CHAPTER 7

Evolution

7.1 Origin of Life

1. From his experiments, S.L. Miller produced amino acids by mixing the following in a closed flask.
(a) CH_4, H_2, NH_3 and water vapor at 800°C
(b) CH_3, H_2, NH_4 and water vapor at 800°C
(c) CH_4, H_2, NH_3 and water vapor at 600°C
(d) CH_3, H_2, NH_3 and water vapor at 600°C
(NEET 2020)

2. Which of the following is the correct sequence of events in the origin of life?
I. Formation of protobionts
II. Synthesis of organic monomers
III. Synthesis of organic polymers
IV. Formation of DNA-based genetic systems
(a) I, II, III, IV (b) I, III, II, IV
(c) II, III, I, IV (d) II, III, IV, I
(NEET-II 2016)

3. Following are the two statements regarding the origin of life.
(A) The earliest organisms that appeared on the earth were non-green and presumably anaerobes.
(B) The first autotrophic organisms were the chemoautotrophs that never released oxygen.
Of the above statements which one of the following options is correct?
(a) Both (A) and (B) are correct.
(b) Both (A) and (B) are false.
(c) (A) is correct but (B) is false.
(d) (B) is correct but (A) is false. *(NEET-I 2016)*

4. Which one of the following is incorrect about the characteristics of protobionts (coacervates and microspheres) as envisaged in the abiogenic origin of life?
(a) They were partially isolated from the surroundings.
(b) They could maintain an internal environment.
(c) They were able to reproduce.
(d) They could separate combinations of molecules from the surroundings. *(2008)*

5. The concept of chemical evolution is based on
(a) interaction of water, air and clay under intense heat
(b) effect of solar radiation on chemicals
(c) possible origin of life by combination of chemicals under suitable environmental conditions
(d) crystallisation of chemicals. *(2007)*

6. Which of the following amino acids was not found to be synthesised in Miller's experiment?
(a) Alanine (b) Glycine
(c) Aspartic acid (d) Glutamic acid
(2006)

7. Which one of the following experiments suggests that simplest living organisms could not have originated spontaneously from non-living matter?
(a) Larvae could appear in decaying organic matter.
(b) Microbes did not appear in stored meat.
(c) Microbes appeared from unsterilised organic matter.
(d) Meat was not spoiled, when heated and kept sealed in a vessel. *(2005)*

8. According to Oparin, which one of the following was not present in the primitive atmosphere of the earth?
(a) Methane (b) Oxygen
(c) Hydrogen (d) Water vapour
(2004)

9. There is no life on moon due to the absence of
(a) O_2 (b) water
(c) light (d) temperature. *(2002)*

10. Most abundant organic compound on earth is
(a) protein (b) cellulose
(c) lipids (d) steroids. *(2001)*

11. 1st life on earth was
(a) cyanobacteria (b) chemoheterotrophs
(c) autotrophs (d) photoautotrophs.
(2001)

12. The correct sequence for the manufacture of molecules/organic compounds on the primitive earth is
(a) NH_3, nucleic acid, protein and carbohydrate
(b) protein, carbohydrate, water and nucleic acid
(c) NH_3, protein, carbohydrate and nucleic acid
(d) NH_3, water, nucleic acid and protein. *(1996)*

13. The first organisms were
(a) chemoautotrophs (b) chemoheterotrophs
(c) autotrophs (d) eukaryotes. *(1992)*

14. Which was absent in the atmosphere at the time of origin of life?
(a) NH_3 (b) H_2
(c) O_2 (d) CH_4 *(1991)*

7.2 Evolution of Life Forms - A Theory

15. Which one of the following sequences was proposed by Darwin and Wallace for organic evolution ?
(a) Overproduction, variations, constancy of population size, natural selection
(b) Variations, constancy of population size, overproduction, natural selection
(c) Overproduction, constancy of population size, variations, natural selection
(d) Variations, natural selection, overproduction, constancy of population size *(2003)*

16. Darwin's theory of pangenesis shows similarity with theory of inheritance of acquired characters then what shall be correct according to it?
(a) Useful organs becomes strong and developed while useless organs become extinct.
(b) Size of organs increase with aging.
(c) Development of organs is due to will power.
(d) There should be some physical basis of inheritance. *(2001)*

7.3 What are Evidences for Evolution?

17. Which of the following refer to correct example(s) of organisms which have evolved due to changes in environment brought about by anthropogenic action?
(1) Darwin's Finches of Galapagos islands.
(2) Herbicide resistant weeds.
(3) Drug resistant eukaryotes.
(4) Man-created breeds of domesticated animals like dogs.
(a) only (1) (b) (1) and (3)
(c) (2), (3) and (4) (d) only (4) *(NEET 2020)*

18. Embryological support for evolution was disapproved by
(a) Karl Ernst von Baer (b) Alfred Wallace
(c) Charles Darwin (d) Oparin. *(NEET 2020)*

19. Flippers of penguins and dolphins are examples of
(a) adaptive radiation (b) convergent evolution
(c) industrial melanism (d) natural selection.
(NEET 2020)

20. The similarity of bone structure in the forelimbs of many vertebrates is an example of
(a) homology (b) analogy
(c) convergent evolution (d) adaptive radiation.
(NEET 2018)

21. Among the following sets of examples for divergent evolution, select the incorrect option.
(a) Forelimbs of man, bat and cheetah
(b) Heart of bat, man and cheetah
(c) Brain of bat, man and cheetah
(d) Eye of octopus, bat and man *(NEET 2018)*

22. Which of the following structures is homologous to the wing of a bird?
(a) Hindlimb of rabbit (b) Flipper of whale
(c) Dorsal fin of a shark
(d) Wing of a moth *(NEET-I 2016)*

23. Analogous structures are a result of
(a) shared ancestry (b) stabilising selection
(c) divergent evolution (d) convergent evolution.
(NEET-I 2016)

24. The wings of a bird and the wings of an insect are
(a) phylogenetic structures and represent divergent evolution
(b) homologous structures and represent convergent evolution
(c) homologous structures and represent divergent evolution
(d) analogous structures and represent convergent evolution. *(2015)*

25. Industrial melanism is an example of
(a) mutation (b) Neo-Lamarckism
(c) Neo-Darwinism (d) natural selection.
(2015)

26. Forelimbs of cat, lizard used in walking; forelimbs of whale used in swimming and forelimbs of bats used in flying are an example of
(a) analogous organs
(b) adaptive radiation
(c) homologous organs
(d) convergent evolution. *(2014)*

27. Which one of the following are analogous structures?
(a) Wings of bat and wings of pigeon
(b) Gills of prawn and lungs of man
(c) Thorns of *Bougainvillea* and tendrils of *Cucurbita*
(d) Flippers of dolphin and legs of horse *(2014)*

28. The process by which organisms with different evolutionary history evolve similar phenotypic adaptations in response to a common environmental challenge, is called

(a) non-random evolution
(b) adaptive radiation
(c) natural selection
(d) convergent evolution. *(NEET 2013)*

29. The eye of octopus and eye of cat show different patterns of structure, yet they perform similar function. This is an example of
(a) analogous organs that have evolved due to convergent evolution
(b) analogous organs that have evolved due to divergent evolution
(c) homologous organs that have evolved due to convergent evolution
(d) homologous organs that have evolved due to divergent evolution. *(NEET 2013)*

30. Which one of the following options gives one correct example each of convergent evolution and divergent evolution?

	Convergent evolution	**Divergent evolution**
(a)	Eyes of octopus and mammals	Bones of forelimbs of vertebrates
(b)	Thorns of *Bougainvillea* and tendrils of *Cucurbita*	Wings of butterflies and bird
(c)	Bones of forelimbs of vertebrates	Wings of butterfly and birds
(d)	Thorns of *Bougainvillea* and tendrils of *Cucurbita*	Eyes of octopus and mammals

(2012)

31. Given below are four statements (A-D) each with one or two blanks. Select the option which correctly fills up the blanks in two statements.
Statements:
(A) Wings of butterfly and birds look alike and are the results of __(i)__ evolution.
(B) Miller showed that CH_4, H_2, NH_3 and __(i)__ when exposed to electric discharge in a flask resulted in formation of __(ii)__ .
(C) Vermiform appendix is a __(i)__ organ and an __(ii)__ evidence of evolution.
(D) According to Darwin evolution took place due to __(i)__ and __(ii)__ of the fittest.
(a) (D) – (i) small variations, (ii) survival,
(A) – (i) convergent
(b) (A) – (i) convergent,
(B) – (i) oxygen, (ii) nucleosides
(c) (B) – (i) water vapour, (ii) amino acids
(C) – (i) rudimentary, (ii) anatomical
(d) (C) – (i) vestigial, (ii) anatomical
(D) – (i) mutations, (ii) multiplication
(Mains 2010)

32. *Peripatus* is a connecting link between
(a) mollusca and echinodermata
(b) annelida and arthropoda
(c) coelenterata and porifera
(d) ctenophora and platyhelminthes. *(2009)*

