

Let us Practice

Exercise I

1. Scientists calculated that a particular piece of rock with a fossil imprint of an extinct species contained about 16 g of radioactive isotope when it was formed. The rock was found to now contain 4 g of the same radioactive isotope. If the half-life of the radioactive isotope is 100,000 years, how long ago did the extinct species exist?
(a) 100,000 years ago
(b) 200,000 years ago
(c) 300,000 years ago
(d) 400,000 years ago
2. Natural selection is often called 'survival of the fittest'. Which of the following statements best describes an organism?
(a) The number of fertile offspring it has
(b) How strong it is compared to other individuals of the same species
(c) The ability to adapt to the environment in the niche it occupies
(d) How much food and resources it is able to gather for its offspring
3. Which of the following changes to a DNA molecule is least likely to result in a deleterious mutation?
(a) Insertion of a transposable element in a coding region
(b) Deletion of a base pair in a coding region
(c) Change of a base pair in the first codon of a coding region
(d) Change of the first base pair of a codon
(e) Change of the third base pair of a codon
4. A man and a woman who both appear normal have a child together, who has sickle cell anaemia. Sickle cell anaemia is an autosomal recessive trait. The woman becomes pregnant again and is told that she is carrying fraternal twins. What is the probability that both of the couple's twins will develop sickle cell anaemia?
(a) $\frac{1}{16}$
(b) $\frac{1}{4}$
(c) $\frac{1}{2}$
(d) $\frac{9}{16}$
5. Which statement best defines evolution?
(a) The close resemblance between parents and their offspring
(b) Difference between individuals in survival
(c) Individuals in two populations look different
(d) Change in the phenotype of an individual through time
(e) Change in genetic composition of a population
6. Diversifying (disruptive) selection is a mode of natural selection that
(a) favours variants of opposite extremes over intermediate forms
(b) shifts the overall make up of a population by favouring variants of one extreme
(c) culls extreme variants from the population
(d) has little or no impact in terms of the evolutionary process
7. The frequency of crossing over between any two linked genes is
(a) higher if they are recessive
(b) difficult to predict
(c) determined by their relative dominance
(d) the same as if they were not linked
(e) proportional to the distance between them
8. A population contains equal number of individuals with the genotypes AA and Aa. Proportion of alleles 'A' and 'a' in the gametes will be (4th NSEB)
(a) 3 : 1
(b) 1 : 1
(c) 1 : 2
(d) Can't be determined
9. In a family, both the husband and the wife (both normal) are heterozygous for a condition of infantile blindness. They wish to have at least three children. The possibility that all these children will be normal is (1st NSEB)
(a) 42%
(b) 75%
(c) 25%
(d) 58%
10. Barbie and Ken have their first child. Barbie knows her blood type is A, but Ken does not know his blood type. However, Ken knows that both his mother and father have type B blood. Their first child is a boy named Skip. Skip has type O blood.

- Barbie and Ken do not understand how this happened. Which of the following is the best explanation?
- Barbie's genotype is AA and Ken's genotype is OO; thus, Skip expresses the O phenotype
 - Barbie's genotype is AO, and Ken's genotype is OO; thus, Skip expresses the O phenotype
 - Because Ken's parents are both type B, Ken is not Skip's father
 - Skip's blood type will need to be checked after his first month of life, if Barbie and Ken want to know his blood type, as it takes about a month for the blood type to develop in a newborn child
 - Since Barbie has type A blood, there had to be mix-up in the lab report, as Skip should also have type A blood
11. Scientists consider the horse and the donkey to be different species, but when individuals of these two species mate, they produce a strong offspring called a mule. According to the biological species concept, should scientists reclassify the horse and donkey as belonging to the same species?
- Yes, horses and donkeys must be considered one species, if they can mate and produce an offspring
 - Yes, because horses and donkeys are morphologically similar
 - No, because the mule cannot breed with either horse or donkey
 - No, because this cross-mating is rare in nature
 - No, horses and donkeys are probably different genetically, which is the only factor used in determining species
12. You perform the following dihybrid genetic cross: $AABb \times aaBB$, where: A = big (dominant), a = small, B = dark (dominant), b = light. In the F_1 generation, all of the progeny are big and dark. You now self the F_1 progeny and score 100 of the F_2 progeny. How many of the F_2 progeny do you expect to be big and light?
- 16
 - 3/16
 - 1/4
 - 9/16
 - 3/4
13. What does the term "reproductive isolation" refer to?
- An individual is unable to fertilize itself
 - Genes are not exchanged between two populations
 - Individuals from two populations never mate
 - Individuals from two populations never produce offspring
 - Individuals are solitary breeders
14. Why is it unlikely that humans will undergo speciation in the future?
- Migration among populations is high
 - Natural selection is no longer operating on humans
 - Random effects have become more important in large populations
 - The environment on Earth is being controlled and stabilized
 - The human species has exhausted nearly all of its genetic potential
15. If one gamete in five carries a recessive allele, what must be the frequency of the homozygous recessive genotype in a population at Hardy-Weinberg equilibrium?
- 4%
 - 16%
 - 20%
 - 60%
 - 80%
16. Which one provides correct sequence of events in origin of new species according to Darwinism?
- Natural selection
 - Variation and their inheritance
 - Survival of the fittest
 - Struggle for existence
- I, II, III and IV
 - II, III, I and IV
 - III, IV, I and II
 - IV, II, III and I
17. With regard to the ABO blood group typing system, if a man who has type A blood and a woman who has type B blood were to have children, what blood types could the children have?
- A or B
 - AB only
 - A, B or O
 - A, B, AB or O
18. Although the seal and the penguin both have streamlined, fish-like bodies with a layer of insulating fat, they are not closely related. This similarity results from
- homologous evolution
 - convergent evolution
 - adaptive radiation
 - coevolution
 - parallel evolution

