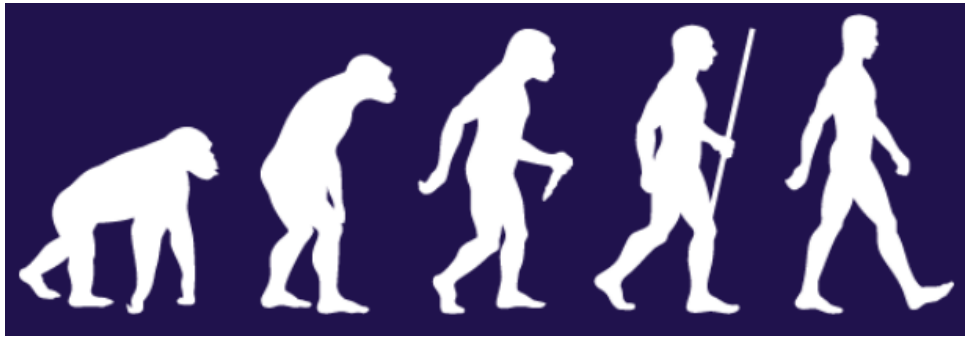
Mohanlal Sukhadia University

Department of Botany

B.Sc. II year Paper III

Evolution - Lecture 2

(Darwin and Lamarck's theory, Evolution evidence)



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JEAN-BAPTISTE DE LAMARCK
(1744 - 1829)

- A great French naturalist.
- Lamarck sought a naturalistic explanation for the diversity of modern organisms and the animals seen in the fossil record.

- Proposed theory in 1809.

“THEORY OF INHERITANCE OF ACQUIRED CHARACTERS”

Images taken from internet.

POSTULATES OF LAMARCKISM

A) New needs

- Changes in environment factors like light, temperature, medium, food, air etc or migration lead to origin of new needs in living organisms.

- To fulfil these new needs , living organisms have to exert special efforts like changes in habits or behavior.

B) Use and disuse of organs

- The new habits involve the greater use of certain organs to meet new needs, and the disuse or lesser use of certain other organs which are of no use in new conditions.

Images taken from internet.

C) Inheritance of acquired characters

He believed that the favorable acquired characters are inheritable and are transmitted to the offspring's so that these are born fit to face the changed environmental conditions and the chances of their survival are increased.

D) Speciation

Lamarck believed that in every generation , new characters are acquired and transmitted to next generation, so that new characters accumulate generation after generation.
After a number of generations, a new species is formed.

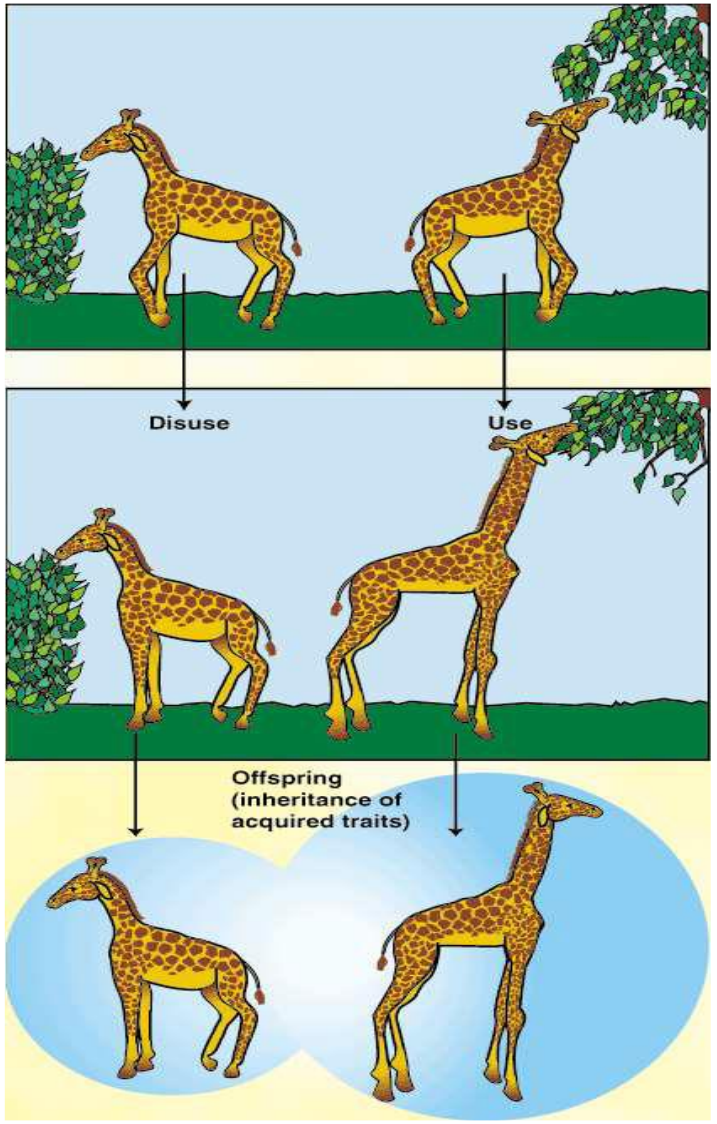
Images taken from internet.

