

FORM 4

BIOLOGY

TOPIC 2: EVOLUTION

1. Explain the meaning of evolution

-A gradual change in living organisms from simple life forms to more complex forms over a long period of time.

2. Differentiate organic evolution from chemical evolution as theories of origin of life

-Organic evolution refers to the emergence of present forms of organisms gradually from pre-existing forms (some of which no longer exist)

-Chemical evolution explains the origin of life as having occurred when simple chemical compounds reacted to form the simplest life forms

3. What is special creation?

-Maintains that the whole universe and all living organisms came into being due to the act of a supernatural being

4. Discuss the various kinds of evidence for evolution

i) Fossils

-Fossils are remains of organisms preserved in naturally occurring materials for many years

-They give evidence of types of plants/animals that existed at certain geological age/long ago/millions of years ago

-Gives evidence of morphological/anatomical/structural changes that have taken place over a long period of time e.g. human skull, leg of horse

ii) Comparative anatomy

-Gives evidence of relationship among organisms/gives evidence of a common ancestry of a group of organisms

-Organisms have similar structures/organs performing the same function e.g.

digestive system/ urinary system/nervous system/vestigial structures and vertebrate heart

-Divergence where the basic structural form is modified to serve different functions e.g. vertebrate forelimb/beak structure in birds/birds feet/parts of a flower. These are called homologous structures

-Homologous structures have a common embryonic origin but are modified to perform different functions e.g. the pentadactyl limb

-Adaptive radiation is a situation where organism have a homologous structure with common embryonic origin which is modified to perform different functions to adapt organisms to different ecological niches/habitats e.g. beaks of Darwinian finches(birds)

-Convergence is where different structures are modified to perform a similar function e.g. wings of birds and insects/eyes of humans and octopuses. These are called analogous structures

-Vestigial structures are greatly reduced in size and have ceased to function e.g. human appendix/caecium/coccyx in humans, wings of kiwi (flightless bird), presence of hind limb pad in python, halteres in insects, human hair nictitating membrane in human eye, human ear muscle, pelvic girdle in whale and third digit of wing of bird.

iii) Comparative embryology

-Some embryos of different animals appear very similar thus showing relationship and possibility of a common ancestry e.g. different classes of vertebrates larvae of annelida and mollusca are similar (tocophere)

iv) Comparative serology/physiology

-These show biochemical and immunological comparisons of blood groups/components to show immunological similarities of tissues therefore showing relatedness of different organisms e.g. antigen antibody reactions, human blood groups/Rh factor reveal some phylogenic relationship among organisms/common ancestry

v) Geographical distribution

-Organisms differ in various geographical regions

-Present continents are thought to have been a large land mass joined together/pangea/Eurasia/Gondwanaland

-Present continents drifted apart from one land mass/continental drift

-As a result of continental drift isolation of organisms occurred bring about different patterns of evolution

-Organisms in each continent evolved along different lines hence emergence of new species/divergence/convergence

Examples

- Marsupials in Australia
- Illama, jaguar, panther in S. America
- Lion, camel in Africa
- Tiger in Asia

vi) Cell biology (cytology)

- Structures and functioning of cells are similar
- Occurrence of organelles e.g. mitochondria in all cells/both plant and animal cells
- These point at a common ancestry

5. State the evolutionary characteristics that adapt human beings to the environment

- **Brain**
- **Eyes**
- **Upright posture/bipedal locomotion**
- **prehensile arm/hand**
- **Speech**

6. State the ways in which Homo sapiens differs from Homo habilis

- Standing upright/erect posture**
- Intellectual capacity/higher thinking capacity/bigger brain/higher brain capacity**
- Communication through language/speech**

7. Explain Lamarck's theory of evolution

- **Inheritance of acquired characteristics/environment induces production of a favorable trait which is then inherited**

8. Explain why Lamarck's theory of evolution is not accepted by biologists today - **Evidence does not support Lamarck's theory**

- **Acquired characteristics are not inherited/inherited characteristics are found in reproductive cells only**

9. Explain Darwin's theory of evolution

- **Inheritance of genetically acquired characteristics**
- **A character happens to appear spontaneously which gives advantage to an organism therefore adapted then inherited through natural selection**

10. What is natural selection?

- **Organisms with certain characteristics are favored by the environment Such organisms tend to survive and produce viable offspring others not favored are eliminated from subsequent generations**

11. With examples, explain how natural selection takes place

- **Organism with certain characteristics are favored by their environment**
- **Such organisms tend to survive and produce viable offspring - Others not favored are eliminated from subsequent generations - As the environmental conditions change the survival value of a character may alter with time so that characteristics which were favored may no longer have advantage and other characters may then become favorable - If a favorable character is inherited, then offspring produce generations which are better adapted to survive in a population**
- **More offspring are produced than can survive which results in struggle for survival**
- **The fittest survive**