19. A disorder which is linked to the Y-chromosome in humans (holandric) will
 - (a) only be expressed in males whose mothers were a carrier of the gene
 - (b) never be passed from father to child
 - (c) show an altern of skipping generations in a family
 - (d) be passed only from father to son
 - (e) not be expressed unless it is recessive
20. The change of the lighter coloured variety of peppered moth *Biston betularia* to its darker variety (*Carbonaria*) is due to
 - (a) mutation of single Mendelian gene for survival in the smoke-laden industrial environment
 - (b) deletion of a segment of gene due to industrial pollution
 - (c) industrial, carbon deposited on the wings of moth resulting in the darker variety
 - (d) translocation of a block of genes in chromosomes in response to heavy carbons
21. A new characteristic usually appears in evolution as a result of
 - (a) accumulation of point mutation in a gene which originally encoded for something else
 - (b) duplication of a gene and accumulation of point mutations in one of the copies coming from that duplication
 - (c) a mutation in a regulator gene
 - (d) genotypical recording of favourable phenotypical adaptation
22. Early atmosphere of the earth in which the prebiotic synthesis of the building blocks of life took place; contained
 - (a) CH_4 , NH_3 , H_2O , H_2
 - (b) H_2O , N_2 , CO_2 , CO
 - (c) P_2O_5 , NH_3 , H_2O , NO
 - (d) CO_2 , N_2 , O_2 , H_2O
23. Appearance of dark coloured pepper moths among the light coloured ones as a result of increased industrial pollution, is an example of
 - (a) disruptive selection
 - (b) stabilizing selection
 - (c) directional selection
 - (d) None of these
24. The relationship between genotype and phenotype is rarely simple. The term 'pleiotropy' describes
 - (a) when a heterozygote individual has a phenotype intermediate between those of the two types of homozygotes
 - (b) when a heterozygote exhibits phenotypes for both its alleles
 - (c) the ability of a single gene to affect multiple phenotypic traits
 - (d) when one gene affects the expression of another gene
 - (e) characters that vary continuously, indicating an additive effect of two or more genes on a single phenotypic character
25. Imagine that in a plant, hairy leaves are dominant to smooth leaves, and blue flowers are dominant to white. You cross a pure breeding hairy-leaved, blue-flowered strain with a pure breeding smooth-leaved, white-flowered strain. You allow the offspring to self-fertilize, and observe that the F_2 offspring are 69% hairy-leaved and blue-flowered, 19% smooth-leaved and blue-flowered, 6% hairy-leaved and white-flowered, and 6% smooth-leaved and blue-flowered. Based on these observations you can conclude that the two genes
 - (a) are in the same biochemical pathway
 - (b) segregate independently
 - (c) exhibit typical Mendelian ratios
 - (d) are on the same chromosome
 - (e) show epistatic interactions
26. Darwin and Wallace convinced most of their contemporaries that evolution had occurred. They did this primarily by relying on evidence from which area of study?
 - (a) Palaeontology
 - (b) Geographic distribution
 - (c) Behaviour
 - (d) Developmental biology
 - (e) Comparative anatomy
27. Which of the following observations was not important in helping Darwin and Wallace to develop their theory of natural selection?
 - (a) In most species, more offsprings are produced than can be supported by their environment
 - (b) The earth, and life on earth, is very old
 - (c) There is variability in populations
 - (d) Young tend to resemble their parents
 - (e) All cells contain DNA which transmits coded information to other cells

