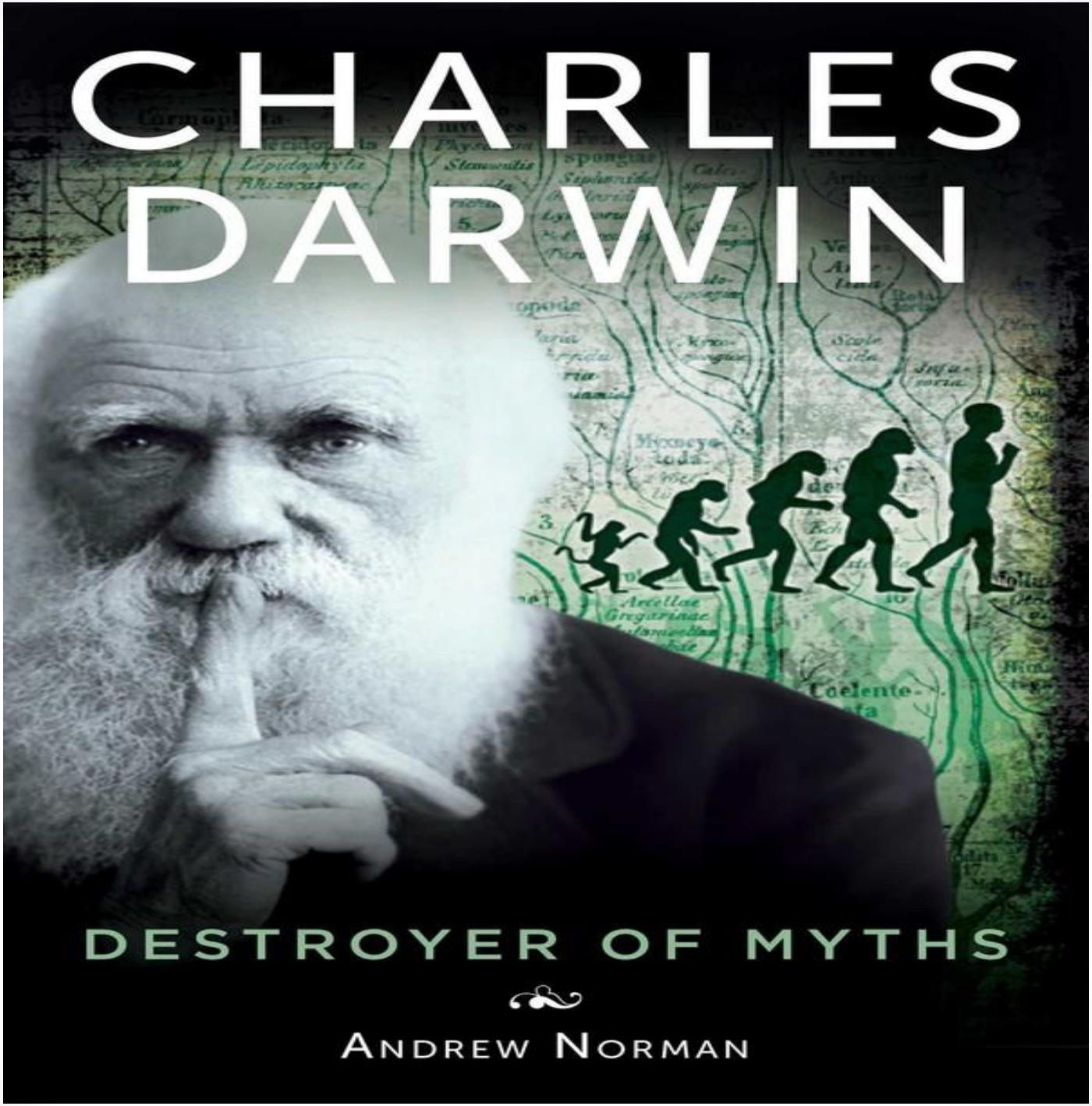


Why was Lamarck wrong?

- Lamarck did not know about the inheritance of traits through the passing of **genes**.
- **ACQUIRED** traits can NOT be inherited.

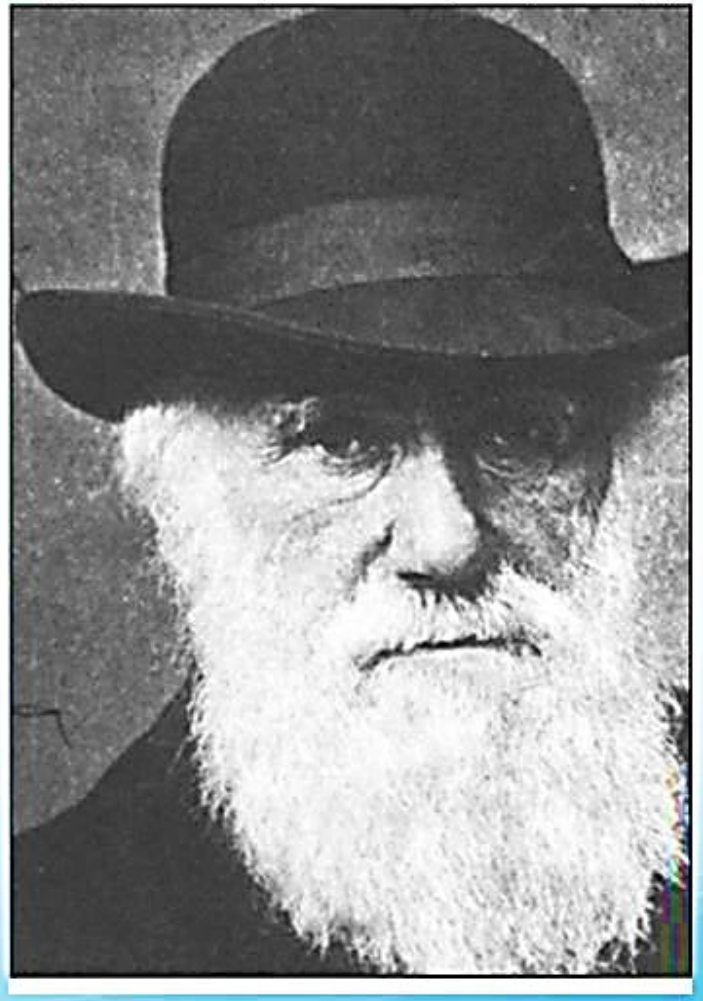
Why is Lamarck Important?