12. State the advantages of natural selection to organisms

- **Assist to eliminate disadvantageous characteristics/perpetuates advantageous characteristics**
- **Allows better adapted organisms to survive adverse changes in the environment/less adapted organisms are eliminated**

13. State the ways in which sexual reproduction is important in the evolution of plants and animals

- **Brings about useful variations/desirable characters**
- **Variations make offspring better adapted for survival/more resistant to diseases**
- **May lead to origin of new species**

14. Explain the significance of mutation in evolution

- **Mutation bring about variation which can be inherited**
- **Some of these variations are advantageous to the organism**
- **Others are disadvantageous**
- **The advantageous variations favor the organism to compete better in the struggle for survival**
- **This results into a more adapted organism to its environment or new species/varieties**
- **Those with disadvantageous characters will be discriminated against therefore eliminated from the population/death/perish**

15. Explain why it is only mutations in genes of gametes that influence evolution - **Because it is the gametes which forms the new offspring.**

16. How would you prove that evolution is still taking place?

- **Resistance of organism to antibiotics, pesticides and drugs**
- **New varieties of bacteria are resistant to certain antibiotics such as penicillin**
- **Houseflies and mosquitoes are resistant to DDT**

17. Explain why some bacteria develop resistance to a drug after they have been subjected to it for some time.

- **Bacteria mutates/develops a new strain/chemical composition is altered hence is able to produce enzymes/chemicals which degrade the drug rendering it non-susceptible to the drug**
- **The new strain is favored by selection pressure/ natural selection**

18. How has peppered moth contributed towards the mechanism of evolution? - **This is an example of natural selection**

- **The peppered moth exists in two distinct forms, the speckled white form (normal form) and a melanin form (the black/dark)**
- **They usually rest on leaves and barks of trees that offer camouflage for protection**
- **Originally the “speckled white” form predominated the unpolluted area of England**
- **This coloration offered protection against predatory birds**
- **Due to industrial pollution tree barks have blackened with soot**
- **The white form underwent mutation**
- **A black variety/mutant emerged suddenly by mutation**
- **It had selective advantage over the white forms that were predated upon in the industrial areas**
- **The speckled white form is abundant in areas without soot/smoke**

19. Two populations of the same species of birds were separated over a long period of time by an ocean. Both populations initially fed on insects only but later it was observed that one population fed entirely on fruits and seeds although insects were available. Name; (a) The type of isolation.

Geographical.

(b) The type of evolutionary change.

Adaptive radiation / Divergent evolution.

20. What are vestigial structures?

Structures which have been greatly reduced in the course of time due to disuse.

21. Name **one** vestigial structure in man.

Coccyx, Appendix.

22. Explain why Lamarck's theory of evolution is not accepted by biologists today.

- **Evidences does not support Lamarck's theory acquired characteristics are not inherited.**
- **Inherited characteristics are found in reproductive cells only.**

23. State two pieces of evidence that support the Lamarck's theory of evolution.

- **Fossils, records, (Paleontology)**
- **Geographical distribution comparative anatomy/taxonomy cell biology**
- **Comparative serology,**
- **Comparative embryology**
- **Comparative immunology**

24. Distinguish between analogous structures and homologous structures. For each structure give an example.

-Analogous structures, are those with different embryonic origin but have undergone modification to perform similar functions in different organisms; Examples wings of insects and birds/webbed feet for frogs and ducks;
Homologous structures, Are those with a common embryonic origin but have undergone modifications to perform different functions; example the pentadactyle limb of vertebrates;

25. Explain the term continental drift as used in evolution.

-The breaking up, drifting and separation; of the big land mass to form the present day different continents;

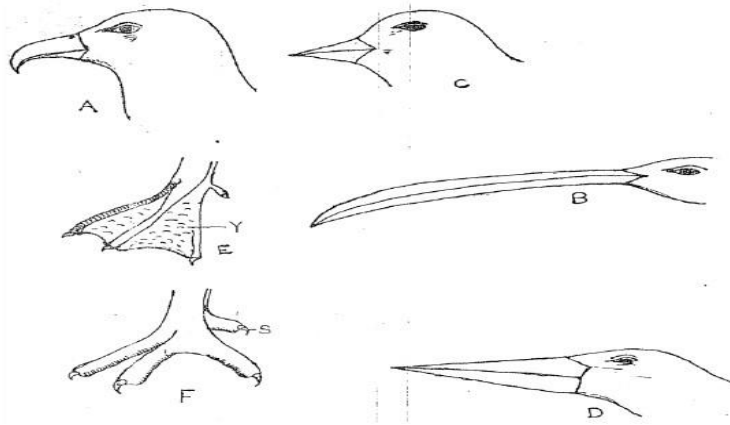
26. State **three** evidence of organic evolution.