28. Which of the following would best demonstrate Lamarckian evolution?

- The discovery of a fossil that is anatomically partway between a reptile and a human
- The tails of laboratory mice were cut off and the progeny from such mice were born without tails
- More red rabbits than brown rabbits survive to reach sexual maturity in a red soil environment with a large fox population
- Bacteria causing infectious disease becoming resistant to repeated doses of antibiotics
- The discovery of a series of fossils that showed a progression in anatomical features

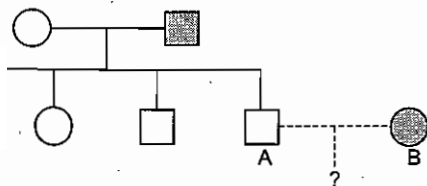
29. In humans, twins that develop from two fertilized ova are

- always of the same sex
- of the same or different sexes but are very similar, if not identical in appearance
- of the same or different sexes and as similar to each other as regular siblings
- always of different sexes

30. In a population of humans, the frequency of a recessive allele causing a genetic disease is 0.01, or 1%. What proportion of the population would you expect to suffer from the disease?

- 0.0001
- 0.001
- 0.0025
- 0.01
- 0.25

31. In the pedigree shown in the figure, individuals with the solid symbols suffer from a genetic disease caused by a recessive allele at an autosomal locus. You would counsel the couple marked A and B that the probability that each of their children will have the disease is



- 0%
- 25%
- 50%
- 75%
- 100%

Which of the following true statements best restates this conclusion in modern terms?

- In the first stage of meiosis, the segregation of one pair of chromosomes does not affect the segregation of other chromosomes
- During fertilization, which sperm combines with which egg, is a matter of chance
- In mitosis, there is no difference between the original DNA strand and the recently synthesized copy
- In the first stage of meiosis, chromosomes pair with their homologues
- Mutations are random events, which affect each locus independently

33. Before beginning a genetic analysis, how would you best ensure that you have homozygous genotypes?

- Mate close relatives for many generations
- Examine each individual very closely for signs of variation
- Start with individuals who are homozygotes for recessive alleles
- Start with individuals from different species
- Both (a) and (c)

34. Which of the following not generally affect allele frequencies in population?

- Non-random mating
- Directional selection
- Mutation
- Immigration
- Emigration

35. A biologist sequenced the cytochrome-c enzyme in a range of animals and compared the amino acid (AA) differences between pairs of species. Which of the following results would be most consistent with modern systematics?

- Chimpanzee/rhesus monkey 23 differences; horse/chimpanzee 2 differences; chimpanzee/shark 8 differences
- Chimpanzee/rhesus monkey 23 differences; horse/chimpanzee 23 differences; chimpanzee/shark 23 differences
- Chimpanzee/rhesus monkey 12 differences; horse/chimpanzee 8 differences; chimpanzee/shark 3 differences
- Chimpanzee/rhesus monkey 2 differences; horse/chimpanzee 12 differences

32. One of Mendel's laws states the following: units of inheritance which control different aspects of the phenotype may be inherited independently.

- differences; chimpanzee/shark 23 AA
differences
- (e) Chimpanzee/rhesus monkey 2 AA
differences; horse/chimpanzee 23 AA
rences; chimpanzee/shark 12 AA
rences
36. 1940s, Barbara McClintock described jumping genes in maize. Such mobile segments of DNA, now called transposons can insert themselves into
- virtually any part of any DNA molecule
 - start and stop signals, only
 - only DNA molecules where there are complementary base pairs with unfilled active sites
 - plasmid molecules only
37. Which of the following statements best describes the effect of genetic drift on the gene frequencies of a population?
- Genes enter a population through immigration, thus changing gene frequencies
 - Genes leave a population through emigration, thus changing gene frequencies
 - Chance alone can cause significant changes in gene frequencies of small populations
 - Mutations over time cause gene frequencies to change
 - Selection against one allele causes gene frequencies to change
38. If the fossil record has few or no intermediate forms, if there are long periods in which the fossils underwent no morphological change, and if new forms arose very quickly, then evolution of these new forms would be best described as
- punctuated equilibrium
 - adaptive radiation
 - gradualism
 - convergent evolution
 - due to stabilizing selection
39. In the evolution of life on Earth, the early primitive cells that were present must have obtained their energy by
- glycolysis and fermentation
 - aerobic respiration
 - cyclic phosphorylation
 - non-cyclic phosphorylation
 - oxidative phosphorylation
40. Jean Baptiste Lamarck published his theory of evolution in 1809, the year that Charles Darwin was born. Lamarck's theory of evolution has been rejected by modern biologists because
- his theory provided a genetic mechanism for how evolutionary change occurred
 - his theory was based on special creation
 - on giraffe's necks involved artificial and not natural selection
 - the characteristics an organism acquires during its lifetime cannot be passed on to its offspring
 - his theory was only applicable to humans
41. On the Galapagos islands, evolutionary divergence has resulted in 14 species of finches that are differentially adapted to feed on seeds, insects, and the buds of various plant species. This example of adaptive radiation occurred because the Galapagos islands are
- close enough to one another to favour considerable inter-island migration
 - close to the mainland
 - small, favouring divergence through genetic drift alone
 - arid and stressful, resulting in many mutations
 - sufficiently isolated from one another that inter-island migration rarely occurs
42. Natural selection is a process that may result in evolution. If evolution is to occur, which of the following must be true?
- Individuals within a species are variable.
 - Some of the variations within species are passed on to the offspring (*i.e.*, they are inherited).
 - More individuals are produced than the environment can support; only a fraction of the offspring produced in each generation survive to reproduce
 - The survival and reproduction of individuals are not random; the individuals who survive and go on to reproduce, or who reproduce the most, are those with the most favourable variations.
- I, II and III
 - I, II and IV
 - I, II, III and IV
 - III only
 - IV only