What Lamarck got right… (+)	What was wrong…. (-)
Lamarck attempted to explain both the fossil record and the current diversity of life through its recognition of the great age of Earth and adaptation of organisms to the environment.	No evidence that acquired characteristics can be inherited. Acquired traits (e.g., bigger biceps) do not change the genes transmitted by gametes to offspring.


CHARLES
DARWIN
DESTROYER OF MYTHS
ANDREW NORMAN

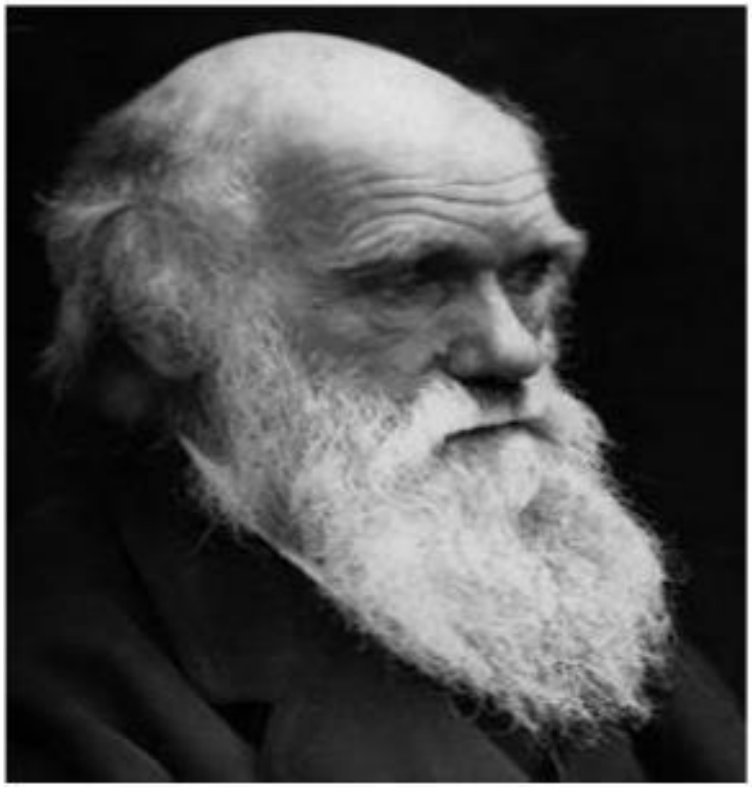
Darwin's Revolutionary Theory

- Charles Darwin presented evidence that many modern organisms are descended from ancestral species that were different.



Evolution Overview

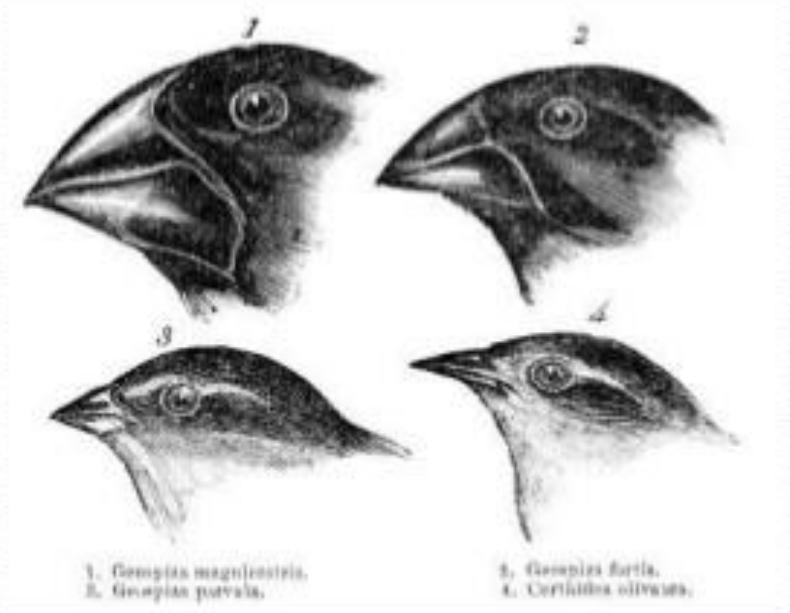
Charles Darwin



- Proposed the **Theory of Evolution**
- **Evolution**-gradual change in a species through adaptations over time
- Theory of Evolution= Natural Selection