33. In the case of peppered moth (*Biston betularia*) the black-coloured form became dominant over the light-coloured form in England during industrial revolution. This is an example of
(a) appearance of the darker coloured individuals due to very poor sunlight
(b) protective mimicry
(c) inheritance of darker colour character acquired due to the darker environment
(d) natural selection whereby the darker forms were selected. *(2009)*

34. Thorn of *Bougainvillea* and tendril of *Cucurbita* are examples of
(a) vestigial organs
(b) retrogressive evolution
(c) analogous organs
(d) homologous organs. *(2008)*

35. Which one of the following pairs of items correctly belongs to the category of organs mentioned against it?
(a) Nephridia of earthworm and Malpighian tubules of cockroach - excretory organs
(b) Wings of honeybee and wings of crow - homologous organs
(c) Thorn of *Bougainvillea* and tendrils of *Cucurbita* - analogous organs
(d) Nictitating membrane and blind spot in human eye - vestigial organs *(2008)*

36. Which one of the following statements is correct?
(a) There is no evidence of the existence of gills during embryogenesis of mammals.
(b) All plant and animal cells are totipotent.
(c) Ontogeny repeats phylogeny.
(d) Stem cells are specialised cells. *(2007)*

37. When two species of different genealogy come to resemble each other as a result of adaptation, the phenomenon is termed
(a) microevolution (b) co-evolution
(c) convergent evolution (d) divergent evolution.
(2007)

38. An important evidence in favour of organic evolution is the occurrence of
(a) homologous and analogous organs
(b) homologous and vestigial organs
(c) analogous and vestigial organs
(d) homologous organs only. *(2006)*

39. Which one of the following is not a living fossil?
(a) *Peripatus* (b) King crab
(c) *Sphenodon* (d) *Archaeopteryx* *(2006)*

40. Which of the following is the relatively most accurate method for dating of fossils?
(a) Radio-carbon method
(b) Potassium-argon method
(c) Electron-spin resonance method
(d) Uranium-lead method *(2005)*

41. Age of fossils in the past was generally determined by radio-carbon method and other methods involve radioactive elements found in the rocks. More precise methods, which were used recently and led to the revision of the evolutionary periods for different groups of organisms, includes
(a) study of carbohydrates/proteins in fossils
(b) study of the conditions of fossilisation
(c) electron spin resonance (ESR) and fossil DNA
(d) study of carbohydrates / proteins in rocks.
(2004)

42. Convergent evolution is illustrated by
(a) rat and dog
(b) bacterium and protozoan
(c) starfish and cuttle fish
(d) dogfish and whale. *(2003)*

43. Industrial melanism is an example of
(a) drug resistance
(b) darkening of skin due to smoke from industries
(c) protective resemblance with the surroundings
(d) defensive adaptation of skin against ultraviolet radiations. *(2003)*

44. Which one of the following describes correctly the homologous structures?
(a) Organs with anatomical similarities, but performing different functions
(b) Organs with anatomical dissimilarities, but performing same function
(c) Organs that have no function now, but had an important function in ancestor
(d) Organs appearing only in embryonic stage and disappearing later in the adult *(2003)*

45. Which of the following are homologous organs?
(a) Wings of birds and locust
(b) Wings of birds and pectoral fins of fish
(c) Wings of bat and butterfly
(d) Legs of frog and cockroach *(2002)*

46. Sequence of which of the following is used to know the phylogeny?
(a) *m*RNA (b) *r*RNA
(c) *t*RNA (d) DNA *(2002)*

47. Half life period of ^{14}C is
(a) 500 years (b) 5000 years
(c) 50 years (d) 5×10^4 years. *(2001)*

48. In Lederberg's replica plating experiment what shall be used to obtain streptomycin resistant strain?
(a) Minimal medium and streptomycin
(b) Complete medium and streptomycin
(c) Only minimal medium
(d) Only complete medium *(2001)*

49. Similarities in organism with different genotype indicates
(a) microevolution
(b) macroevolution
(c) convergent evolution
(d) divergent evolution. *(2001)*

50. Which is not a vestigial organ in man?
(a) Third molar (b) Nails
(c) Segmental muscles of abdomen
(d) Coccyx *(2000)*

51. Phenomenon of 'Industrial melanism' demonstrates
(a) geographical isolation
(b) reproductive isolation
(c) natural selection
(d) induced mutation. *(1999)*

52. Which of the following are homologous organs?
(a) Wings of bird and hands of human
(b) Nails of human being and claws in animals
(c) Wings of bird and wings of insect
(d) Wings of bat and wings of cockroach
(1999)

53. Evolutionary convergence is characterised by
(a) development of dissimilar characteristics in closely related groups
(b) development of a common set of characteristics in groups of different ancestry
(c) development of characteristics by random mating
(d) replacement of common characteristics in different groups. *(1997)*

54. Which of the following is the correct group of vestigial organs in man?
(a) Nictitating membrane, ear muscles, eyelids and coccyx
(b) Appendix, coccyx, ear muscles and elbow joint
(c) Wisdom tooth, coccyx, body hair and ear muscles
(d) Wisdom tooth, body hairs, nictitating membrane and vermiform appendix *(1996)*

55. Which of the following isotopes is most dangerous to *Homo sapiens*?
(a) Phosphorus-32 (b) Strontium-90
(c) Caesium-137 (d) Iodine-131 *(1995)*

56. The change of the lighter-coloured variety of peppered moth (*Biston betularia*) to its darker variety (*Biston carbonaria*) is due to
(a) mutation (b) regeneration
(c) genetic isolation (d) temporal isolation. *(1995)*

57. The homologous organs are those that show similarity in
(a) appearance (b) function
(c) origin (d) size. *(1995)*

58. The presence of gill slits, in the embryos of all vertebrates, supports the theory of
(a) metamorphosis (b) biogenesis
(c) organic evolution (d) recapitulation. *(1995)*

59. The earliest fossil form, in the phylogeny of horse, is
(a) *Equus* (b) *Mesohippus*
(c) *Eohippus* (d) *Merychippus.* *(1994)*

60. Which of the following is a pair of homologous organs?
(a) Pectoral fin of rohu and forelimb of horse
(b) Wings of grasshopper and wings of crow
(c) Lungs of rabbit and gills of rohu
(d) Wings of bat and wings of butterfly *(1994)*

61. Evolutionary convergence is development of
(a) common set of characters in group of different ancestry
(b) dissimilar characters in closely related groups
(c) common set of characters in closely related groups
(d) random mating. *(1993)*

62. Study of fossils is
(a) palaeontology (b) herpetology
(c) saurology (d) organic evolution. *(1991)*

63. Parallelism is
(a) adaptive divergence
(b) adaptive divergence of widely separated species
(c) adaptive convergence of widely different species
(d) adaptive convergence of closely related groups. *(1990)*

64. Basic principles of embryonic development were pronounced by
(a) von Baer (b) Weismann
(c) Haeckel (d) Morgan. *(1990)*

7.4 What is Adaptive Radiation?

65. The finch species of Galapagos islands are grouped according to their food sources. Which of the following is not a finch food?
(a) Carrion (b) Insects
(c) Tree buds (d) Seeds
(Karnataka NEET 2013)

66. Evolution of different species in a given area starting from a point and spreading to other geographical areas is known as
(a) adaptive radiation (b) natural selection
(c) migration (d) divergent evolution. *(2012)*

67. Darwin's finches are a good example of
(a) industrial melanism (b) connecting link
(c) adaptive radiation (d) convergent evolution. *(2010, 2008)*

68. The Finches of Galapagos islands provide an evidence in favour of
(a) evolution due to mutation
(b) retrogressive evolution
(c) biogeographical evolution
(d) special creation. *(2007)*

69. Adaptive radiation refers to
(a) evolution of different species from a common ancestor
(b) migration of members of a species to different geographical areas
(c) power of adaptation in an individual to a variety of environments
(d) adaptations due to geographical isolation. *(2007)*

70. Which evidence of evolution is related to Darwin's finches?
(a) Evidences from biogeographical distribution
(b) Evidences from comparative anatomy
(c) Evidences from embryology
(d) Evidences from paleontology *(2000)*

71. The diversity in the type of beaks of finches adapted to different feeding habits on the Galapagos Islands, as observed by Darwin, provides evidence for
(a) intraspecific competition
(b) interspecific competition
(c) origin of species by natural selection
(d) intraspecific variations. *(1998)*

72. Theory of Natural Selection dwells on
(a) role of environment in evolution
(b) natural selection acting on favourable variations
(c) changes in gene complex resulting in heritable variations
(d) none of these. *(1993)*

73. Humming birds and Hawk illustrate
(a) convergent evolution (b) homology
(c) adaptive radiation (d) parallel evolution. *(1988)*

7.5 Biological Evolution

74. Which one of the following scientist's name is correctly matched with the theory put forth by him?

(a) De Vries - Natural selection
(b) Mendel - Theory of Pangenesis
(c) Weismann - Theory of continuity of germplasm
(d) Pasteur - Inheritance of acquired characters *(2008)*

75. Which one of the following phenomena supports Darwin's concept of natural selection in organic evolution?
(a) Development of transgenic animals
(b) Production of 'Dolly', the sheep by cloning
(c) Prevalence of pesticide resistant insects
(d) Development of organs from 'stem cells' for organ transplantation *(2005)*