EVIDENCES

a) Giraffe

Ancestors of giraffes are supposed to be deer-like quadrupedal grazing upon the grasses in Africa.

Due to disappearance of ground vegetation and availability of trees, long-necked and long forelimbed giraffe developed from short-necked and small forelimbed deer-like ancestors .



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b) SNAKES

Ancestors of limbless snakes were lizard-like reptiles with fully developed pentadactyl limbs.

Due to continuous disuse of limbs and stretching of their body to suit their creeping mode of locomotion, limbless snakes evolved.

c) HORSE

Ancestors of modern horse (*Equus cabalus*)used to live in the areas with soft ground and were short-legged with more number of functional digits.

These gradually took to live in areas with dry ground.

This change in habit was accompanied by increase in length of legs and decrease in functional digits for fast running over hard ground**.**

Images taken from internet.

CRITICISM OF LAMARCKISM

A) August Weismann

A German biologist proposed the ‘Theory of continuity of germplasm’ in 1892 . This theory states that a multicellular organism is formed of two types of cells:

GERM CELLS (have genes for inheritable characters to the offsprings)

SOMATICCELLS (which have genes of particular organ during ones life time only).

Environment affects only somatic cells. As link between the generations is through germ cells and somatic cells are not transmitted to next generation so the acquired characters must be lost with the death of an organism so these should have no role in evolution.

Images taken from internet.

B) Pavlov

A Russian physiologist , trained mice to come for food on hearing a bell . He reported that this training is not inherited and was necessary in each generation.

C) Kellogg and Bell experiment

They fed larva of silk moths on reduced quantity of mulberry leaves . They found decrease in size of larva in the next two generations even though these fed normally.

D) Castle and Philips experiment

They transplanted ovary of black guinea pig into body of white guinea pig before sexual puberty. This female when mated with white male guinea pig , produced all black young ones. This observation shows that environment does not influence germ plasm.

Significance of Lamarckism

a) It was first comprehensive theory of biological evolution.

b) It nicely explains the existence of vestigial organs in animals due to their continuous disuse.

c) It explains the development of strong jaw muscles and claws in the carnivores due to their continued extra use.

d) It stimulated other biologists to look for the mechanism of organic mechanism.

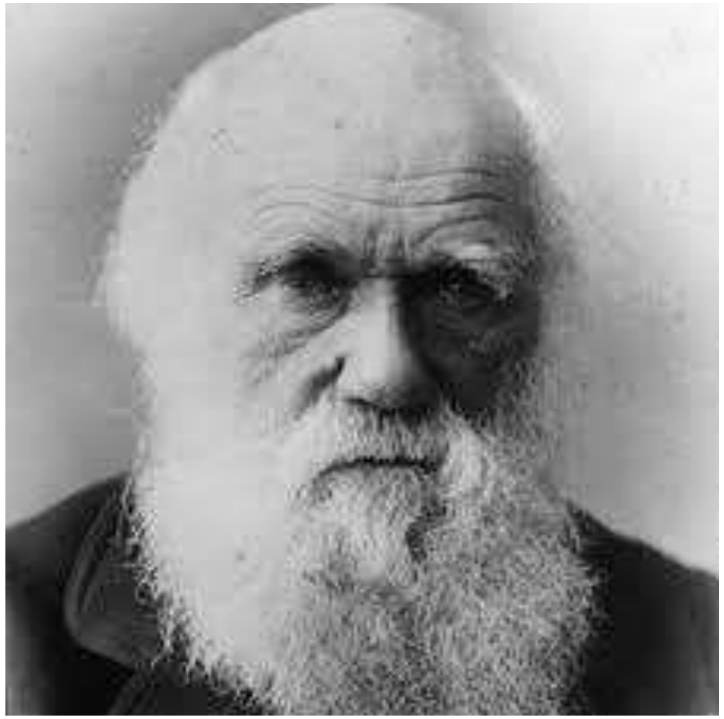
Images taken from internet.

DARWINISM (1809-1882)

Charles Darwinian English naturalist.
Proposed theory
“THEORY OF NATURAL SELECTION”

He went on a voyage on H.M.S Beagle and explored S. America , the Galapagos islands and other islands.

He was highly influenced by essay entitled ‘On the Tendency of varieties on Depart Indefinitely from the original type’’ by Alfred Russell Wallace and another essay ‘Principle of geology’’ written by Charles Lyell.



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POSTULATES OF DARWINISM

A) Geometric increase

B) Limited food and space

C) Struggle for existence

D) Variations

E) Natural selection or survival of the fittest

F) Inheritance of useful variations

G) Speciation

Images taken from internet.

WHAT HAPPENED TO THE GIRAFFE'S?