Theory of Evolution – Facts

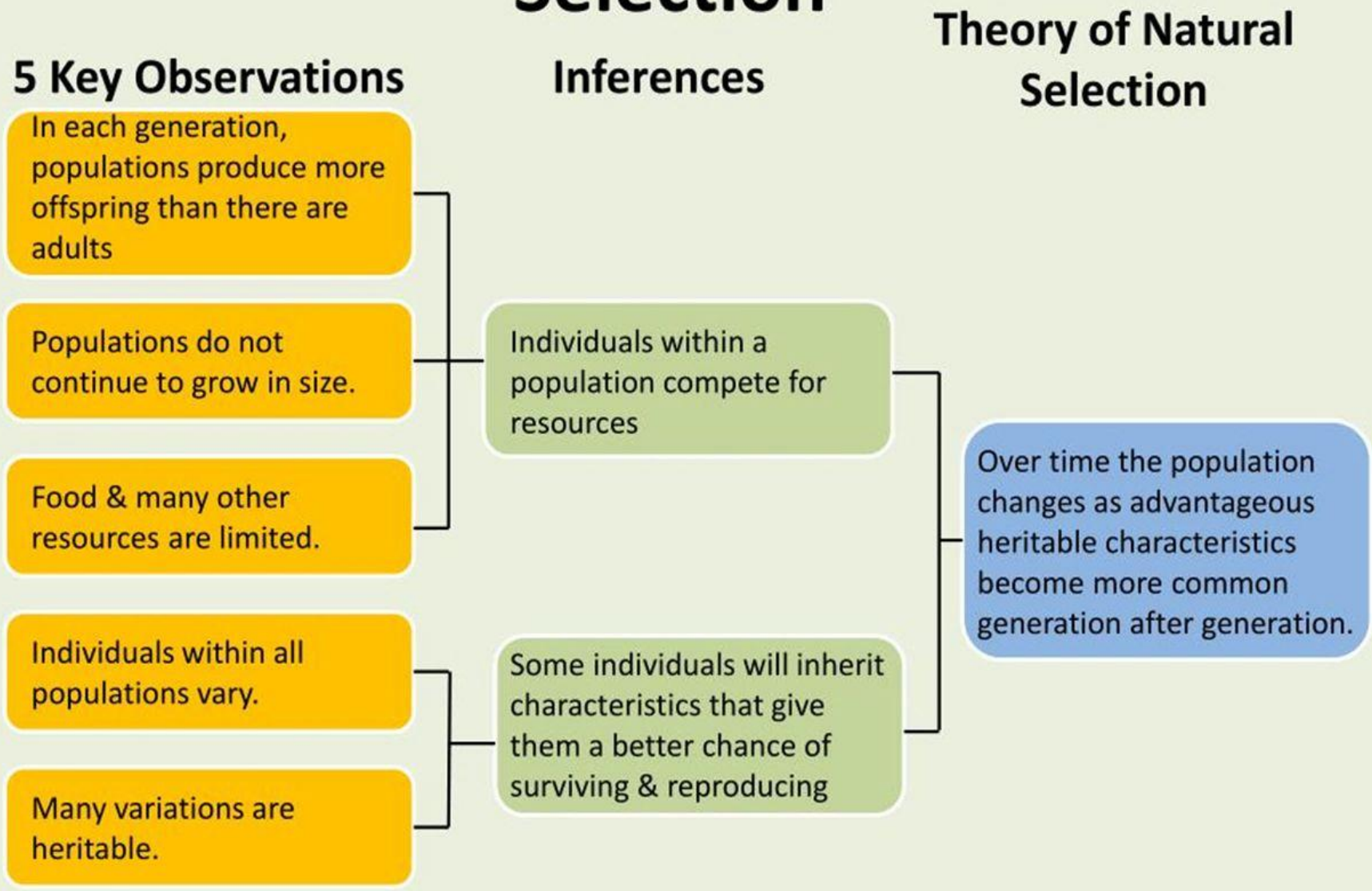
- Charles Darwin voyaged on the Beagle in 1859.
- Darwin wrote *On the Origin of the Species.*
- Various finches lived on different islands. Their beaks adapted to suit the food available.
- Organisms evolve from simpler organisms by random mutation.
- Species survive by Natural Selection.



Summary of Darwin's Theory

- Individual organisms differ, and some of this variation is heritable.
- Organisms produce more offspring than can survive, and many that do survive do not reproduce.
- Because more organisms are produced than can survive, they compete for limited resources.

The Theory of Evolution by Natural Selection



Darwinism v/s Lamarckism

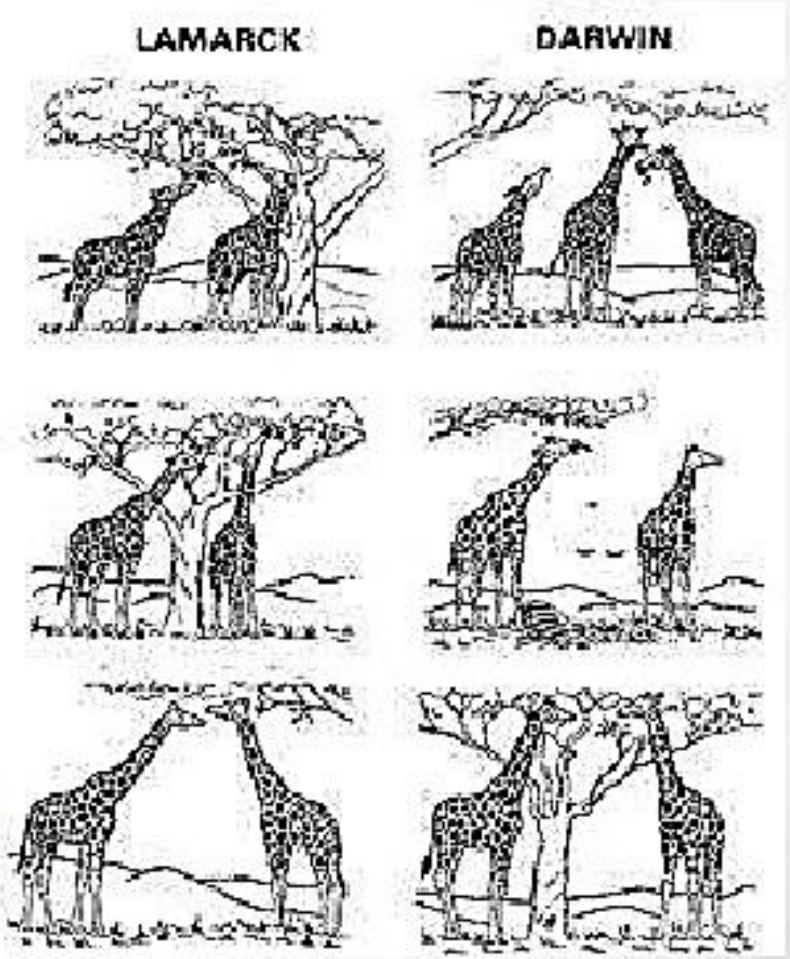
1. It doesn't believe in the internal vital force.
2. These vital force do not form part of Darwin's natural selection.
3. An organ can develop further or degeneration only due to continuous variation
4. Struggle for existence is vary important.
5. Only useful variation are transferred to next generation.
6. Darwin's natural selection theory is based on survival of the fittest.