- Fossil records;**
- Comparative embryology;**
- Comparative serology;**
- Comparative cell Biology;**
- Comparative anatomy;**

27. What are the limitations of fossil records as evidence of organic evolution?

- Several missing fossils records (missing links); these have occurred due to complete decomposition of whole organism/scavenged upon/lack of conditions for fossilization/discovery of few fossils;**
- Distortion of parts of fossil during sedimentation which gives wrong impression of the structures;**
- Distortion of fossils by geological activities e.g. earthquakes, faulting, uplifting and mass movement.**

28. The picture below shows several beaks and feet in birds.



- a). State the type of evolution that may have led to the emergence of the different beaks shown on the pictures above. **Divergent/Adaptive radiation**
- b) Name the type of evolution structure represented by the beaks shown on the pictures above.

Homologous

- c) Observe the pictures carefully. From your observations, what features are responsible for the different types of beaks?

Length; shape; size;

29. Give two examples of natural selection in action.

Resistance of insects and bacteria to Insecticides and antibiotics; Industrial melanism;

30. List three features that make man the most dominant species on earth.

- Ability to communicate through speech;**
- upright posture;**
- A modified forelimb to form hand with an opposable thumb;**

31. Describe how the following evidences support the theory of organic evolution: geographical distribution, fossil records and comparative anatomy.

Evidence of Evolution

Fossil records//Palaeontology;

These are remains of organisms preserved in some naturally occurring materials e.g. sedimentary rocks for many years; they give direct evidence of the type of organisms that existed at a certain geological time//show a gradual increase in complexity/morphological changes of organisms over a long period of time e.g. skull of man **Geographical distribution;**

present continents are thought to have been a large land mass joined together; continental drift led to isolation that lead to different patterns of evolution; e.g. camels of Africa resemble the llamas of S. America// tiger of Asia resemble jaguars of S. America // unique Marsupials of Australia;

Comparative anatomy/taxonomy;

- Members of a phylum show similarities indicating common ancestry; these organisms have similar functions e.g. presence of digestive, urinary, nervous systems e.t.c;
- Homologous structures like pentadactyl limbs in different animals like monkey and rats have similar bone arrangement hence same origin but modified to perform different functions// adaptive radiation//divergent evolution; vestigial organs//coccyx Appendix;
- Analogous structures like wings of birds and wings of insects with different embryonic origin but perform same function//convergent evolution;

32. Differentiate between convergent and divergent evolution.

Convergent evolution - This is where different structures are modified to do same function; whereas **divergent evolution** is where one basic structural form is modified to give rise to different forms which will perform different functions.

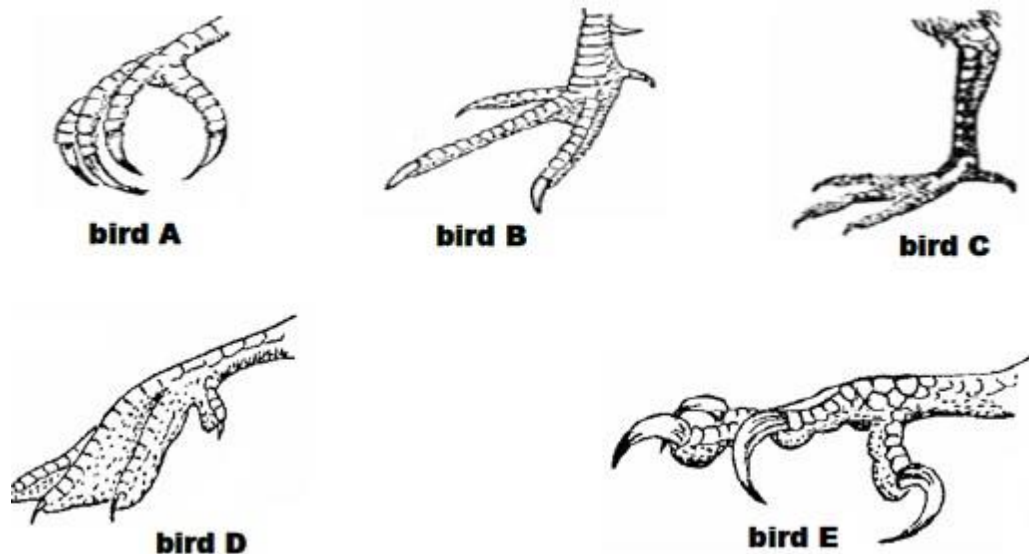
33. What is organic evolution?

Gradual change in organism from simple to complex life form over long period of time.