➢ **Survival of the fittest or natural selection**

- Natural selection said the giraffes with short necks had less food to eat

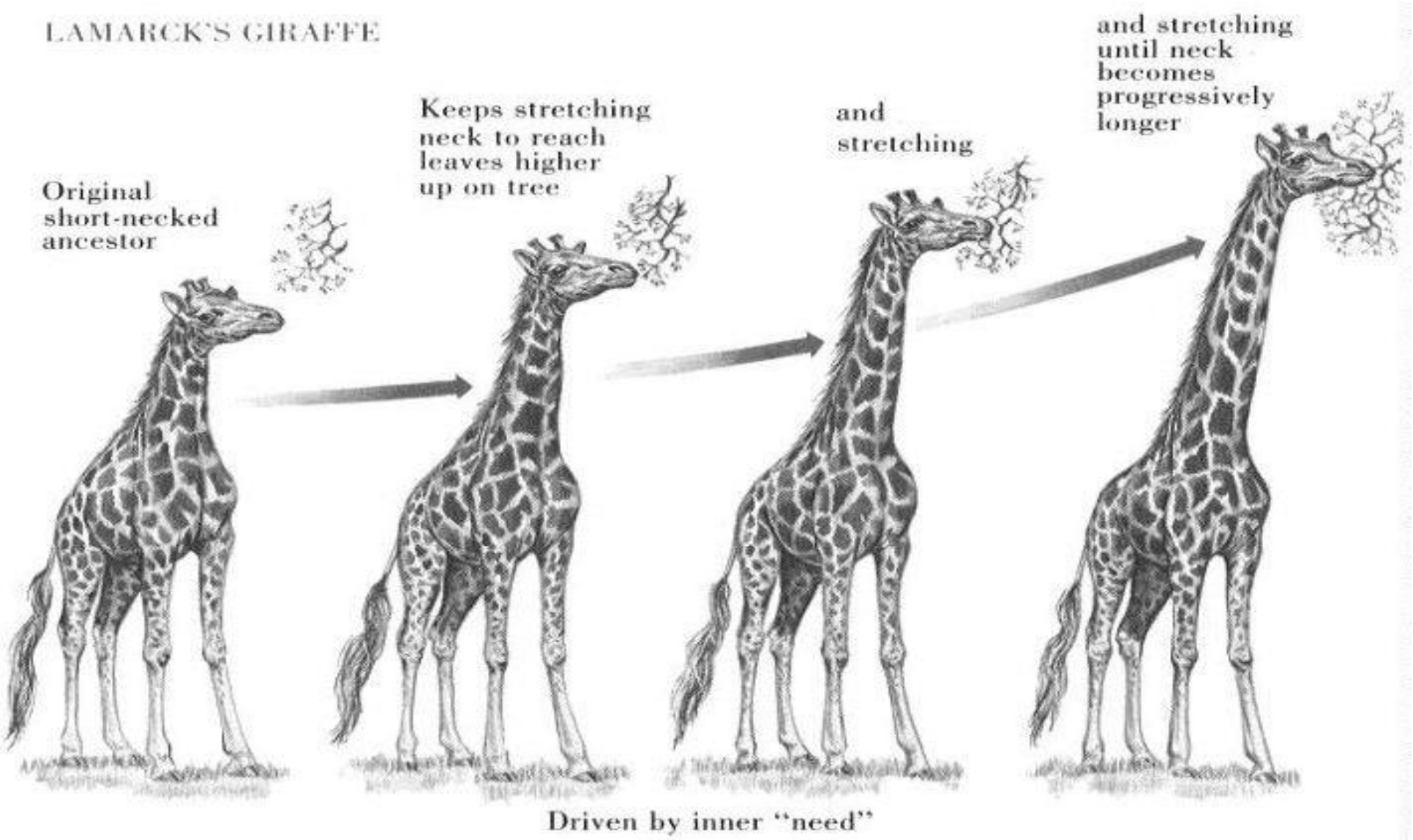
➢ **Why?**

- The food resources changed to leaves only on the upper branches

➢ **What happened**

- Short necks could not reach upper branches and did not survive (couldn't pass on genes .
- Long neck giraffes survived & reproduced because they were able to reach the food

Images taken from internet.