43. In the F_2 generation, the phenotypic and the genotypic ratios are the same in case of
 (a) Mendelian monohybrids
 (b) Mendelian dihybrids
 (c) Incomplete dominance
 (d) Both (a) and (b)
44. Feather colour in budgies (short form of budgerigar—a small green Australian parrot) is determined by two different genes that affect the pigmentation of the feathers: $Y_B_$ is green; $yyB_$ is blue; and $yybb$ is white. Two blue budgies were paired for life. Over many years, they produced 22 offspring, five of which were white. What are the most likely genotypes for the parents? (6th CBO)
 (a) $yyBB$ and $yyBB$ (b) $yyBB$ and $yyBb$
 (c) $yyBb$ and $yyBb$ (d) $yyBB$ and $yybb$
 (e) $yyBb$ and $yybb$
45. Which evolutionary process would best account for the observation that there is a striking similarity in both form and function between the enlarged horns observed in males of some insects and some mammals?
 (a) Descent with modification
 (b) Evolution by natural selection
 (c) Convergent evolution
 (d) Rapid speciation
 (e) Gene flow
46. For a trait that is controlled by two alleles at a single locus, the frequency of the dominant allele is 0.6. What is the genotype frequency of heterozygous individuals, assuming the population is at Hardy-Weinberg equilibrium?
 (a) 0.16 (b) 0.24
 (c) 0.36 (d) 0.48
 (e) 0.72
47. Which prediction from the fossil record is in agreement with the theory of evolution?
 (a) Jawed fishes are found deeper in rock strata (layers) than jawless fishes
 (b) Land animals appear earlier than land plants in the fossil record
 (c) Unicellular organisms are first found in strata above multicellular fossils
 (d) Prokaryote fossils appear earlier than eukaryote fossils
 (e) Reptiles appear earlier than insects in the fossil record
48. In rabbits, black hair (B) is dominant to white hair (b) and short hair (S) is dominant to long hair (s). The cross $BbSs \times bbss$ results in 1 black short; 1 black long; 1 white short; 1 white long. Which of the following crosses would also produce the same result?
 (a) $BBSs \times bbss$ (b) $Bbss \times bbSs$
 (c) $Bbss \times bbSS$ (d) $BbSs \times BbSs$
49. Which of the following is the main disadvantage in using *Drosophila* for breeding experiments?
 (a) Small size of the larva
 (b) Short life cycle
 (c) Mating soon after emergence of flies
 (d) Large numbers of offspring produced
50. Darwin was influenced by Thomas Malthus, who in 1798, wrote that much of human misery is caused by the fact that human population increases....., whereas their resources increase.....
 (a) at 0% rate, at 0% rate
 (b) exponentially, arithmetically
 (c) exponentially, geometrically
 (d) arithmetically, geometrically
51. Two genetic diseases namely phenylketonuria and haemophilia are to be tested in two different individuals. Both these techniques will involve the use of (4th NSEB)
 (a) autosomes (b) sex chromosomes
 (c) restriction enzymes (d) pedigree analysis
52. Which of the following statements presents the best evidence (in this list) that present species developed from earlier forms?
 (a) There are no anatomical similarities between species
 (b) All species contain DNA
 (c) AUG codes for methionine in all living things
 (d) The fins of fish and flippers of whales perform the same function
53. Human serum was injected in rabbit to obtain anti-human serum antibodies. These antibodies were then reacted with the serum of different mammals and the amount of precipitate obtained were recorded as below. (1st NSEB)

Mammalian Species	% Precipitate
Human	100
Gorilla	64
Sheep	10
Jackal	10

Mark the correct interpretation of the results.