1. There is an internal vital force in all organism.
2. It consider new need or desire or produce new structure & change habits of the organism.
3. According to this theory if organ is contently used it would be better developed where as disuse of organ results in its degeneration.
4. No concept of struggle for existence
5. All the acquired characters are inherited to the next generation .
6. Lamarckism does not believe in survival of the fittest.

Lamarckism vs. Darwinism

- **Lamarckism:** characteristics are gained/lost/modified to suit environment
- **Darwinism:** natural selection

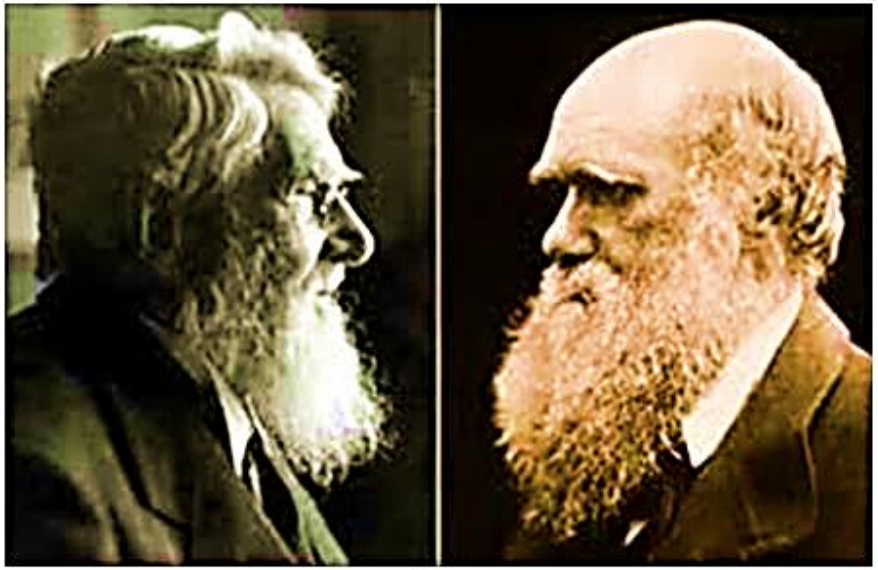
http://www.youtube.com/watch?v=4HBdxDBqfHc



Darwin-Wallace theory of evolution by natural selection

In 1858, both Charles Darwin and Alfred Wallace proposed the same mechanism for evolution-the mechanism of natural selection. Their theory is based on four main points:

1. Variation
2. Natural selection
3. Survival of the fittest
4. Isolation



pbs.org

The Darwin – Wallace Theory

- In 1858, another British naturalist, Alfred Wallace, *did* come to the same conclusion as Darwin.
- Darwin received a letter from Wallace that described the same basic mechanism for evolutionary change that Darwin had proposed.
- Within a month, some of Wallace's and Darwin's writings were jointly presented in public. Darwin published his book *The Origin of Species* about a year later.

Darwin and the Wallace-Darwin Theory

Darwin's Theory	The Wallace-Darwin Theory
1. Adaptation	1. Variability in traits
2. Variation	2. Over-reproduction
3. Over-reproduction	3. Variability in fitness
4. Natural selection	4. Fitness determines success
	5. Heritable traits and change between generations

Charles Darwin & Natural Selection

Evidences against Darwinism

Darwinism is not able to explain:

1. The inheritance of small variations in those organs which can be of use only when fully formed e.g. wing of a bird. Such organs will be of no use in incipient or underdeveloped stage.

2. Inheritance of vestigial organs.

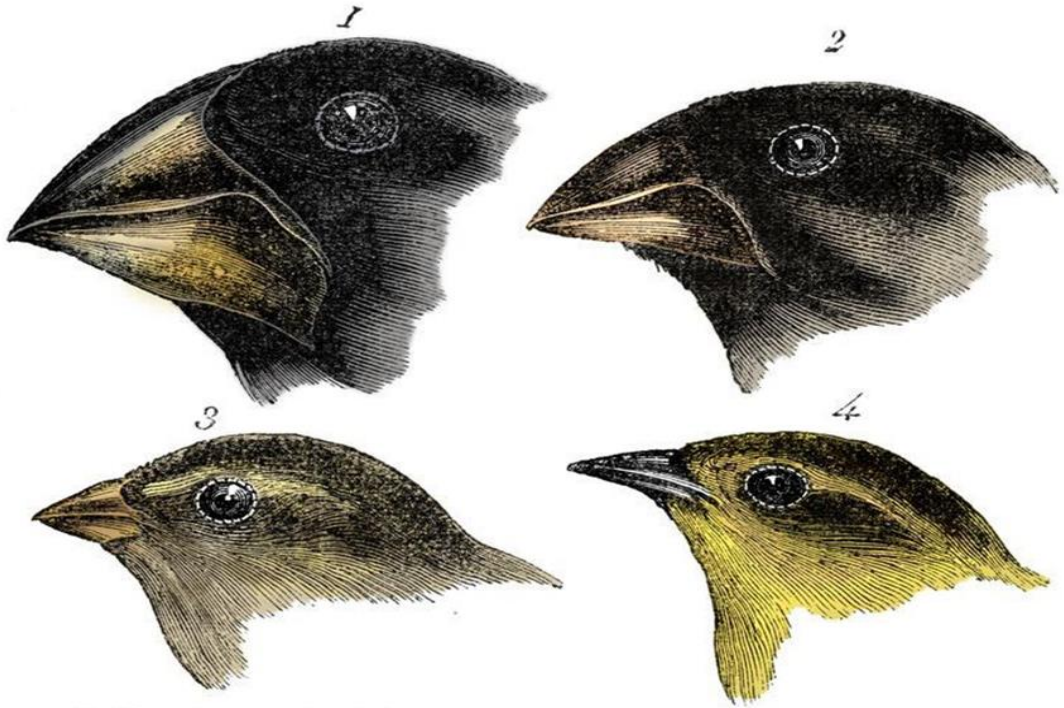
3. Inheritance of over-specialized organs