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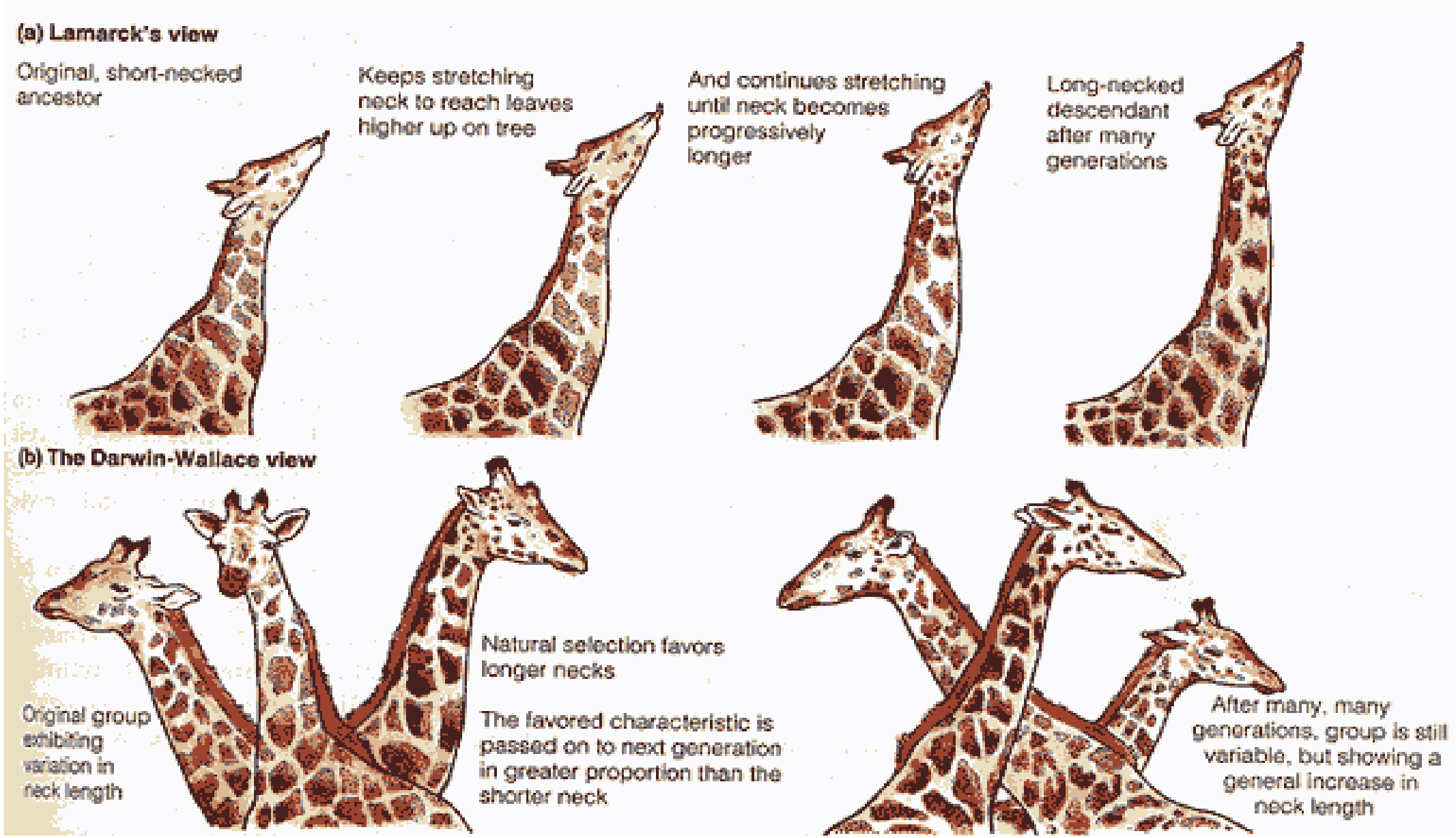