- (a) Gorilla is more closely related to man antigenically as compared to jackal
 - (b) Jackal and sheep are very closely related to each other
 - (c) Jackal and sheep are more closely related to man than to gorilla
 - (d) Both are equally related to gorilla
54. Mouth parts of insects belonging to different genera show the same basic structure such as labra, mandibles, maxillae and labia. This is indicative of (2nd NSEB)
- (a) convergent evolution
 - (b) divergent evolution
 - (c) adaptive radiation
 - (d) punctuated equilibrium
55. A small, isolated population is more likely to undergo speciation than a large population because a small population
- (a) is more affected by genetic drift and natural selection
 - (b) contains relatively more genetic diversity
 - (c) is more susceptible to gene flow
 - (d) has higher mutation rate
56. Which statement about genetic mutations is false?
- (a) Only mutations that occur in the cells that produce sperm and eggs can be transmitted to the next generation
 - (b) Beneficial mutations are rare
 - (c) Mutations occur during the process of DNA replication
 - (d) Dominant lethal mutations can be passed on to the next generation by heterozygous individuals
 - (e) Mutations that increase an individual's fitness (reproductive success) are favoured by natural selection
57. When a yellow mouse was crossed to another yellow mouse, the F₁ generation produces yellow and brown black mice in the ratio 2 : 1. The yellow mice are never homozygous. The reason is
- (a) homozygous yellow cannot survive due to lethal effect of genes
 - (b) yellow mice are not very suitable to live
 - (c) there is no formation of zygote with homozygous yellow constitution
 - (d) None of the above
58. Which member of the genus *Homo* has the largest brain (cranial capacity ranging from 1300-1750 cm³)?
- (a) *Homo habilis*
 - (b) *Homo erectus*
 - (c) *Homo sapiens neanderthalensis*
 - (d) *Homo sapiens sapiens*
59. Which of the following did not influence the formulation of Darwin's theory of evolution?
- (a) Lyell's theories on geological change, which indicated that earth must be very old
 - (b) The resemblance between the fauna of South America and the fauna of the Galapagos islands
 - (c) Mendel's crossing experiments with peas
 - (d) Malthus' theories on population growth and competition
 - (e) The development of new varieties by plant and animal breeders
60. Oceanic islands are often called 'natural laboratories for evolutionary studies.' This is because they
- (a) are isolated from other land masses
 - (b) are geologically very young
 - (c) have low speciation rates
 - (d) are ecologically very similar
 - (e) always have small numbers of species on them
61. Origin of life on earth through accidental invasion by primitive life forms as spores and microbes probably existing throughout universe, is called (3rd NSEB)
- (a) Panspermia theory by Arrhenius
 - (b) Cataclysm proposed by Cuvier
 - (c) Protobiogenesis theory by Haeckel
 - (d) Chemobiological theory by Oparin and Haldane
62. A trait in a hypothetical diploid organism is inherited via a single gene with four different alleles. How many different genotypes would be possible in this system?
- (a) 3 (1st NSEB)
 - (b) 6
 - (c) 8
 - (d) 10
 - (e) 16
63. The important evidences for evolutionary studies are obtained from (2nd NSEB)
- (a) gene mapping
 - (b) homologous and vestigial organs
 - (c) ecological studies
 - (d) All of the above