- e.g. antlers in deer and tusks in elephants.

4. Presence of neuter flowers and sterility of hybrids.

5. Did not differentiate between somatic and germinal variations.

6. He did not explain the causes of the variations and the mode of transmission of variations.



1. Geospiza magnirostris.
3. Geospiza parvula.

2. Geospiza fortis.
4. Certhidea olivasea.

7. It was also refuted by Mendel’s laws of inheritance which state that inheritance is particulate.

So this theory explains only the survival of the fittest but does not explain the arrival of the fittest so Darwin himself confessed, “natural selection has been main but not the exclusive means of modification.

Who was Hugo De Vries?

1848-1935

He was a Dutch botanist and one of the first geneticist.

Evening primrose
Oenothera lamarckiana

He is known mainly for suggesting the concept of

1. Genes
2. Rediscovering the laws of heredity in the 1890s while unaware of Gregor Mendel's work
3. Introducing the term "mutation"
4. Developing a mutation theory of evolution.

https://en.wikipedia.org/wiki/Hugo_de_Vries

The theory of mutation of Hugo De Vries.

- 1. Mutations or discontinuous variations are **the raw material of evolution**.
- 2. Mutations **appear all of a sudden**. They become **operational immediately**.
- 3. Unlike Darwin's continuous variations or fluctuations, mutations do not **revolve around the mean or normal character of the species.**
- 4. The same type of mutations **can appear in a number of individuals of a species.**
- 5. **All mutations are inheritable.**
- 6. Mutations **appear in all conceivable directions**.
- 7. Useful mutations are **selected by nature**. Lethal mutations are **eliminated**. However, **useless and less harmful ones can persist in the progeny.**
- 8. Accumulation of variations **produce new species**. Sometimes a new species is produced from a **single mutation**.
- 9. **Evolution is a jerky and discontinuous process.**

Hugo De Vries Theory of Evolution by Mutation

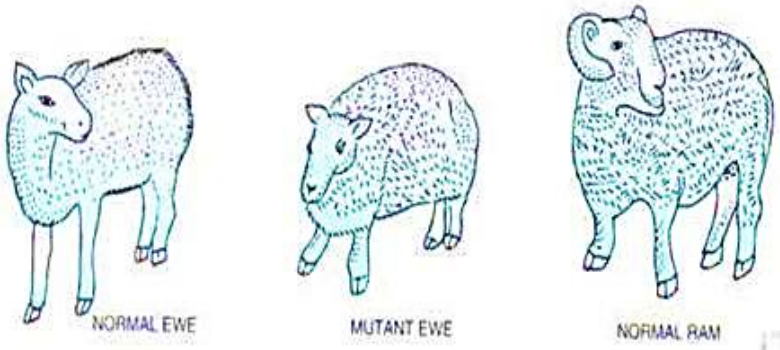
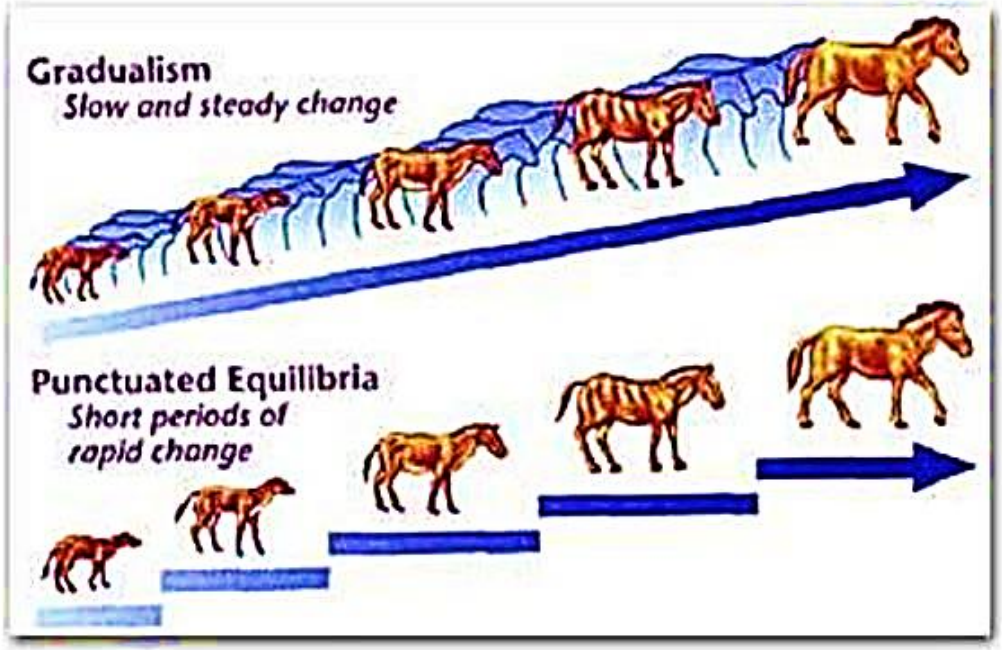


Fig. 7.39. Appearance of short-legged Ancon sheep mutant.