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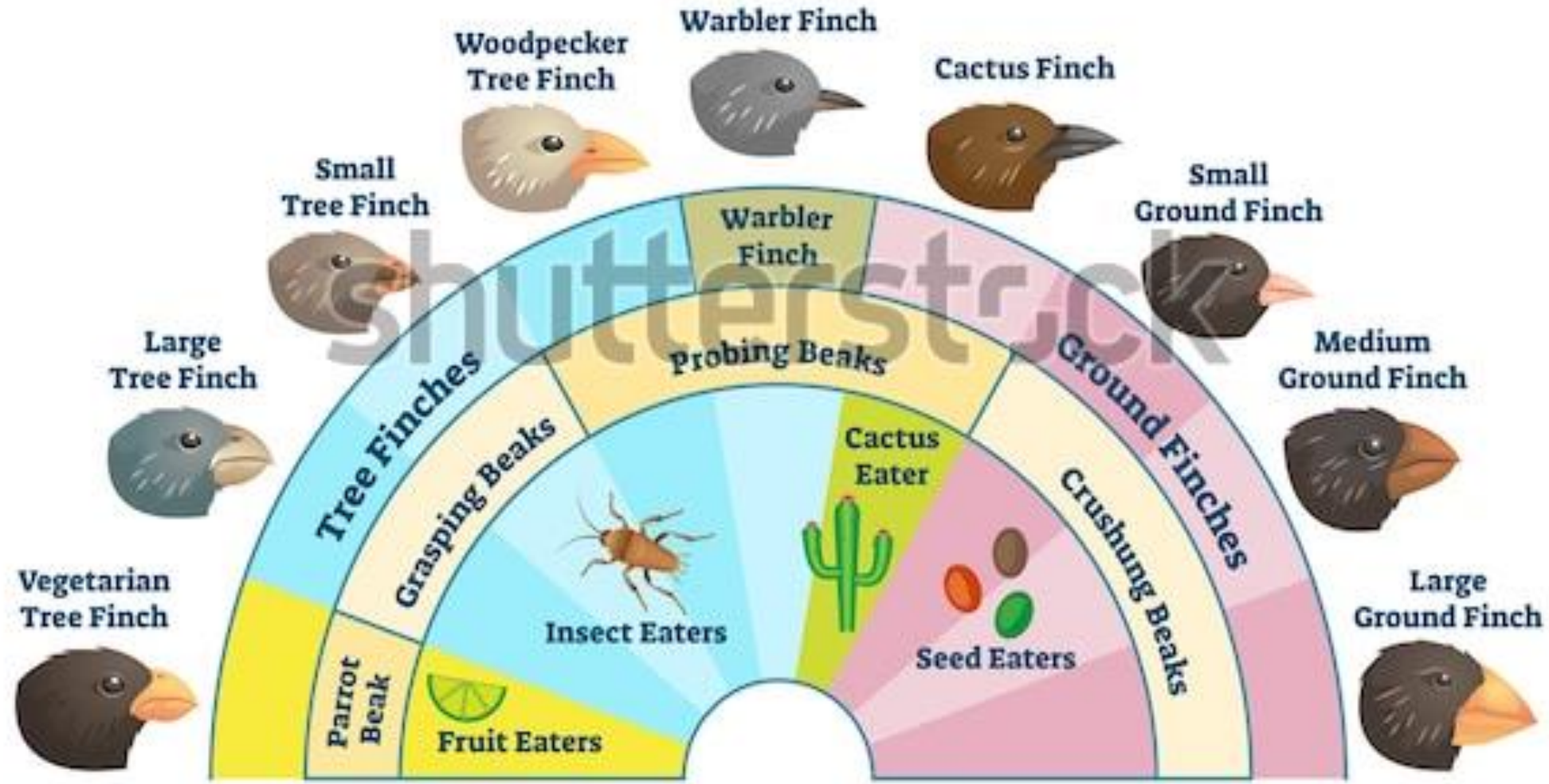
ADAPTIVE RADIATION



Images taken from internet.

EVIDENCE IN FAVOUR OF DARWINISM

A) Close parallelism between natural selection and artificial selection.

B) The remarkable cases of resemblance e.g. Mimicry and protective coloration.

C) Replacement of earlier giant dinosaurs by small sized carnivorous reptiles due to scarcity of food, space and global cooling.

D) pedigree of horse and other animals also support Darwinism.

E) Correlation between position of nectarines in flower and length of proboscis of pollinating insect which van be developed only gradually.

Images taken from internet.

EVIDENCES AGAINST DARWINISM

A) Inheritance of vestigial organs.

B) Inheritance of over-specialized organs.

C) He didn’t explain the cause of variations and the mode of transmission of variations.

D) It doesn’t include the transitional stages which have no fossil record.

E) Darwin did not differentiate between somatic and germinal variations.

F) It doesn’t explain the evolution of terrestrial animals from aquatic animals.

Images taken from internet.

Evidence of Evolution

- The fossil record= shows patterns of evolution over millions of years
- Comparative Anatomy
- Comparative Embryology
- Comparative Biochemistry: amino acid tables
- Geographic Distribution: similar organisms separated by land

Images taken from internet.

Fossil Record

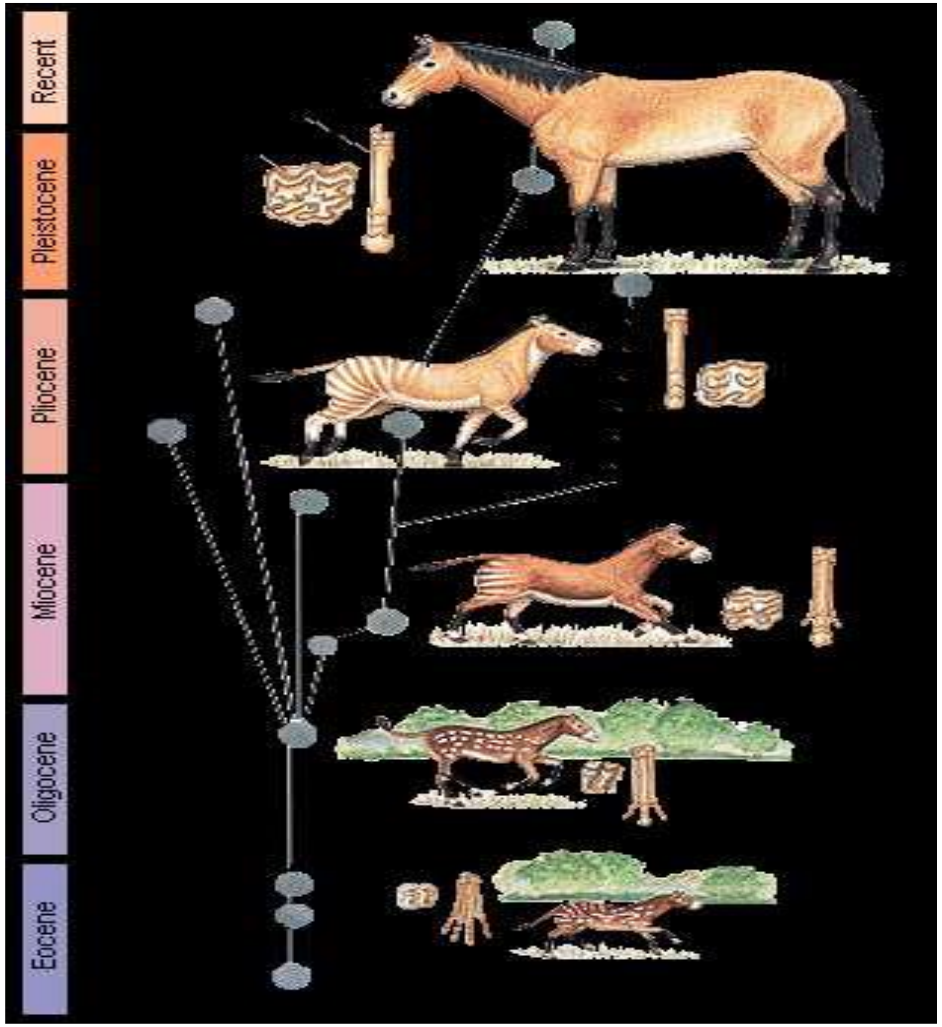
- Fossils provide a record of species that lived long ago.
- Fossils show that ancient species share similarities with species that now live on Earth.