64. In *Drosophila*, the gene for brown eyes is recessive to its normal allele for red eyes; the gene for curled wings is recessive to its normal allele for straight wings. The two genes show independent assortment. Males heterozygous for both genes are mated to females that are heterozygous for the eye colour gene, but homozygous for the gene for curled wings. What proportion of the offsprings should have normal red eyes and normal straight wings?
(a) 3/16 (b) 3/8 (c) 1/2 (d) 3/4
(e) 9/16
65. Two alternative alleles, the dominant 'A' and the recessive 'a' are in equilibrium in a population. The frequency of A is 0.6. The percentage of individuals showing the dominant trait in the population should be
(a) 36% (b) 40% (c) 60% (d) 75%
(e) 84%
66. A segment of the DNA has a base sequence AAG, GAG, GAC, CAA, CCA. Which of the following sequences represents a frameshift mutation?
(a) AAG GAG GAC CAA CCA
(b) AGG AGG ACC AAC CA
(c) ACG GAC GAC CAG CCA
(d) AAG GCG GAC CCA AC
67. How many different genotypes can be seen in the offsprings from a dihybrid cross between two organisms which are heterozygous for both characters?
(a) 4 (b) 8
(c) 9 (d) 16
68. The use of Hardy-Weinberg equation for a population shows that:
(a) immigration of new mating type can be accounted for
(b) result of breeding over a number of generation can be predicted
(c) proportion of phenotype is 3 : 1
(d) there are twice as many phenotypes as recessive phenotype
69. In humans, the sex ratio is very close to 50 : 50. The best genetic explanation for this is
(a) crossing over
(b) independent assortment
(c) linkage
(d) transformation
(e) segregation
70. There are three alleles at the ABO antigen locus in humans. The A and B alleles produces A and B antigens, respectively, while the O allele produces no antigen. For which of the following phenotypes could you be certain that an individual (with that phenotype) a homozygote?
(a) Type A only (b) Type B only
(c) Type O only (d) Types A, B and O
(e) None of the phenotypes
71. A man who carries an X-linked allele will pass on to
(a) all of his daughters (b) half of his daughters
(c) all of his sons (d) half of his sons
(e) all of his children
72. The main feature of the 'biological species concept' is its emphasis on the
(a) large morphological differences between different species
(b) genetic variation within populations
(c) recognition of different species based on the ecological separation
(d) role of sexual reproduction in maintaining diversity within a species
(e) absence of gene flow between different species
73. Speciation is most likely to occur in a species with a number of populations, when there is a
(a) large population living in a niche with an environment like that of other populations
(b) small population living in a niche with an environment like that of other populations
(c) small population living in an isolated niche
(d) large population living in an isolated niche
(e) population in an environment which does not allow it to reproduce at all
74. Genes of certain coat colours in cattle show incomplete dominance. When a red animal is crossed with a white one, an intermediate colour a roan is produced. When two roans are crossed phenotypic ratio of F_1 generation is (1st NSE)
(a) 3 : 1 (b) 9 : 3 : 3 : 1
(c) 1 : 2 : 1 (d) None of these
75. In an experiment, black mice (BB) are crossed with brown mice (bb). The F_1 generation thus obtained is crossed with brown mice. The progeny will be (1st NSE)
(a) all black
(b) black : brown :: 3 : 1
(c) all brown
(d) brown : black :: 1 : 1

76. Baldness is more common in males than in females. This is explained on the basis that (3rd NSEB)
- genes of baldness are holandric genes
 - of baldness are located on X-chromosome of male
 - of baldness are located on autosome but are influenced by androgens
 - genes do not regulate baldness but hormones do
77. Which of the following mutations is likely to cause the greatest impact on the expression of a gene?
- Insertion of a base pair in the middle of the coding sequence
 - Deletion of a base pair in the middle of the coding sequence
 - Changing a base pair in the middle of the coding sequence
 - Changing a base pair in the second codon of the coding sequence
 - Deletion of a base pair in the second codon of the coding sequence
78. A trait that is maternally (cytoplasmically) inherited in animals is
- passed from mothers to daughters only
 - passed from father to son only
 - expressed only in females
 - expressed only in males every second generation
 - passed to offspring from the mother
79. One out of every 10,000 newborns in a country has phenylketonuria (PKU), a debilitating disease (when untreated) caused by a recessive allele. The frequency of carriers of this disease is
- 2%
 - 5%
 - 10%
 - 50%
80. Many people were sceptical of the theory of evolution when Darwin first proposed it. Darwin received such sharp criticism because
- the bones in the wings of bats, fins of porpoises, and legs of humans were known to be analogous structures
 - he could not explain completely, how evolution occurred because he did not know the mechanism of inheritance
 - the fossil record indicated that there were links between birds and reptiles
 - earth was thought to be much older than it actually is
- (d) he proposed that chimpanzees had evolved into humans
81. Below are some highlights on plant evolution. Mark the correct option, especially one in correct order:
- Origin of brown algae—tissue differentiation—Origin of gymnosperms—Origin of angiosperms
 - Origin from yeast, an eukaryote—Adaptation to land—Protective gametangia—Seed plants
 - Origin of green algae—Early vascular plants—first seed plants—Radiation of flowering plants
 - Origin of green algae—Rapid tissue differentiation—Dominant gametophyte stage leading to angiosperms
82. Below are given a few evolutionary trends relating to the flower structure either directly or indirectly. Mark the incorrect trend (1st NSEB)
- Wind pollination—Insect pollination
 - Single seed fruits—Multiple seeded fruits
 - Close proximity of carpels and stamens—Separate sexes
 - Ovules open—Protected ovules in cones
83. About 2 billion years ago, the oxygen content in the earth's atmosphere began to increase dramatically. This increase in atmospheric oxygen had important implications for the evolution of life on the planet. Which of the following is/are a result of this oxygen increase?
- The increase in atmospheric oxygen levels inhibited the evolution of aerobic respiration
 - All of the Fe⁺³ dissolved in the oceans had been converted to Fe⁺²
 - The accumulation of oxygen in the atmosphere allowed the evolution of photosynthetic organisms
 - None of the above
84. Three strains of a plant virus having different protein coats are prepared. These are allowed to infect plant cells. The type of disease produced in plants will be (1st NSEB)
- markedly different
 - dependent of chemical composition of protein coat