New characteristics suddenly appear (mutation), but they may be selected against due to not being as 'fit to survive..

de Vries theory	Darwin's theory
Evolution resulted from mutation.	Evolution resulted from variations.
Evolution was sudden.	Evolution was gradual.
Mutations are random and directionless.	Variations are small and directional.



Punctuated equilibrium is similar to De Vries **Discontinuous Evolution** by Mutation Theory

Mutation Theory of Evolution

The mutation theory of evolution was proposed by a Dutch botanist, Hugo de Vries (1848-1935 A.D.) in 1901 A.D. in his book entitled “Species ,and Varieties, Their Origin by Mutation”. He worked on evening primrose *(Oenothera lamarckiana)*. الروزماري

A. Experiment:

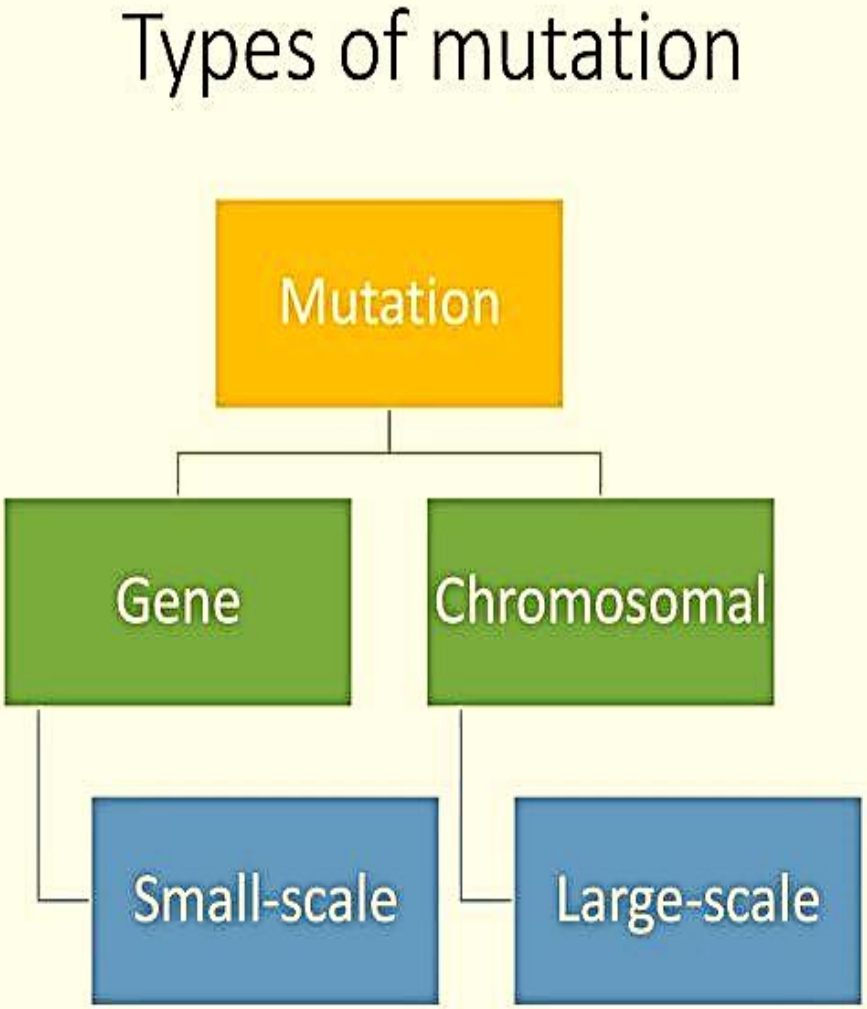
Hugo de Vries cultured O. lamarckiana in botanical gardens at Amsterdam.

The plants were, allowed to self pollinate and next generation was obtained. The plants of next generation were again subjected to self pollination to obtain second generation. Process was repeated for a number of generations.

B. Observations:

Majority of plants of first generation were found to be like the parental type and showed only minor variations but 837 out of 54,343 members were found to be very different in characters like flower size, shape and arrangement of buds, size of seeds etc. These markedly different plants were called primary or elementary species.

C. Conclusion:



Causes of Genetic Mutations

Spontaneous Mutations

Mutations that occur randomly for no reason…

Environmental Causes

Environmental agents

X-rays

UV light

Radiation

Certain chemicals

Evidences of Mutation theory:

1. Appearance of a short-legged sheep variety, Ancon sheep from long legged parents in a single generation in 1791 A.D. It was first noticed in a ram (male sheep) by an American farmer, Seth Wright.

2. Appearance of polled Hereford cattle from horned parents in a single generation in 1889.

3. De Vries observations have been experimentally confirmed by McDougal and Shull in America and Gates in England.

4. Mutation theory can explain the origin of new varieties or species by a single gene mutation e.g. Cicer gigas, Nuval orange. Red sunflower, hairless cats, double- toed cats, etc.

5. It can explain the inheritance of vestigial and over-specialized organs.

6. It can explain progressive as well as retrogressive evolution.

MODERN SYNTHETIC THEORY OF EVOLUTION

Neo-Darwinism

- Neo-Darwinism is a modified version of the **theory of natural selection** and is a sort of reconciliation between Darwin and de varies theory.
- Scientist contributed to this theory – Huxley,
- R.A.Fischer
- etc.