76. Darwin in his "Natural Selection Theory" did not believe in any role of which one of the following in organic evolution?
(a) Parasites and predators as natural enemies
(b) Survival of the fittest
(c) Struggle for existence
(d) Discontinuous variations *(2003)*

77. *Nicotiana sylvestris* flowers only during long days and *N.tabacum* flowers only during short days. If raised in the laboratory under different photoperiods, they can be induced to flower at the same time and can be cross-fertilised to produce self-fertile offspring. What is the best reason for considering *N.sylvestris* and *N.tabacum* to be separate species?
(a) They cannot interbreed in nature.
(b) They are reproductively distinct.
(c) They are physiologically distinct.
(d) They are morphologically distinct. *(2003)*

78. Which of the following is most important for speciation?
(a) Seasonal isolation
(b) Reproductive isolation
(c) Behavioural isolation
(d) Tropical isolation *(2002)*

79. Some bacteria are able to grow in streptomycin containing medium due to
(a) natural selection
(b) induced mutation
(c) reproductive isolation
(d) genetic drift. *(2002)*

80. Reason of diversity in living being is
(a) mutation
(b) long term evolutionary change
(c) gradual change
(d) short term evolutionary change. *(2001)*

81. Which is the most important factor for continuity of a species from evolutionary point of view?
(a) Replication of genetic material
(b) Formation of gametes
(c) Synthesis of proteins
(d) None of these *(2000)*

82. Species occurring in different geographical area are called as
(a) sympatric (b) allopatric
(c) sibling (d) neopatric. *(1998)*

83. Which of the following evidences does not favour the Lamarckian concept of inheritance of acquired characters?
(a) Lack of pigment in cave-dwelling animals
(b) Melanisation in peppered moth
(c) Absence of limbs in snakes
(d) Presence of webbed toes in aquatic birds *(1994)*

84. Weismann cut off tails of mice generation after generation but tails neither disappeared nor shortened showing that
(a) Darwin was correct
(b) tail is an essential organ
(c) mutation theory is wrong
(d) Lamarckism was wrong in inheritance of acquired characters. *(1993)*

85. Evolution is
(a) progressive development of a race
(b) history and development of race along with variations
(c) history of race
(d) development of race. *(1989)*

86. "Continuity of germplasm" theory was given by
(a) De Vries (b) Weismann
(c) Darwin (d) Lamarck. *(1989)*

87. Theory of inheritance of acquired characters was given by
(a) Wallace (b) Lamarck
(c) Darwin (d) De Vries. *(1989)*

88. 'Origin of Species' was written by
(a) Oparin (b) Weismann
(c) Lamarck (d) Darwin. *(1989)*

7.6 Mechanism of Evolution

89. Variations caused by mutation, as proposed by Hugo de Vries, are
(a) small and directionless
(b) random and directional
(c) random and directionless
(d) small and directional. *(NEET 2019)*

90. According to Hugo de Vries, the mechanism of evolution is
(a) multiple step mutations
(b) saltation
(c) phenotypic variations
(d) minor mutations. *(NEET 2018)*

91. The idea of mutations was brought forth by
(a) Hugo de Vries who worked on evening primrose
(b) Gregor Mendel who worked on *Pisum sativum*
(c) Hardy-Weinberg who worked on allele frequencies in a population
(d) Charles Darwin who observed a wide variety of organisms during sea voyage. *(Mains 2012)*

92. De Vries gave his mutation theory on organic evolution while working on
(a) *Pisum sativum*
(b) *Drosophila melanogaster*
(c) *Oenothera lamarckiana*
(d) *Althea rosea*. *(2005)*

7.7 Hardy-Weinberg Principle

93. A gene locus has two alleles A, a. If the frequency of dominant allele A is 0.4, then what will be the frequency of homozygous dominant, heterozygous and homozygous recessive individuals in the population?
(a) 0.16 (AA); 0.36 (Aa); 0.48 (aa)
(b) 0.36 (AA); 0.48 (Aa); 0.16 (aa)
(c) 0.16 (AA); 0.24 (Aa); 0.36 (aa)
(d) 0.16 (AA); 0.48 (Aa); 0.36 (aa) *(NEET 2019)*

94. In a species, the weight of newborn ranges from 2 to 5 kg. 97% of the newborn with an average weight between 3 to 3.3 kg survive whereas 99% of the infants born with weights from 2 to 2.5 or 4.5 to 5 kg die. Which type of selection process is taking place?
(a) Cyclical selection
(b) Directional selection
(c) Stabilising selection
(d) Disruptive selection *(NEET 2019)*

95. Artificial selection to obtain cows yielding higher milk output represents
(a) directional as it pushes the mean of the character in one direction
(b) disruptive as it splits the population into two, one yielding higher output and the other lower output
(c) stabilising followed by disruptive as it stabilises the population to produce higher yielding cows
(d) stabilising selection as it stabilises this character in the population. *(NEET 2017)*

96. Genetic drift operates in
(a) small isolated population
(b) large isolated population
(c) non-reproductive population
(d) slow reproductive population.
(NEET-II 2016, 2002)

97. In Hardy-Weinberg equation, the frequency of heterozygous individual is represented by
(a) p^2 (b) $2pq$
(c) pq (d) q^2. *(NEET-II 2016)*

98. In a population of 1000 individuals 360 belong to genotype AA, 480 to Aa and the remaining 160 to aa. Based on this data, the frequency of allele A in the population is
(a) 0.4 (b) 0.5 (c) 0.6 (d) 0.7.
(2014)

99. The tendency of population to remain in genetic equilibrium may be disturbed by
(a) lack of mutations
(b) lack of random mating
(c) random mating
(d) lack of migration. *(NEET 2013)*

100. Variation in gene frequencies within populations can occur by chance rather than by natural selection. This is referred to as
(a) random mating (b) genetic load
(c) genetic flow (d) genetic drift.
(NEET 2013)

101. Random unidirectional change in allele frequencies that occurs by chance in all populations and especially in small populations is known as
(a) migration (b) natural selection
(c) genetic drift (d) mutation.
(Karnataka NEET 2013)

102. Genetic variation in a population arises due to
(a) recombination only
(b) mutation as well as recombination
(c) reproductive isolation and selection
(d) mutations only. *(Karnataka NEET 2013)*

103. At a particular locus, frequency of *A* allele is 0.6 and that of *a* is 0.4. What would be the frequency of heterozygotes in a random mating population at equilibrium?
(a) 0.36 (b) 0.16 (c) 0.24 (d) 0.48
(2005)

104. Which of the following is not true for a species?
(a) Members of a species can interbreed.
(b) Gene flow does not occur between the populations of a species.
(c) Each species is reproductively isolated from every other species.
(d) Variations occur among members of a species.
(2005)

105. Random genetic drift in a population probably results from
(a) highly genetically variable individuals
(b) interbreeding within this population
(c) constant low mutation rate
(d) large population size. *(2003)*

106. In which condition, the gene ratio remains constant for any species population?
(a) Sexual selection (b) Random mating
(c) Mutation (d) Gene flow *(2002)*

107. Forthcoming generation are less adaptive than the parental generation due to
(a) natural selection (b) mutation
(c) genetic drift (d) adaptation. *(2001)*

108. In the developmental history of mammalian heart, it is observed that it passes through a two chambered fish like heart, three chambered frog like heart and finally four chambered stage. To which hypothesis can this above cited statement be approximated?
(a) Lamarck's principle
(b) Mendelian principles
(c) Biogenetic law
(d) Hardy-Weinberg law *(1998)*

109. Genetic drift operates only in
(a) larger populations
(b) Mendelian populations
(c) island populations
(d) smaller populations. *(1998)*

110. Genetic drift is change of
(a) gene frequency in same generation
(b) appearance of recessive genes
(c) gene frequency from one generation to next
(d) none of these. *(1993)*

7.8 A Brief Account of Evolution

111. Dinosaurs dominated the world in which of the following geological eras?
(a) Cenozoic (b) Jurassic
(c) Mesozoic (d) Devonian
(Karnataka NEET 2013)

112. Jurassic period of the Mesozoic era is characterised by
(a) flowering plants and first dinosaurs appear
(b) gymnosperms are dominant plants and first birds appear
(c) radiation of reptiles and origin of mammal like reptiles
(d) dinosaurs become extinct and angiosperms appear.
(2006)

113. Diversification in plant life appeared
(a) due to long periods of evolutionary changes
(b) due to abrupt mutations
(c) suddenly on earth
(d) by seed dispersal. *(2004)*

114. In which era reptiles were dominant?
(a) Coenozoic era (b) Mesozoic era
(c) Palaeozoic era (d) Archaeozoic era
(2002)

115. Which statement is correct about centre of origin of plants?
(a) More diversity in improved variety
(b) Frequency of dominant gene is more
(c) Climatic condition more favourable
(d) None of these *(2001)*

116. Which period is dubbed as the age of prokaryotic microbes?
(a) Precambrian (b) Phanerozoic
(c) Archean (d) Proterozoic *(1995)*

117. Correct order is
(a) Palaeozoic → Archaeozoic → Coenozoic
(b) Archaeozoic → Palaeozoic → Proterozoic
(c) Palaeozoic → Mesozoic → Coenozoic
(d) Mesozoic → Archaeozoic → Proterozoic.
(1991)

7.9 Origin and Evolution of Man

118. Match the hominids with their correct brain size.

(A) *Homo habilis*	(i) 900cc
(B) *Homo neanderthalensis*	(ii) 1350 cc
(C) *Homo erectus*	(iii) 650-800cc
(D) *Homo sapiens*	(iv) 1400cc

Select the correct option.