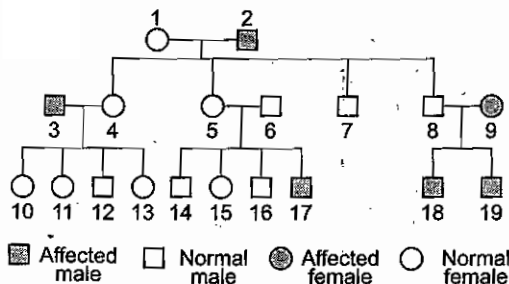
- (c) identical
(d) dependent on the interaction between the plant cell and the protein coat
85. Fertile hybrids between different plant species are common in nature and form much of the basis for plant breeding in horticulture and agriculture. The plant species pairs involved in forming fertile hybrids are consistent with
(a) both the biological and the morphological species concepts
(b) the biological but not the morphological species concept
(c) the morphological but not the biological species concept
(d) neither the biological nor the morphological species concept
(e) all of the species' concepts that have been proposed
86. Which of the following is not required for the size of a given trait to evolve by natural selection?
(a) The size of the trait varies among individuals in population
(b) There is a relationship between the size of the trait and the fitness (reproductive success) of the bearer of the trait
(c) The size of the trait has genetic basis
(d) Individuals with larger traits live longer
(e) Both (a) and (b)
87. A population of 100 diploid individuals is in Hardy-Weinberg equilibrium. If the frequency of the dominant allele is 40%, how many individuals are homozygous recessive?
(a) 48 (b) 36
(c) 24 (d) 18
(e) 16
88. If father shows normal genotype and mother shows a carrier trait for haemophilia
male child has 50% chances of active disease
the female children will be carriers
male child has probability of 0.5 to have active disease
(d) all the female children will be normal
89. A horse has a karyotype of 64 chromosomes and a donkey has a karyotype of 62 chromosomes. The hybrid offspring of a horse donkey cross is a mule which has 63 chromosomes. A mule is sterile because it cannot successfully
(a) court with mule
(b) complete development of the zygote
(c) copulate with mules, donkeys or horses
(d) form gametes
90. A pure strain of mice (BB) shows brown hair. Another pure strain of the same species (bb) shows grey hair. If one requires to determine the unknown genotype of a mouse with brown hair, it should be crossed with (2nd NSE)
(a) a heterozygous brown mouse
(b) a homozygous brown mouse
(c) a grey mouse
(d) All of the above
91. Which of the following is a set of discontinuous variations? (3rd NSE)
(a) Blood group, sex
(b) Hair colour, intelligence
(c) Height, excellence in mathematics
(d) Skin colour, mechanical skills
92. Haemolytic jaundice is due to a dominant gene. Only 10% of the people develop this disease. A heterozygous man marries a homozygous normal woman. What are the chances of occurrence of disorder in their offsprings? (3rd NSE)
(a) 1/2th (b) 1/5th
(c) 1/10th (d) 1/20th
93. In a population that is in Hardy-Weinberg equilibrium, the frequency of a recessive allele for a certain hereditary trait is 0.20. What percentage of the individuals in the next generation would be expected to show the dominant trait?
(a) 8% (b) 16% (c) 32% (d) 64%
(e) 96%
94. Dominant mutations are easier to detect than recessive mutations because they
(a) are always lethal and so their appearance is unmistakable
(b) are expressed in both homozygotes and heterozygotes
(c) occur at a higher frequency
(d) are always neutral in their effect
(e) are always favoured by selection
95. Which of the following are necessary for evolution by natural selection to take place?
I. Offspring resemble their parents more than other individuals in the population.
II. Differences among individuals exist and lead to different numbers of successful offspring being produced.