Postulates of Neo-Darwinism

1.GeneticVariability:

Variability is an opposing force to heredity and is essential for evolution as the variations form the raw material for evolution .The studies showed that the units of both heredity and mutations are genes which are located in a linear manner on the chromosomes. Various sources of genetic variability in a gene pool are:

(i) Mutations:

These are sudden, large and inheritable changes in the genetic material. Based on amount of genetic material involved;

mutations are of three types: morphological changes in chromosomes, changes in chromosomes number and changes in chemical nature of a gene.

(ii) Recombination of genes:

Thousands of new combinations of genes are produced due to crossing over, chance arrangement of bivalents at the equator during metaphase – I and chance fusion of gametes during fertilization.

(iii) Hybridization:

It involves the interbreeding of two genetically different individuals to produce „hybrids".

(iv) Physical mutagens (e.g. radiations, temperature etc.) and chemical mutagens (e.g. nitrous acid, colchicine, nitrogen mustard etc.).

v) Genetic drift:

It is the elimination of the genes of some original characteristics of a species by extreme reduction in a population due to epidemics or migration or Sewell Wright effect.

2. Natural Selection:

Natural selection of Neo- Darwinism differs from that of Darwinism that it does not operate through “survival of the fittest” but operates through differential reproduction and comparative reproductive success.

Differential reproduction states that those members, which are best adapted to the environment, reproduce at a higher rate and produce more off springs than those which are less adapted.

So, these contribute proportionately greater percentage of genes to the gene pool of next generation while less adapted individuals produce fewer off springs.

If the differential reproduction continues for a number of generations, then the genes of those individuals which produce more off springs will become predominant in the gene pool of the population.

Due to sexual communication, there is free flow of genes so that the genetic variability which appears in certain individuals, gradually spreads from one deme to another deme, from deme to population and then on neighboring sister populations and finally on most of the members of a species.

- So natural selection causes progressive changes in gene frequencies, „i.e. the frequency of some genes increases while
  the frequency of some other genes decreases.

MODERN EVOLUTIONARY THEORY

WHAT HAPPENED AFTER DARWIN?

The Modern Synthesis

- The **modern synthesis** is a comprehensive theory of evolution that brings in ideas from many fields.
  - R. A. Fisher (statistician)
  - J. B. S. Haldane (biologist)
  - Theodosius Dobzhansky (geneticist)
  - Sewall Wright (geneticist)
  - Ernst Mayr (biogeographer)
  - George Gaylord Simpson (paleontologist)
  - G. Ledyard Stebbins (botanist)

Modern Synthesis Theory

- *TODAY'S theory on evolution*
- *Recognizes that GENES are responsible for the inheritance of characteristics*
- *Recognizes that POPULATIONS, not individuals, evolve due to natural selection & genetic drift*
- *Recognizes that SPECIATION usually is due to the gradual accumulation of small genetic changes*