- Earth has been estimated to be between 4.5-5 billion years old. (Determined through radioactive carbon dating).

- Fossil remains-the direct or indirect remains of organisms preserved in media such as tar, ice, rock, or amber.

- Fossils of prokaryotic life indicate that life existed over 3.4 billion years ago.

- Fossils can be found in the upper, and lower strata. These have been found to resemble each other, suggesting a connection between modern forms and older forms, as well as, divergent pathways from common ancestors.



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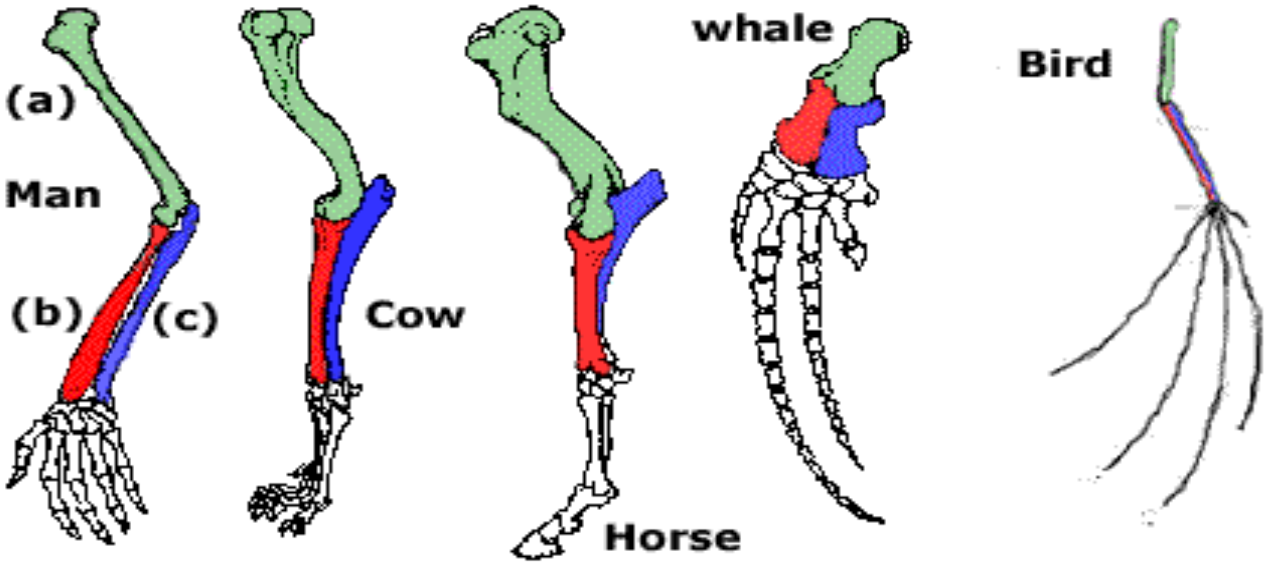
Comparative Anatomy

- Homologous structures= anatomically similar structures inherited from a common ancestor



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Comparative Anatomy

- Comparative studies of certain organisms indicate similarities in anatomical features.
- Homologous structures- anatomical parts that are similar in structure and origin (development), but function differently. (Ex.- wing of bird, arm of man, foreleg of horse).
- Homologous bones exist in the forelimbs of many different vertebrates such as birds, horses, man, bats, whales.
- Analogous structures- are similar in appearance and function, but have developmental differences. (Ex.- wing of bird and wing of butterfly).