	(A)	(B)	(C)	(D)
(a)	(iv)	(iii)	(i)	(ii)
(b)	(iii)	(i)	(iv)	(ii)
(c)	(iii)	(ii)	(i)	(iv)
(d)	(iii)	(iv)	(i)	(ii)

(NEET 2019)

119. Which of the following statements is correct about the origin and evolution of men ?
(a) Agriculture came around 50,000 years back.
(b) The *Dryopithecus* and *Ramapithecus* primates existing 15 million years ago, walked like men.
(c) *Homo habilis* probably ate meat.
(d) Neanderthal men lived in Asia between 1,00,000 and 40,000 years back.
(Odisha NEET 2019)

120. The chronological order of human evolution from early to the recent is
(a) *Australopithecus* → *Ramapithecus* → *Homo habilis* → *Homo erectus*
(b) *Ramapithecus* → *Australopithecus* → *Homo habilis* → *Homo erectus*
(c) *Ramapithecus* → *Homo habilis* → *Australopithecus* → *Homo erectus*
(d) *Australopithecus* → *Homo habilis* → *Ramapithecus* → *Homo erectus* *(NEET-II 2016)*

121. Which of the following had the smallest brain capacity?
(a) *Homo neanderthalensis*
(b) *Homo habilis*
(c) *Homo erectus*
(d) *Homo sapiens* *(2015 Cancelled)*

122. What was the most significant trend in the evolution of modern man (*Homo sapiens*) from his ancestors?
(a) Shortening of jaws
(b) Binocular vision
(c) Increasing cranial capacity
(d) Upright posture *(2012, 2011)*

123. The extinct human who lived 1,00,000 to 40,000 years ago, in Europe, Asia and parts of Africa, with short stature, heavy eye brows, retreating fore heads, large jaws with heavy teeth, stocky bodies, a lumbering gait and stooped posture was
(a) *Homo habilis*
(b) Neanderthal human
(c) Cro-magnon human
(d) *Ramapithecus.* *(2012)*

124. The most apparent change during the evolutionary history of *Homo sapiens* is traced in
(a) loss of body hair
(b) walking upright
(c) shortening of the jaws
(d) remarkable increase in the brain size
(Mains 2010)

125. There are two opposing views about origin of modern man. According to one view *Homo erectus* in Asia were the ancestors of modern man. A study of variation of DNA however suggested African origin of modern man. What kind of observation on DNA variation could suggest this?
(a) Greater variation in Asia than in Africa
(b) Greater variation in Africa than in Asia
(c) Similar variation in Africa and Asia
(d) Variation only in Asia and no variation in Africa
(2005)

126. What kind of evidence suggested that man is more closely related with chimpanzee than with other hominoid apes?
(a) Evidence from DNA extracted from sex chromosomes only
(b) Comparison of chromosomes morphology only
(c) Evidence from fossil remains, and the fossil mitochondrial DNA alone
(d) Evidence from DNA extracted from sex chromosomes, autosomes. *(2004)*

127. In recent years, DNA sequences (nucleotide sequence) of *mt*DNA and Y chromosomes were considered for the study of human evolution, because
(a) they are small and therefore, easy to study
(b) they are uniparental in origin and do not take part in recombination
(c) their structure is known in greater detail
(d) they can be studied from the samples of fossil remains. *(2003)*

128. According to fossils discovered up to present time origin and evolution of man started from
(a) France (b) Java
(c) Africa (d) China. *(2002)*

129. Which of the following is closest relative of man?
(a) Chimpanzee (b) Gorilla
(c) Orangutan (d) Gibbon *(2001)*

130. Which of the following is correct order of the evolutionary history of man?
(a) Peking man, *Homo sapiens*, Neanderthal man, Cromagnon man
(b) Peking man, Heidelberg man, Neanderthal man, Cromagnon man
(c) Peking man, Neanderthal man, *Homo sapiens*, Cromagnon man
(d) Peking man, Neanderthal man, *Homo sapiens*, Heidelberg man *(2001)*

131. *Homo sapiens* have evolved in
(a) Paleocene (b) Pleistocene
(c) Oligocene (d) Holocene. *(2000)*

132. Character which is closely related to human evolution is
(a) disappearance of tail
(b) reduction in size of jaws
(c) binocular vision
(d) flat nails. *(2000)*

133. Who is directly related to man?
(a) Gorilla (b) Rhesus
(c) Gibbon (d) Orangutan *(2000)*

134. Which one of the following statements is correct?
(a) *Australopithecus* is the real ancestor of modern man.
(b) Neanderthal man is the direct ancestor of *Homo sapiens.*
(c) *Homo erectus* is the ancestor of man.
(d) Cro-magnon man's fossil has been found in Ethiopia. *(1998)*

135. The age of the fossil of *Dryopithecus* on the geological time scale is
(a) 2.5×10^6 years back
(b) 50×10^6 years back
(c) 75×10^6 years back
(d) 25×10^6 years back. *(1998)*

136. Which of the following statements is correct regarding evolution of mankind?
(a) *Homo erectus* is preceded by *Homo habilis.*
(b) Neanderthal man and cro-magnon man were living at the same time.
(c) *Australopithecus* was living in Australia.
(d) None of these *(1997)*

137. Common origin of man and chimpanzee is best shown by
(a) binocular vision (b) chromosome number
(c) dental formula (d) cranial capacity. *(1997)*

138. Which of the following changes for man in the course of evolution is probably useless?
(a) Development of being erect
(b) Development of cranial capacity
(c) Loss of tail
(d) Development of opposable thumb *(1996)*

139. Which of the following is the direct ancestor of *Homo sapiens*?
(a) *Australopithecus*
(b) *H. sapiens neanderthals*
(c) *Homo erectus*
(d) *Homo sapiens fossilis* *(1996)*

140. The first domesticated animal by primitive man was
(a) cat (b) cow
(c) dog (d) horse. *(1996)*

141. Which one of the following changes involved is irrelevant, in the evolution of man?
(a) Perfection of hand for tool making
(b) Change of diet from hard nuts and hard roots to soft food
(c) Loss of tail
(d) Increase in the ability to communicate with others and develop community behaviour *(1994)*

ANSWER KEY

1.	(a)	**2.**	(c)	**3.**	(a)	**4.**	(c)	**5.**	(c)	**6.**	(d)	**7.**	(d)	**8.**	(b)	**9.**	(b)	**10.**	(b)
11.	(b)	**12.**	(d)	**13.**	(b)	**14.**	(c)	**15.**	(c)	**16.**	(d)	**17.**	(c)	**18.**	(a)	**19.**	(b)	**20.**	(a)
21.	(d)	**22.**	(b)	**23.**	(d)	**24.**	(d)	**25.**	(d)	**26.**	(c)	**27.**	(a,b)	**28.**	(d)	**29.**	(a)	**30.**	(a)
31.	(a)	**32.**	(b)	**33.**	(d)	**34.**	(d)	**35.**	(a)	**36.**	(c)	**37.**	(c)	**38.**	(b)	**39.**	(d)	**40.**	(c)
41.	(c)	**42.**	(d)	**43.**	(c)	**44.**	(a)	**45.**	(b)	**46.**	(b)	**47.**	(b)	**48.**	(a)	**49.**	(c)	**50.**	(b)
51.	(c)	**52.**	(a)	**53.**	(b)	**54.**	(d)	**55.**	(b)	**56.**	(a)	**57.**	(c)	**58.**	(d)	**59.**	(c)	**60.**	(a)
61.	(a)	**62.**	(a)	**63.**	(d)	**64.**	(a)	**65.**	(a)	**66.**	(a)	**67.**	(c)	**68.**	(c)	**69.**	(a)	**70.**	(a)
71.	(c)	**72.**	(c)	**73.**	(c)	**74.**	(c)	**75.**	(c)	**76.**	(d)	**77.**	(a)	**78.**	(b)	**79.**	(a)	**80.**	(b)
81.	(a)	**82.**	(b)	**83.**	(b)	**84.**	(d)	**85.**	(b)	**86.**	(b)	**87.**	(b)	**88.**	(d)	**89.**	(c)	**90.**	(b)
91.	(a)	**92.**	(c)	**93.**	(d)	**94.**	(c)	**95.**	(a)	**96.**	(a)	**97.**	(b)	**98.**	(c)	**99.**	(b)	**100.**	(d)
101.	(c)	**102.**	(b)	**103.**	(d)	**104.**	(b)	**105.**	(b)	**106.**	(b)	**107.**	(b)	**108.**	(c)	**109.**	(d)	**110.**	(d)
111.	(b)	**112.**	(b)	**113.**	(a)	**114.**	(b)	**115.**	(a)	**116.**	(a)	**117.**	(c)	**118.**	(d)	**119.**	(d)	**120.**	(b)
121.	(b)	**122.**	(c)	**123.**	(b)	**124.**	(d)	**125.**	(b)	**126.**	(d)	**127.**	(b)	**128.**	(c)	**129.**	(a)	**130.**	(b)
131.	(d)	**132.**	(a)	**133.**	(a)	**134.**	(c)	**135.**	(a)	**136.**	(a)	**137.**	(d)	**138.**	(c)	**139.**	(d)	**140.**	(c)
141.	(b)																		

Hints & Explanations

1. (a) : In 1953, S.L. Miller, an American scientist created similar conditions in a laboratory scale. He created electric discharge in a closed flask containing CH_4, H_2, NH_3 and water vapour at 800°C and observed formation of amino acids.