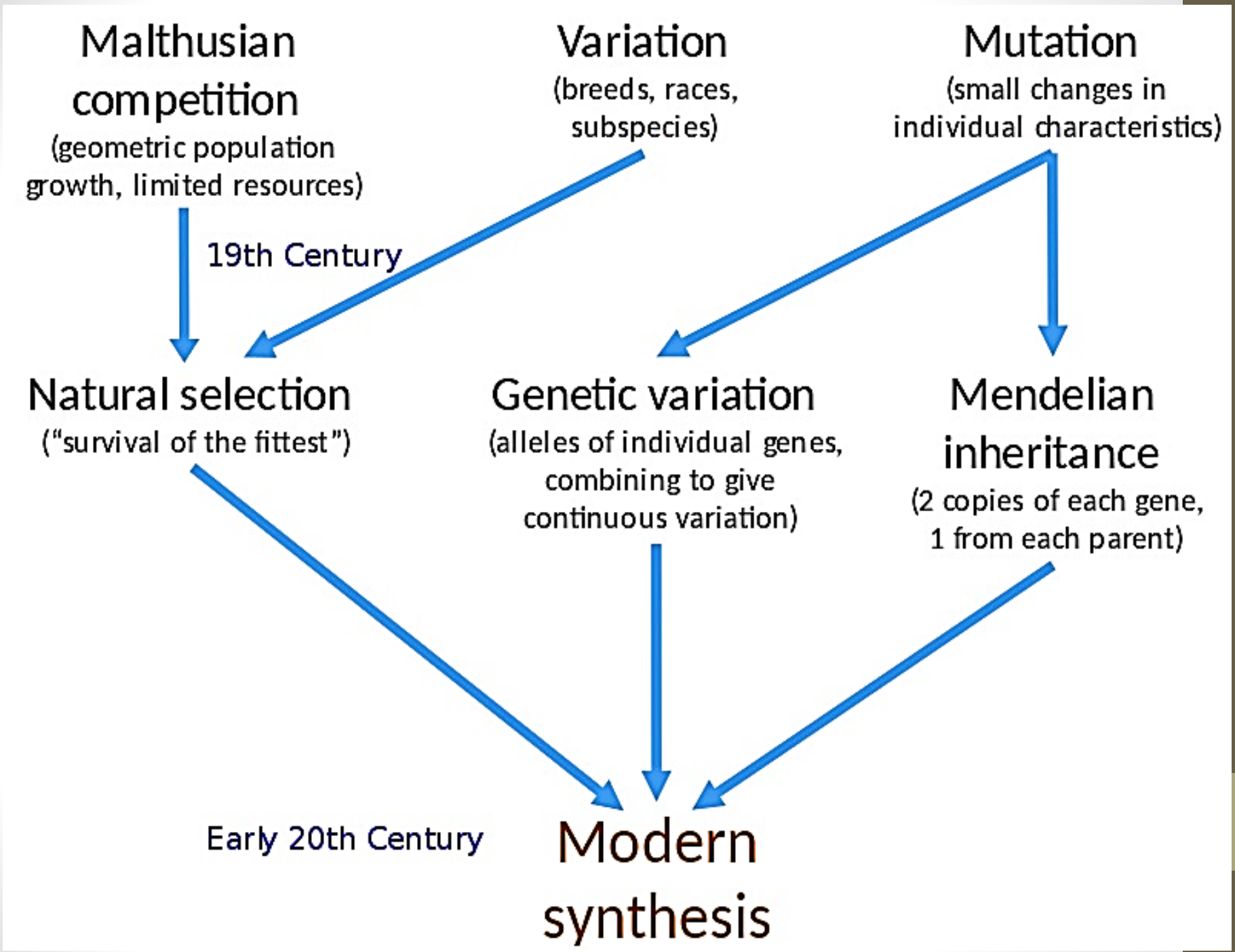
Modern Synthetic theory of Evolution

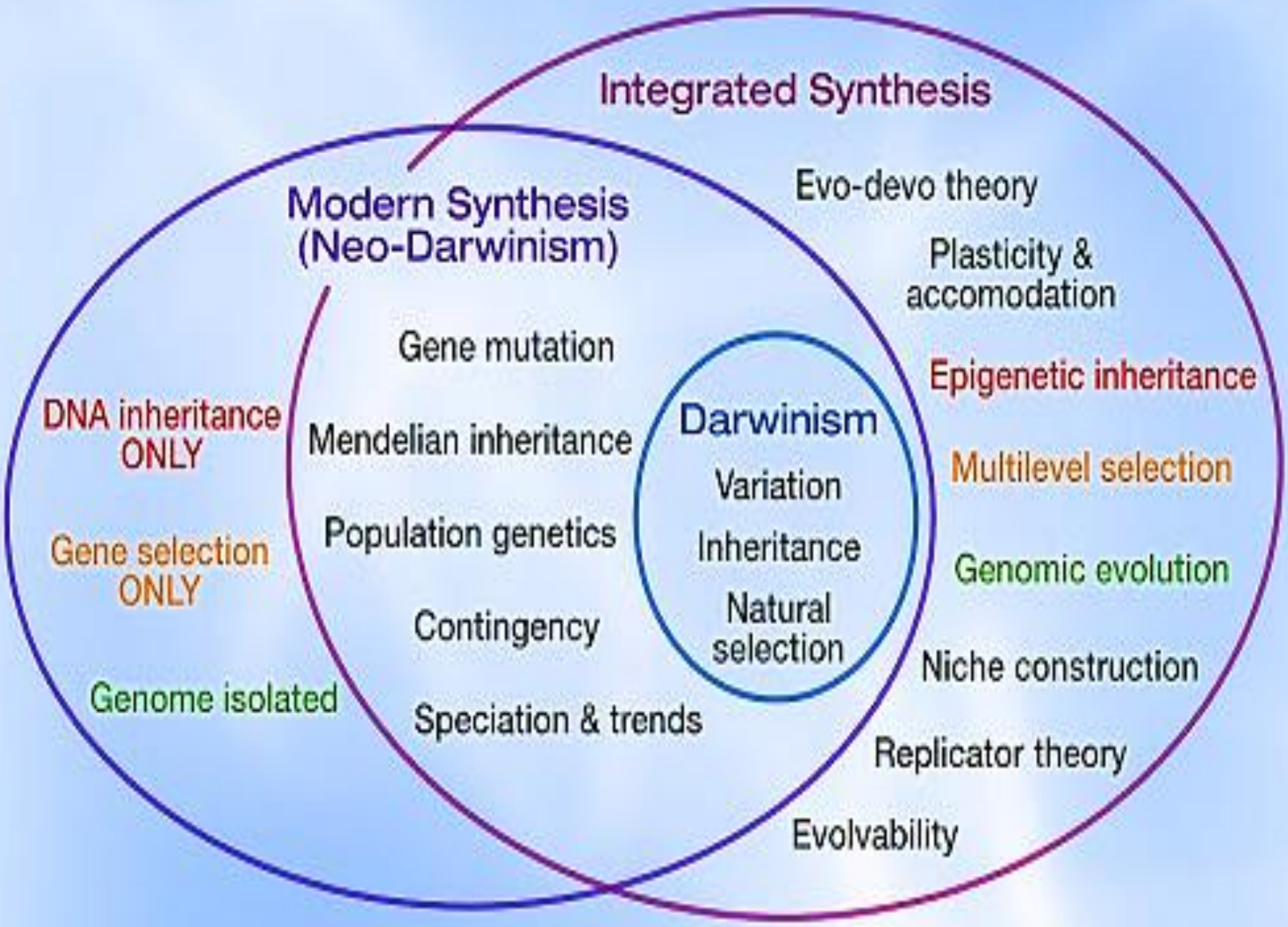
The Modern synthetic theory explains evolution in terms of genetical change in populations leading to origin of new species.

- **Mendelian population or Genetic population**
- **Gene pool**
- **Gene Frequency**

Concepts of Modern synthetic theory

a. **Genetic variations**
b. **Natural selection**
c. **Geographical and Reproductive Isolation**


Malthusian competition
(geometric population growth, limited resources)
Variation
(breeds, races, subspecies)
Mutation
(small changes in individual characteristics)
19th Century
Natural selection
("survival of the fittest")
Genetic variation
(alleles of individual genes, combining to give continuous variation)
Mendelian inheritance
(2 copies of each gene, 1 from each parent)
Early 20th Century
Modern synthesis


Integrated Synthesis
Modern Synthesis
(Neo-Darwinism)
Darwinism
Variation
Inheritance
Natural selection
Gene mutation
Mendelian inheritance
Population genetics
Contingency
Speciation & trends
DNA inheritance ONLY
Gene selection ONLY
Genome isolated
Evo-devo theory
Plasticity & accomodation
Epigenetic inheritance
Multilevel selection
Genomic evolution
Niche construction
Replicator theory
Evolvability

THE END OF THE COURSE

BEST WISHES