Images taken from internet.

Comparative Embryology

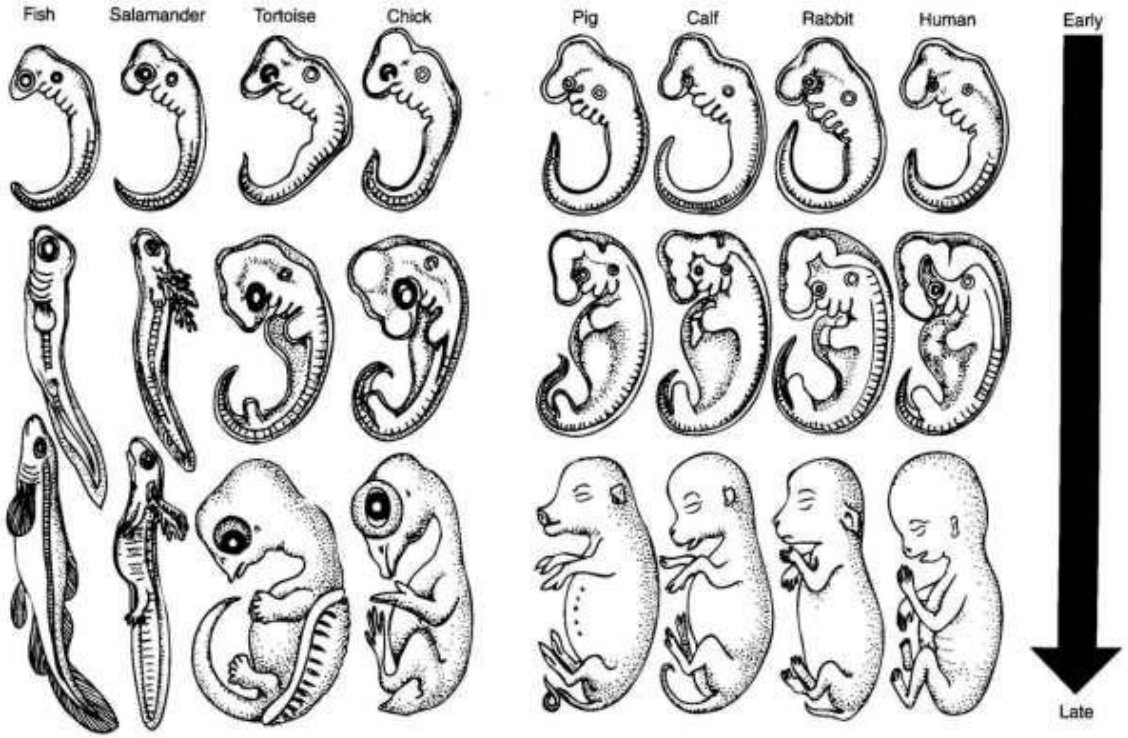
- Similar phases of development

The study of embryonic developments among groups of organisms reveals similarities that suggest common ancestry.

1. Early vertebrate embryos resemble each other.

2. As development proceeds, the distinctive features of each species becomes apparent.

3. All have gill slits, tail-bones (coccyx), segmented backbones, and are C-shaped.



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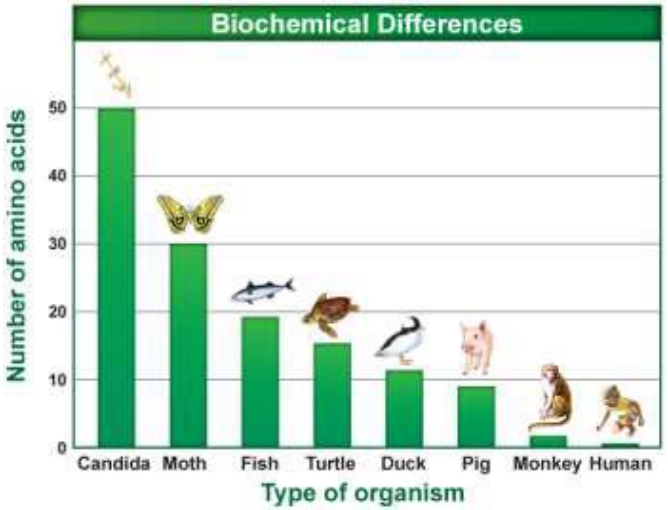
Comparative Biochemistry

- Common ancestry can be seen in the complex metabolic molecules that many different organisms share.

- Organisms with closely related morphological features have more closely related molecular features.

- Nucleic acids, their structure and function, are similar in living organisms.
- Many different organisms have similar proteins and enzymes.
- In order for this similarity to occur, their DNA must be similar.
- The greater their biochemical similarity, the closer the relationship among organisms, thus suggesting evolutionary relationships.