2. (c) **3. (a)**

4. (c) : The condition for origin of life, partial isolation, has been attained within aggregates of artificially formed prebiotic molecules. These aggregates are called protobionts which can separate combinations of molecules from the surroundings. They maintain an internal environment but are unable to reproduce. Two important protobionts are coacervates and microspheres.

5. (c) : Chemical evolution has two meanings and uses. The first refers to the theories of evolution of the chemical elements in the universe through nucleosynthesis. The second use of chemical evolution or chemosynthesis is as a hypothesis to explain how life might possibly have developed or evolved from non-life.

6. (d) : Stanley Miller in 1953, who was then a graduate student of Harold Urey at the University of Chicago, circulated four gases - methane, ammonia, hydrogen and water vapour in an air tight apparatus and passed electrical discharges from electrodes. He passed the mixture through a condenser. He circulated the gases continuously in this way for one week and then analysed the chemical composition of the liquid inside the apparatus. He found a large number of simple organic compounds including some amino acid such as alanine, glycine and aspartic acid. Glutamic acid was not found.

7. (d) : Microbes were killed by heating the meat and the sealed vessel formed a closed system wherein the new microbes could not come in contact with the nutrient medium and hence no spoilage of meat.

8. (b) : The first scientific explanation of origin of life was put forward by a Russian Scientist, A.I. Oparin in 1923. J.B.S. Haldane (1928), England-born Indian Scientist, also made similar observations regarding the origin of life. According to them primitive atmosphere was reducing atmosphere because hydrogen atoms (most numerous and most reactive) combined with all available oxygen atoms to form water and leaving no free oxygen.

9. (b) : Water is the most essential material to survive. One can thrive without O_2 (anaerobic bacteria) and light and in a wide range of temperature but one cannot live without water which is the most important component of the body (about 90% of plasma consists of water) and life was originated from abiogenetic materials in water.

10. (b)

11. (b) : The first living beings were prokaryotic, like bacteria. They were single-celled. Nucleic acid core consisted of naked DNA. These living beings were present in the environment of soupy sea having abundant organic molecules. Nutritionally they were chemoheterotrophs. They absorbed the organic materials from outside both for body building and liberation of energy. Respiration was anaerobic since free oxygen was absent in the environment.

12. (d) : Hydrogen atoms were most numerous and most reactive in primitive atmosphere. First hydrogen atoms combined with all oxygen atoms to form water and leaving no free oxygen. Hydrogen atoms also combined with nitrogen, forming ammonia (NH_3). So water and ammonia were probably the first compound molecules of primitive earth. Later methane, water and NH_3 join to form amino acids which gets converted into proteins while hydrogen bases, sugars and phosphates combine to form nucleic acids.

13. (b) : *Refer to answer 11.*

14. (c) : The primitive atmosphere was reducing atmosphere, *i.e.*, without free oxygen.

15. (c) : The gist (in brief) of Darwin - Wallace theory is as follows.

(i) Individuals within species show considerable but continuous variation in the form and physiology.

(ii) This variation arises in a random fashion and is heritable.

(iii) The potential for increase within population of animals and plants is considerable.

(iv) Since resources are limited, so individuals in a population struggle for their own existence.

(v) Only some survive and leave offspring with the same trait - through this natural selection of the fittest species become represented by individuals which are better adapted.

16. (d) : According to theory of pangenesis, Darwin thought that every somatic cell of the body produces a tiny particle called gemmule or pangene which contains both the parental and acquired characters. All gemmules or pangenes of the body cells collect in the gametes and are passed on to the zygote where they guide the growth of different parts of the embryo.

17. (c) : Herbicide resistant weeds, drug resistant eukaryotes and man-created breeds of domesticated animals like dogs are examples of evolution by anthropogenic action. Darwin's Finches of Galapagos islands are example of natural selection, adaptive radiation and Founder's effect.

18. (a) : Embryological support for evolution was disapproved by Karl Ernst von Baer. He noted that embryos never pass through the adult stages of other animals.

19. (b) : Analogous structures are result of convergent evolution, *i.e.*, different structures evolving for the same function and hence having similarity. For example,

the eye of the octopus and of mammals, the flippers of penguins and dolphins.

20. (a) : Homologous organs are those organs which have the same fundamental structure but are different in functions. Wings of birds and forelimbs of horse show homology because skeletal parts of their forelimbs are similar in structure and arrangement but have different functions.

21. (d) : Eye of octopus, bat and man are examples of analogous organs showing convergent evolution.

22. (b) : Homologous organs have same fundamental structure but different functions. The wing of a bird and flipper of a whale are structurally forelimbs, which consist of humerus, radio-ulna, carpals, metacarpals and digits but they perform different functions. The wings of birds help them to fly while flipper helps the whale to swim.

23. (d) : The organs which have similar functions but are different in their structural details and origin are called analogous organs. The analogous structures are the result of convergent evolution.

24. (d) : Analogous organs are the organs which have similar function but are different in their structural details and origin. The analogous structures are the result of convergent evolution. The wings of an insect are analogous to wings of a bird because the basic structure of the wings of the insects is different from the wings of bird. However, their function is similar.

25. (d) : Natural selection is the most widely accepted theory concerning the principal causal mechanism of evolutionary change profounded by Charles Darwin and Alfred Russel Wallace. It results from the differential reproduction (some members of a population produce abundant offspring, some only a few and still others none), one phenotype as compared with other phenotypes in the same population. This determines the relative share of different genotypes which individuals possess and propagate in a population. Industrial melanism supports evolution by natural selection. It is an adaptation where the moths living in the industrial areas developed melanin pigments to match their bodies to the tree trunks.

26. (c) : The organs which have the same fundamental structure but are different in functions are called homologous organs. These organs follow the same basic plan of organisation during their development. But in the adult condition, these organs are modified to perform different functions as an adaptation to different environments. The forelimbs of cat, lizard, whale and bat have the same basic structural plan. In each case the forelimb consists of humerus, radio-ulna, carpals, metacarpals and digits. The skeletal parts of the forelimbs of all these vertebrates are similar in structure and arrangement. But the forelimbs of these animals have different shapes and functions. In lizard they are used for walking, in cat for running, in whale for swimming and in bat for flying.

27. (a, b) : The organs which have similar functions but are different in their structural details and origin are called analogous organs. The wings of bat are analogous to wings of pigeon. It is due to the fact that the basic structure of the wings of the mammal is different from the wings of bird. However, their function is similar. Similarly, gills of prawn and lungs of man, both are respiratory organs yet they have very different basic structure.

28. (d) : Convergent evolution is the development of superficially similar structures in unrelated organisms, usually because the organisms live in the same kind of environment. Examples are the wings of insects and birds and the streamlined bodies of whales and fish. One can say that it is the similar habitat that has resulted in selection of similar adaptive features in different groups of organisms but toward the same function. An example of convergent evolution is the similar nature of the flight/ wings of insects, birds, pteridosaurs and bats. All four serve the same function and are similar in structure, but each evolved independently. Some species of the lens of eyes also evolved independently in various animals.

29. (a)

30. (a) : Development of similar adaptive functional structures in unrelated groups of organisms is called convergent evolution. It shows analogy. Examples are wings of butterfly and birds, eye of the octopus and the mammals, flippers of penguins and dolphins, etc. On the other hand, divergent evolution involves development of different functional structures along different directions due to adaptations to different needs from a common ancestral form. For example, forelimbs of vertebrates (whales, bat, cheetah, human). Though these perform different functions, they have similar anatomical structures.

31. (a)

32. (b) : *Peripatus* belongs to Phylum Onychophora. It shows characters of annelids as well as arthropods. Owing to its resemblance with two different phyla, *Peripatus* is often referred to as connecting link between them. This shows an important morphological and anatomical evidence of evolution.

33. (d) : During post industrialisation period, the tree trunk became dark due to industrial smoke and soots.

White winged moths did not survive due to predators and dark winged moths survived because they were less easily seen by them against a dark background. Thus industrial melanism supports evolution by natural selection that favours the establishment of one particular advantageous mutation within a population.

34. (d) : The organs which have the same fundamental structure but are different in function are called homologous organs. Thorn of *Bougainvillea* and tendril of *Cucurbita* both arises in the axillary position, but have different functions.