34 Briefly explain how the peppered moth (*Biston betularia*) shows natural selection.

Industrial areas have dark sooty tree trunks, in rural areas the trunks are covered with lichens. The dark melanin forms camouflage on the dark tree trunk. The white were predated upon the dark survive to reproductive maturity and produced more moths.

35. The figure below shows feet of various birds. Study the diagram and answer the questions that follow.



i).Name the type of evolution represented by the diagrams. **Divergent evolution;**

ii) Using Darwin's theory of evolution, explain how the feet of **bird E** would have evolved.

Small variations occurred in feet of birds within the population; competition for limited food occurred in the environment; predation as a mode of feeding favored birds whose feet had long, sharp and curved claw / talons; to kill prey / tear flesh of prey; iii) Explain how Lamarck could have explained the evolution of feet of bird C. All birds had same length of feet; the (aquatic environment favored long feet talons; leading to continuous natural use of the feet; which kept increasing in length; the longer trait was then passed on to offspring along the generations;

36. Explain the following terms as used in evolution.

(a) Struggle for existence

Competition for resources

(b) Divergent evolution

Structures from a common origin modified to perform different functions; (c)

Vestigial structure

Structure which have ceased to be functional thus reduced in size;

37. Define each of the following terms.

a) Speciation.

This refers to the emergence or development of a new species of organism from a pre-existing one; b) Natural selection.

The process by which the environment allows those organisms with favorable adaptive characteristics to survive, reach maturity and pass on favorable traits to offspring; while at same time ensuring that those without favorable traits die young without passing on their traits to next generation;

38. Define a fossil.

Preserved remains of dead organism that lived in ancient times and were accidentally preserved under sedimentary rocks;

39. State **two** biological evidence of organic evolution.

– **Fossil records/paleontology**

- **Geographical distribution of organism**

- **Cell biology/serology**

- Comparative embryology
- Comparative anatomy

40. Define Chemical evolution.

Chemical evolution maintain that chemicals like water vapor, oxygen, ammonia, hydrogen and methane were heated by catalytic effect of lighting during the cooling of the earth to form first life.

41. Explain how the process of evolution may result to the formation of a new species.

Organisms with beneficial / favorable mutations are able to pass them onto their offspring (during reproduction). ; Accumulation of such favorable characteristics over successive generations lead to the formation of new species;

42. Birds have beaks which are structurally modified to different modes of feeding.

i) What is the name given to such structures in evolution?

Homologous structures; ii) What is the name given to the evolution of the beaks of birds?

Divergent evolution;

43. State the roles of Lamarck's theory of evolution.

Tries to explain the occurrence of vestigial structures;

44. What is adaptive radiation?

One basic structural form with a common embryonic origin is modified to give rise to various different forms to exploit different environment;

45. State Darwin's theory of natural selection.

Nature selects suitable adapted organisms to be parents of future generation rejecting poorly adapted ones;

46. State **two** advantages of divergent evolution to organisms.

Enables the organisms to exploit different ecological niche (due to homologous structure; specialization development of new species;

47. State the significance of the following in evolution

i) Accumulation of variations in organisms

Leads to emergence of new organisms/ species/ animals/ plants/ flora/ fauna

ii) Survival of the fittest

Enables the well/ moist adapted organism to live up to reproductive age/ survive/ and pass their characteristics to their offspring.

48. Explain what leads to struggle for existence in organisms

Scarcity of resources/ limitation of resources/ breeding mates/ shelter

49. What is the difference between Darwinian and Lamarckian theories of evolution?

Lamarckian

Inheritance of acquired characteristics / environment induces production of inheritable character which is then inherited.

Darwinian

Inheritance of genetically acquired characteristics / character happens to appear spontaneously which then gives advantage of organisms therefore better – adaptable characters are then inherited by natural selection.

50. How does natural selection bring about adaptations of species to their environment?

- Organisms in the same environment are always competing for resources such as food mates, shelter etc as well as enduring the harshness of the environment.**
- This phenomenon is described as a struggle for existence**
- Those organisms that best adapted to survive to productive maturity and give rise to offspring of the next generation.**
- The less well adapted die young, hence survival of the fittest**
- If the favorable characteristics possessed by the ‘fittest’ organisms are genetic they are passed onto the offspring this leads to a natural occurrence of variation onto the offspring**
- This leads to a natural occurrence of various without a species**
- If these variations are genetic change in the characteristics of the species making it better adapted to its environment**
- Accumulation of small variations over a long period of time lead to the emergence of new forms of life i.e new species**
- If suited and well adapted to the new environment these new forms reproduce successfully and pass on their characteristics**
- If not suited these new forms are eliminated by nature leaving mutant forms which are better adapted to the environment**
- Through this process nature selects those organisms with better adaptations while ensuring the elimination of those not able to adapt to the changing environment.**
- Thus the changing environment (nature) forces and organism (a species) to adapt or otherwise be eliminated**