Species	Sequence of Amino Acids in the Same Part of the Hemoglobin Molecules
Human	Lys–Glu–His–Iso
Horse	Arg–Lys–His–Lys
Gorilla	Lys–Glu–His–Lys
Chimpanzee	Lys–Glu–His–Iso
Zebra	Arg–Lys–His–Arg

Images taken from internet.

Comparative Cytology

According to the cell theory, the cell is the unifying structure for living things. Organelles such as the cell membrane, ribosomes, and mitochondria, are structurally and functionally similar in most divergent organisms. This suggests that all living things are related to some degree. The fewer the differences in these cell structures, the closer the relationship appears.

Images taken from internet.

Vestigial Structures

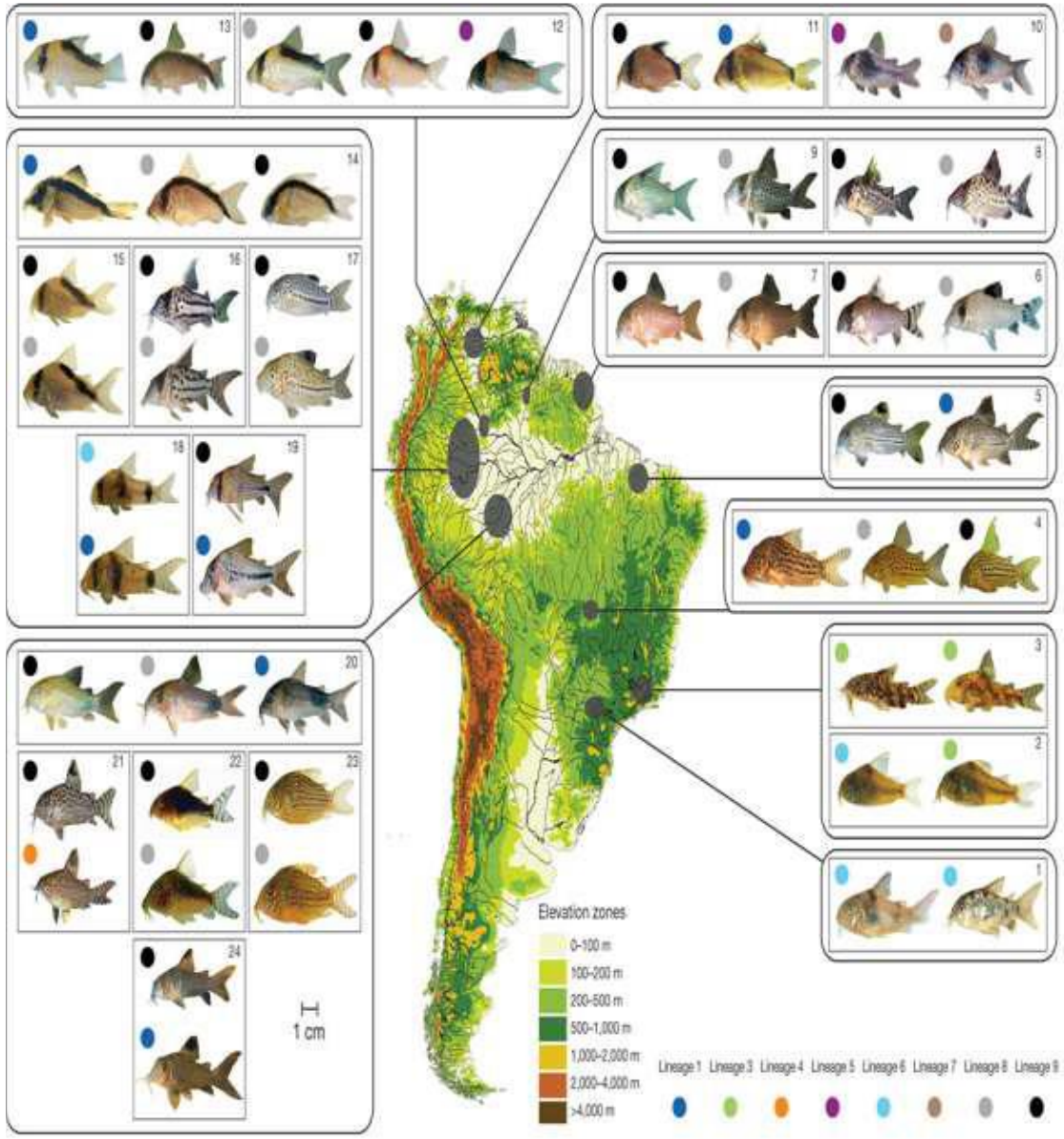
- These are structures that do not have any use, but are the remains of structures that were once functional in ancestral organisms.

- Some examples of vestigial organs are:
  Humans- appendix, coccyx, 3rd molars
  Horses- splint bones
  Whales- pelvic (hip) bones

Images taken from internet.

Geographical Distribution

- The distribution of plants and animals that Darwin saw first suggested evolution to Darwin.
- Patterns of migration were critical to Darwin when he was developing his theory.
- Evolution is intimately linked with climate and geological forces.



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