35. (a) : Nephridia are excretory organs of earthworm which consist of a simple or branched tube formed by the ingrowth of ectoderm with cilia at the inner end. Excretory products diffuse into the nephridium and are wafted to the exterior by ciliary action. Malpighian tubules are the organs that are involved in the excretion of nitrogenous wastes in cockroach. It open into the intestine; selectively extract from the blood uric acid, which together with water and salts – is deposited into the hindgut and excreted in the faeces.

36. (c) : Haeckel (1810) proposed that developing animal embryo passes through stages resembling adult forms of its ancestors. Ernst Haeckel (1868, 1874) formulated biogenetic law or recapitulation theory which states that ontogeny (developmental history of an individual) repeats phylogeny (development history of races).

37. (c) : Convergent evolution is the development of superficially similar structures in unrelated organisms, usually because the organisms live in the same kind of environment. Examples are the wings of insects and birds and the streamlined bodies of whales and fish. One can say that it is the similar habitat that has resulted in selection of similar adaptive features in different groups of organisms but towards the same function. An example of convergent evolution is the similar nature of the flight/wings of insects, birds, pteridosaurs and bats. All four serve the same function and are similar in structure, but each evolved independently. Some species of the lens of eyes also evolved independently in various animals.

38. (b) : Homologous organ and vestigial organs provide an important evidence in favour of organic evolution (process by which changes in the genetic composition of populations of organisms occur in response to environmental changes). For example, human appendix is a developmental derivative and evolutionary vestige of the end of the much larger herbivorous caecum found in our primate ancestors. They both are structurally homologous and have different functions. In most vertebrates, the caecum is a large, complex gastrointestinal organ, enriched in mucosal lymphatic tissue and specialised for digestion of plants. The caecum varies in size among species, but in general the size of the caecum is proportional to the amount of plant matter in a given organism's diet. It is largest in obligate herbivores, animals whose diets consist entirely of plant matter. However, even though humans are herbivorous, the small human caecum does not house cellulose-digesting bacteria and lost an essential function of cellulose digestion.This shows the close evolutionary relationships between homologous and vestigial organs.

39. (d) : Living fossil is a term for any living species of organism which closely resembles species otherwise only known from fossils and has no close living relatives. These species have all survived major extinction events and generally retain low taxonomic diversities.
Some examples of living fossils in animals are – coelacanth, coral (polyp), crocodylia (crocodiles, gavials and alligators), horseshoe crab (*Limulus polyphemus*), monotremes (*Platypus* and *Echidna*), snout-nosed frog (*Nasikabatrachus sahyadrensis*). *Archaeopteryx* is the earliest and most primitive known bird. It lived in the Jurassic Period around 150-155 million years ago. It has feathers and wings but it also had teeth and a skeleton similar to a small carnivorous dinosaur, therefore, it had both bird and theropod dinosaur features. *Archaeopteryx* is a powerful piece of evidence that shows that birds have evolved from dinosaurs.

40. (c) : Electron spin resonance (ESR) measures the number of charges occupying deep traps in the crystal bandgap. By measuring the change in absorption of microwave energy within a continuously varying strong magnetic field, this method detects the number of "unpaired spins" of electronic charges trapped at various defects in the mineral lattice.

41. (c) : *Refer to answer 40.*

42. (d) : Convergent evolution is the formation of similar traits by unrelated groups of organisms. Dogfish and whale are the interesting examples of convergent evolution in animals as both of them have more or less similar body organisation.

43. (c) : Industrial melanism is an adaptation where the moths living in the industrial areas developed melanin pigments to match their body to the soot-covered surroundings. These melanic forms are mainly distributed in and around large industrial cities, where the environment has been altered by the pollution of the atmosphere; and is manifested by the appearance of dark colour of lichen-covered tree trunks, on which the moths rest during the day time. The peppered moth exists in two strains (forms) : light coloured (white) and

melanic (black). In the past, bark of trees was covered by whitish lichens, so white moths escaped unnoticed from predatory birds. After industrialisation barks got covered by smoke, so the white moths were selectively picked up by birds. But black moths escaped unnoticed so they managed to survive resulting in more population of black moths and less population of white moths.

44. (a) : *Refer to answer 26.*

45. (b)

46. (b) : Carl Woese came up with the theory of life based on his discovery that the genes encoding ribosomal RNA are ancient and distributed over all lineages of life with little or no gene transfer. Therefore, *r*RNA are commonly recommended as molecular clocks to the phylogeny.

47. (b) : ^{14}C has a half life of 5570 years and is used in radio carbon dating. Carbon in living things contains a uniform amount of radioactive ^{14}C produced constantly in the atmosphere. From the amount of ^{14}C in the dead sample, the age of the organism can be determined.

48. (a) : If streptomycin resistant mutants are to be obtained, material should be allowed to grow on medium lacking streptomycin so that both mutant and wild types may grow. These colonies are imprinted on petriplates to form the master pattern on other plates having streptomycin can then be pressed on velveteen to get an impression. The plate now containing only mutants for streptomycin resistance will grow.

49. (c) : *Refer to answer 37.*

50. (b) : The vestigial organs are the useless remnants of structures or organs which might have been large and functional in the ancestors. Segmental muscles in abdomen, coccyx, third molar (wisdom teeth) of human are vestigial organs. Nail is not a vestigial organ of human.

51. (c) : *Refer to answer 25.*

52. (a) : Wings of birds and hands of human have the same structure but different functions. Birds use their wings for flying while humans use their hands for grasping. Other options show examples of analogous organs. Analogous organs are those organs which have similar functions but different structural details.

53. (b) : Development of similar adaptive functional structures in unrelated groups of organisms is called convergent evolution. Example : wings of insect, bird and bat. Thus analogous organs show convergent evolution (adaptive convergence).

54. (d) : Human body has been described to possess about 90 vestigial organs. Some of these are nictitating membrane, muscles of pinna (part of external ear), vermiform appendix, caudal vertebrae (also called coccyx or tail bone), third molars (wisdom teeth), hair on body and nipples in male.

55. (b) : The radioactive strontium - 90 can lead to various bone disorders and diseases, including bone cancer. It emits high energy beta radiations.
Phosphorus - 32 also emit high energy beta radiations but they cannot penetrate human skin. Caesium - 137 (beta emitter) and iodine - 131 (β and γ emitter) also pose danger to human health but not as much as strontium - 90 which is a long-lived radioactive element and tends to cycle like calcium.

56. (a)

57. (c)

58. (d) : In the embryos of all vertebrates, the presence of gill slits support the theory of recapitulation (repeating the early stages of embryogenesis in earlier evolved animals.)

59. (c) : The first fossil of the horse was found in North America. It was named *Eohippus*. This horse was about the size of a fox having short head and neck. The fore feet were with four complete fingers and one splint of first finger and the hind feet with three functional toes and one splint of fifth toe. Other stages in the evolution of horse were *Mesohippus*, *Merychippus*, *Pliohippus* and *Equus*.

60. (a)

61. (a)

62. (a) : Palaeontology is the study of extinct organisms, including their structure, environment, evolution, and distribution, as revealed by their fossil remains. Herpetology is the study of reptiles and amphibians. Saurology is the study of snakes. Organic evolution deals with study of origin of life and origin of new species.

63. (d) : Development of similar adaptive functional structures in unrelated groups of organisms is called adaptive convergence or convergent evolution, *e.g.* wings of insect, bird and bat show marked convergent evolution. When convergent evolution is found in closely related species, it is called "Parallel evolution". Example : development of running habit in deer (2-toed) and horse (1-toed) with two vestigial splint bones.

64. (a)

65. (a) : Darwin's finches show adaptive radiation. This radiation occurred in response to various food resources available. These finches feed on insects, tree buds, seeds, cactus, etc. Carrion are dead bodies and no finches feed on them.

66. (a) : Adaptive radiation (divergent evolution) is the evolution from one species of animals or plants of

a number of different forms. As the original population increases in size it spreads out from its centre of origin to exploit new habitats and food sources. In time, this results in a number of populations each adapted to its particular habitat, eventually these populations will differ from each other sufficiently to become new species.

67. (c) : *Refer to answer 66.*

68. (c) : Biogeographical evolution is a process in which gene pool of a population gradually changes in response to environmental pressures, natural selection and genetic mutations.

69. (a) : *Refer to answer 66.*

70. (a) : Galapagos Islands are a chain of 14 islands in the Pacific ocean on the west coast of South America. Charles Darwin visited these islands during his famous voyage on HMS Beagle (name of his ship) in 1835. The flora and fauna of these islands resemble with those of the South American mainland with which the Galapagos Islands were once connected. However, Darwin's finches (birds of Galapagos Islands) influenced Darwin to think about the evolutionary change. These birds designated as Darwins' finches by Dr. David Lack (1947) do not resemble the birds of the South American species. These finches were the first to reach the Galapagos Islands as migrants from the mainland (South America). When they reached the islands, they faced many problems for obtaining food. Thus, they had to change their feeding habits.

71. (c) : Darwin observed great variations among the organisms that lived on Galapagos islands. The common birds of Galapagos islands, the finches were markedly different from the finches of main land. In fact Darwin took idea from the finches found on the Galapagos Islands for his theory of natural selection.

72. (c) : The theory of natural selection is based on the following factors :

(i) Rapid multiplication and limited food and space which leads to struggle for existence.

(ii) Struggle for existence and variations which leads to natural selection or survival of the fittest.

(iii) Natural selection and inheritance of useful variation over many generation which leads to formation of new species.

Darwin in his "Natural Selection Theory" did not believe in the role of discontinuous variation in natural selection. Darwin always believed in the universal occurrence of variation. In his opinion, variation is continuous in nature. Darwin did not understand the cause of variation and assumed it was one of the innate properties of living things. Now it is known that variation is due to mutation and thus it may be discontinuous.

73. (c)

74. (c) : Theory of continuity of germplasm was put forward by August Weismann. According to this, the characters influencing the germ cells are only inherited. There is a continuity of germplasm but the somataplasm is not transmitted to the next generation hence it does not carry characters to next generation.

75. (c) : According to Darwin's theory of survival of the fittest (Natural selection), the organisms which are provided with favourable variations would survive, because they are the fittest to face their surroundings, while the unfit are destroyed. Darwin considered that useful variations are transmitted to the offspring and appear more prominently in succeeding generations. After some generations these continuous and gradual variations in the possessor would be so distinct that they form a new species. This is proved by, the pesticide resistant insects that have the ability to survive as they have resistance genes and so they are selected by nature. Other insects lacking these genes will be killed by pesticides.

76. (d)

77. (a) : According to biological species concept a species is a natural inbreeding or panmictic species or group of natural populations which have essentially similar morphological traits, they are genetically distinct and reproductively isolated from others. Since under laboratory conditions *N. tabacum* and *N. sylvestris* can produce self-fertile offspring so they are not reproductively isolated. They are considered as separate species because since their flowering periods are different so cross pollination is not possible between them naturally. This makes them different species.

78. (b) : The phenomenon of development of a new species from pre-existing one is called speciation. Reproductive isolation is the prevention of interbreeding between the populations of two different species. It maintains the characters of the species but can lead to the origin of new species.

79. (a) : Normally bacteria cannot survive in antibiotic containing medium but if it does so it must have acquired resistance against that antibiotic.These are well adapted to grow in streptomycin containing medium and thus are more evolved. So due to natural selection only the more evolved and better adapted species is able to survive.

80. (b) : The organisms which are provided with favourable variations would survive, because they are the fittest to face their surroundings, while the unfit are

destroyed. Darwin considered that useful variations are transmitted to the offspring and appear more prominently in succeeding generations. After some generations these continuous and gradual variations in the possessor would be so distinct that they form a new species.

81. (a) : Replication of genetic material is the most important factor for continuity of a species from evolutionary point of view. When genetic material replicates, only then it could be transferred from one generation to next resulting in continuity of a species. Asexual animals do not produce gametes while sexual animals do. So, formation of gametes is not an important factor in asexual animals though replication of genetic material takes place in both asexual as well as sexual animals. Synthesis of proteins does not play any role in continuity of species.

82. (b) : Allopatric species are those that could interbreed but do not because they are geographically isolated. Sympatric are groups of similar organisms that, although in close proximity and theoretically capable of interbreeding, do not interbreed because of differences in behaviour, flowering time, etc. Siblings are offspring of the same parents.

83. (b) : Melanisation in peppered moth is an example in support of the theory of natural selection. Lamarckism is the first theory of evolution, which was proposed by Jean Baptiste de Lamarck. Its theory of inhertance of acquired characters cannot be explained by melanisation in peppered moth.

84. (d) : Lamarck gave theory of Lamarckism in which he explained inheritance of acquired characters which states that whatever an individual acquires characters in its life time due to internal vital force, effect of environment, new needs and use and disuse of organs, they are inherited to the next generations. The process continues. After several generations, the variations are accumulated upto such extent that they give rise to new species. This theory was proved wrong by August Weismann. Weismann cut off the tails of rats for as many as 22 generations and allowed them to breed, but tailless rats were never born.

85. (b) : The term evolution was coined by Herbert Spencer, an English philosopher which means unrolling or unfolding of nature that brings about an orderly change from one form or condition to another resulting in descendents becoming different from ancestors. Thus, it is history and development of race alongwith variations.

86. (b)

87. (b) : *Refer to answer 84.*

88. (d) : Darwin published his observations and conclusions regarding evolution in the book "Origin of Species" in 1859. Darwin's this book became very popular and changed people's thinking about organic evolution.

89. (c) : Hugo de Vries (1901) put forward the theory of evolution called mutation theory. He believed that mutation causes evolution. Mutations are discontinuous variations that are random and directionless.

90. (b) : As per mutation theory given by Hugo de Vries, the evolution is a discontinuous phenomenon or saltatory phenomenon (single step large mutation).

91. (a) : The term mutation was coined by Hugo de Vries (1901) for large spontaneous inheritable changes which occur suddenly in naturally reproducing population. He also proposed mutation theory of evolution in his book "The Mutation Theory" published in 1903 in which he put forth that evolution occurred due to large discontinuous variations. He worked on *Oenothera lamarckiana* or evening primrose. During his experiments he found 834 mutations in a population of 54343 plants. It was later on found that the mutations observed by Hugo de Vries were actually chromosomal aberrations.

92. (c) : *Refer to answer 91.*

93. (d) : Frequency of dominant allele (A) = 0.4

Applying Hardy-Weinberg equilibrium; $p + q = 1$

$q = 1 - 0.4 = 0.6$; $p^2 + q^2 + 2pq = 1$

Frequency of homozygous dominant genotype

$(p^2 \therefore AA) = (0.4)^2 = 0.16$

Frequency of heterozygous genotype

$(2pq \therefore Aa) = 2 \times 0.4 \times 0.6 = 0.48$

Frequency of homozygous recessive genotype

$(q^2 \therefore aa) = (0.6)^2 = 0.36$

94. (c) : Stabilising selection is a balancing type of natural selection which favours average sized individuals and eliminates extreme individuals.

95. (a)

96. (a) : The random changes in gene frequencies in a population occurring by chance alone rather than by natural selection are called genetic drift or Sewall Wright effect. The effects of genetic drift are most marked in very small isolated population, although it occurs in all populations.

97. (b) : In a stable population, for a gene with two alleles, 'A' (dominant) and 'a' (recessive), if the frequency of 'A' is p and the frequency of 'a' is q, then the frequencies of the three possible genotypes (AA, Aa and aa) can be expressed by the Hardy-Weinberg equation:

$$p^2 + 2pq + q^2 = 1$$

where

p^2 = Frequency of AA (homozygous dominant) individuals

q^2 = Frequency of aa (homozygous recessive) individuals

$2pq$ = Frequency of Aa (heterozygous) individuals

98. (c) : According to Hardy-Weinberg principle

$p^2 + 2pq + q^2 = 1$; $(p + q)^2 = 1$

(AA) p^2 = 360 out of 1000 individual

or $p^2 = 0.36$

Therefore, $p = 0.6$

99. (b) : Hardy-Weinberg law states that allele frequencies in a population are stable and remain constant from generation to generation when there is random and non-selective mating. In case of lack of random mating, genetic equilibrium may be disturbed.

100. (d) : Genetic drift (Sewall Wright effect) is the random change in the frequency of alleles in a population over successive generations in the gametes. Each new generation differs from its parental generation with regard to allele frequencies simply because of random variation in the distribution of gametes. This process is more rapid in smaller populations, or when the alleles concerned confer no apparent benefit compared to their counterparts.

101. (c) : *Refer to answer 100.*

102. (b) : The genetic variations exist due to reshuffling of genes caused by recombinations or by mutations. The recombinations are produced by the routine reshuffling of genes during independent assortment of chromosomes, reciprocal crossing of genes during crossing over and random fertilisation of gametes. Mutation is the sudden inheritable discontinuous variation which appears in an organism due to permanent changes in its genotype. Mutation can occur at any stage during the development. Mutations are heritable changes, that is, if they appear in somatic cells they are inherited to daughter cells by mitosis but if they appear in gamete cells they are inherited to the offspring. The former are known as somatic mutations and latter as germ mutations. They bring about a change in the genetic message and cause variation.

103. (d) : In a stable population, for a gene with two alleles, *A* (dominant) and *a* (recessive), if the frequency of *A* is *p* and the frequency of *a* is *q*, then the frequencies of the three possible genotypes (*AA*, *Aa*, and *aa*) can be expressed by the given Hardy-Weinberg equation :

$p^2 + 2pq + q^2 = 1$.

where p^2 = frequency of AA (homozygous dominant) individuals, $2pq$ = frequency of Aa (heterozygous) individuals, and q^2 = frequency of aa (homozygous recessive) individuals. The equation can be used to calculate allele frequencies if the numbers of homozygous recessive individuals in the population is known. The equation and the equilibrium are named after British mathematician G.H. Hardy and German physician W. Weinberg.

So $p = 0.6$ and $q = 0.4$ (given)

$\therefore$ $2pq$ (frequency of heterozygote)

$= 2 \times 0.6 \times 0.4 = 0.48$

104. (b) : Species may be defined as an uniform interbreeding population or group of individuals which freely interbreed among themselves. Gene flow occurs between populations of a species by gene migration *i.e.*, emigration and immigration.

105. (b)

106. (b) : Allele frequency in a population can remain constant only if individuals of the population randomly interbreed. Generally it never happens in nature and species populations exist in small groups of randomly breeding subpopulations. Thus allele frequency between two subpopulations may differ but allele frequency within the subpopulation will remain constant. Such subpopulations are termed Mendelian populations or deme. Exchange of genes between demes takes place occasionally. Mutation, gene flow (due to migration), etc. may tend to change the allele frequency of the subpopulation.

107. (b) : Mutation is any hereditary change in the make up of an individual other than that which may be caused by the simple recombination of genes. Mutations may occur in any direction.

108. (c) : Haeckel's biogenetic law states that "Ontogeny repeats phylogeny". Ontogeny is the life history of an organism while phylogeny is the evolutionary history of the race of that organism. In other words an organism repeats its ancestral history during development. Therefore, during embryonic development the mammalian heart first takes the form of fish, then frog and at last mammal.

109. (d) : The random changes in gene frequencies in a population occurring by chance alone rather than by natural selection are called genetic drift or Sewall Wright effect. The effects of genetic drift are most marked in very small isolated population, although it occurs in all populations.

110. (d)

111. (b) : Dinosaurs dominated the world in Mesozoic era. There are three periods of this era :

(i) Dinosaurs originated in the Triassic period, (ii) dominated in Jurassic period and (iii) became extinct in cretaceous period.

112. (b) : Jurassic period of Mesozoic era is characterised by gymnosperms as dominant plants and the appearance of first toothed bird. Conifers, cycads and ferns were widespread.

113. (a) : Diversification in plant life appeared due to long periods of evolutionary changes. Initially plants were thalloid. There were no differentiation among root, stem and leaves. Vascular tissues were absent.

114. (b) : Mesozoic era is the era during which reptiles were dominant. It includes three periods : Triassic (240 million years ago), Jurassic (195 million years ago) and Cretaceous (135 million years ago). Origin of dinosaurs occurred during Triassic period. During Jurassic period, lizards, crocodiles and alligators originated. Dinosaurs became large and reptiles were dominant during this period. During Cretaceous period, dinosaurs got extinct.

115. (a) : The two criteria on basis of which Nikolai Ivanwitch Vavilov proposed different centre of origin were (i) occurrence of maximum variation in the crop and (ii) occurrence of wild relatives.

116. (a) : Precambrian period extends from 2300 to 3800 million years ago, which is considered as period of early life. During this period prokaryotes (monera) and eukaryotes (protista) originate.

117. (c) : The first geological time scale was developed by Giovanni Avduina, Italian scientist in 1760. The history of the earth has been divided into a number of major divisions called eras. The eras are sub-divided into periods. The modern periods are further divided into epochs. There are four eras. The correct sequence is Precambrian Palaeozoic (era of ancient life) → Mesozoic (era of medieval life) → Coenozoic (era of modern life).

118. (d)

119. (d) : Agriculture came around 10,000 years back and human settlements started. About 15 mya primates called *Dryopithecus* and *Ramapithecus* were existing. They were hairy and walked like gorillas and chimpanzees. *Homo erectus* probably ate meat.

120. (b)

121. (b) : The brain capacity gradually increased from early human ancestors to modern man. *Homo habilis* had 650 - 800 cc brain capacity which increased around 900 cc in *Homo erectus*. The Neanderthal man (*Homo neanderthalensis)* had 1400 cc brain capacity which evolved to around 1450 cc in *Homo sapiens*.

122. (c) : Binocular vision, smaller jaw and upright posture are the main adaptations that led to evolution of man from its ancestors. But, during human evolution major and most significant changes occurred in the cranial capacity of man. In living modern man it is about 1450 cc compared to 500 cc in *Australopithecus*. Increased cranial capacity accommodates larger brain and forms the basis of social, cultural and educational evolution of modern man.

123. (b)

124. (d) : *Refer to answer 121.*

125. (b)

126. (d) : Apes are the members of the hominoidea superfamily of primates, which includes humans. Under the current classification system there are two families of hominoids:

- The family hylobatidae consists of 4 genera and 13 species of gibbons, including the Lar Gibbon and the Siamang, collectively known as the "lesser apes"
- The family hominidae consisting of orangutans, gorillas, chimpanzees, and humans, collectively known as the "great apes".

Within the Superfamily hominoidea, gibbons are the outgroup: this means that the rest of the hominoids are more closely related to each other than any of them are to gibbons.

Investigation showed orangutans to be the outgroup, but comparing humans to all three other hominid genera showed that African apes (chimpanzees and gorillas) and humans are more closely related to each other than any of them are to orangutans.

However, DNA comparisons from sex chromosomes and autosomes provide convincing evidence that within the subfamily homininae, gorillas are the outgroup. This suggests that chimpanzees should be in hominini along with humans.

127. (b) : Sequence of both *mt*DNA and Y chromosomes are considered for the study of human evolution because they are uniparental in origin. *mt*DNA is inherited along with the maternal cytoplasm and Y chromosome is inherited from father. So they do not take part in recombination. In addition, *mt*DNA has a higher mutation rate than nuclear DNA so that it is more useful for short term evolutionary studies.

128. (c) : The common ancestor of both ape and man is *Dryopithecus* – a 20 million years old fossil discovered from Africa. *Austroalopithecus* also lived in Africa between 6 million to 1 million years ago. The Genus *Homo* evolved 2 million years ago from one of such

Australopithecines in Africa and then only moved out of the continent.

The first such *Homo* lived throughout Asia, some parts of Europe and Africa. But obviously its evolution took place in Africa.

129. (a)

130. (b)

131. (d) : *Homo sapiens sapiens* appeared about 25000 years ago in Holocene epoch and started spreading all over the world about 10000 years ago. It is believed that the man of today first appeared about 11000 or 10000 years ago in the region around Caspian and Mediterranean Seas. From there, its members migrated westwards, eastwards and southwards, respectively changing into the present day white or Caucasoid, Mongoloid and black or Negroid races.

132. (a) : Humans differ from most primates in that they lack a tail. The lower primates have tails, and the apes, which are believed by many to be our closest relatives, likewise are tailless.

133. (a) : *Refer to answer 126.*

134. (c) : *Homo erectus* is the ancestor of man (not the direct ancestor of modern man). It includes three fossils: Java Ape-man, Peking man and Heidelberg man. Neanderthal man is the direct ancestor of Cro-magnon man which in turn is the direct ancestor of modern man. Fossils of Cro-magnon were discovered from France. *Australopithecus* is the first ape man.

135. (a) : The fossil of *Dryopithecus africanus* was discovered from Miocene rocks of Africa and Europe. It lived about 20-25 million years ago. It was ape-like but had arms and legs of the same length. Heels in its feet indicate its semi-erect *Dryopithecus africanus* is regarded a common ancestor of man and apes (gibbons, organgutan, chimpanzee and gorilla).

136. (a) : *Homo habilis* lived during Pleistocene. He lived in Africa about 2 million years ago. He was about 1.2 to 1.5 metres tall. He had bipedal locomotion, moved erect and was omnivorous. *Homo habilis* (*habilis* = mentally able or skilful) was the first tool maker and used tools of chipped stones extensively. *Homo erectus* appeared about 1.7 million years ago in middle Pleistocene. *H. erectus* evolved from *Homo habilis*. He had erect posture, protruding jaws, projecting brow ridges and small canines and large molar teeth. He was omnivorous and made more elaborate tools of stones and bones, hunted big game and perhaps knew use of fire.

137. (d) : A close relationship of apes with man is revealed by their relatively larger brain and cranial capacity, efficient memory. Cranial capacity of apes is under 650 cc. Cranial capacity of man is 1350 to 1600 cc.

138. (c) : Loss of tail is probably the useless change for the man in the course of evolution. The volume of cranial cavity and size of skull also increased in order to accommodate the large and complex brain. The modern man excels all other animals in intelligence. Erect posture of human beings is due to major changes in the muscle skeletal system. During the course of evolution of man, thumb (pollex) has been brought opposite to the fingers thus enabling the hand for better grasping power.

139. (d) : *Homo sapiens fossilis* is also known by the name of Cro-magnon man. He was the direct ancestor of modern man (*Homo sapiens*). Cro-magnon man emerged about 34000 years ago in Holocene epoch. Thus, it is regarded as most recent ancestor of today's man. Its cranial capacity was, however, somewhat more than ours, being about 1650 cc. It became extinct about 10000-11000 years ago.

140. (c) : The first domesticated animal by primitive man was dog. Cro-magnon man used to carry domesticated dogs while going for hunting.

141. (b) : In ancient period hands were used to collect food and to save themselves. Gradually men learnt to cook food, to make tools for their own purpose, this change in habit brings perfection in their hand. Similarly, there is an increase in the ability to communicate with others and develop community behaviour. But as in ancient period, men still eat hard nuts and hard roots (though they often take soft food also). Thus change in diet is the most irrelevant change in the evolution of man.

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