- III. Individuals adjust their development depending on the environment.
- IV. Every individual has a desire to have many offspring.
- ulations tend to grow faster than their supplies.
- (I II) (b) I and V
- (c) II, III and IV (d) III and V
- (e) All of these
96. Hardy-Weinberg's principle of "Zero evolution" is based on
- I. genetic equilibrium
- II. random mating
- III. no migrations
- IV. high gene frequency
- V. differential reproduction (4th NSEB)
- (a) I and V (b) II, III and IV
- (c) I, II and III (d) I, IV and V
97. Which pattern of evolutionary change has not been recognized in portions of the fossil record that have been thoroughly sampled?
- (a) Rapid change from one species to another over a short period of time (punctuation)
- (b) Rapid change from one family or order to another over a short period of time (saltation)
- (c) Stasis (equilibrium)
- (d) Gradual change
- (e) Fluctuating change
98. The observation that placental mice in North America are very similar in appearance to marsupial mice in Australia, even though they are not closely related to one another, is an example of
- (a) homology
- (b) analogy
- (c) divergent evolution
- (d) local adaptation
- (e) convergent evolution
99. Two unrelated organisms that become similar in appearance and ways in life as they adapt to similar environmental situation exhibit
- (a) adaptive radiation
- (b) convergent evolution
- (c) parallel evolution
- (d) homology
100. Individuals affected with haemophilia suffer from excessive bleeding due to the failure of the normal clotting mechanism. The disease is associated with a sex-linked recessive gene. Two brothers are haemophiliacs; their parents do not suffer from excessive bleeding. The probability that their sister inherited the gene for haemophilia is most likely
- (a) 0 (b) 1/4
- (c) 1/2 (d) 3/4
- (e) 1
101. Albinism (lack of skin pigmentation) is caused by a recessive autosomal allele. A man and a woman, both normal pigmented, have an albino child together. The couple then have a second child. What is the probability that the second child will be albino?
- (a) 0% (b) 25%
- (c) 50% (d) 75%
- (e) 100%
102. Plants pure for red and white flowers were allowed to cross (red dominant over white). After selfing of F₁ plants, the proportion of white flowered plants in the total progeny would be (4th NSEB)
- (a) one-third (b) one-fourth
- (c) three-fourth (d) half
103. If you cross a diploid individual that is homozygous recessive for a given trait with a heterozygous diploid individual, what is the probability of obtaining an offspring with the homozygous recessive phenotype?
- (a) 0% (b) 25%
- (c) 50% (d) 75%
- (e) 100%
104. Hereditary transmission of character dependent on the cytoplasm or structure in the cytoplasm, is known as
- (a) extra-chromosomal inheritance
- (b) chromosomal inheritance
- (c) blended inheritance
- (d) sex linked inheritance
105. Which of the following best describes Darwin's theory of the mechanism of genetic inheritance?
- (a) Inheritance of acquired characteristics
- (b) Blending inheritance
- (c) Molecular inheritance
- (d) Particulate inheritance
- (e) Adaptive inheritance

106. Haemophilia is a X-linked disease. A haemophilic male marries a normal woman, whose father is also a haemophilic. It is expected that
 (a) half their children will be haemophilic
 (b) all the children will be haemophilic
 (c) one-fourth of the children will be haemophilic
 (d) none of the children will be haemophilic
107. In grasshoppers, X-chromosome distribution in female and male genotype is XX and XO (O means no chromosome) respectively. If a sperm fertilizes a grasshopper egg, the zygote will be (1st NSEB)
 (a) female (XX) (b) male (XY)
 (c) male (XX) (d) female (XO)
108. Two organisms with a genotype of TtGg (T-height, G-colour) are mated with each other. Which is the probability for the offsprings to carry only one of the dominant characters?
 (a) 6/16 (b) 1/16
 (c) 4/16 (d) 1/4
109. DNA was isolated from wild type (Gal⁺) and mutant (Gal⁻) *E. coli* cells and separated by density gradient centrifugation technique. DNA from (Gal⁻) strain acquired a lower position. This indicates that the mutation is caused by (2nd INBO)
 (a) deletion (b) insertion
 (c) mis-sense mutation (d) point mutation
110. The statement "Dinosaur fossils are found in rock containing many plant fossils" is an example of
 (a) a theory (b) an observation
 (c) an assumption (d) a law
111. A certain type of grass has a diploid chromosome number of 8. A similar species of grass has a diploid chromosome number of 10. Interspecific hybridization between the two species results in sterile hybrids that can, nonetheless, reproduce vegetatively. The diploid chromosome number of these hybrids would be
 (a) 9 (b) 16 (c) 18 (d) 20
 (e) 36

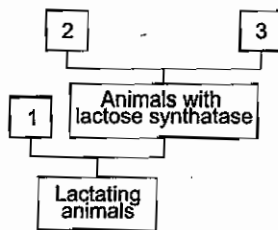
Exercise II

1. Radioactive dating was performed on a rock to estimate its age. When the rock was analyzed for its atomic content, it showed presence of potassium 40: argon 40 in the ratio 1 : 7. (Half life of potassium 40 is 1.25 billion years). The age of the rock is (2nd INBO)
 (a) 1.25 billion years (b) 2.50 billion years
 (c) 8.75 billion years (d) 3.75 billion years
2. In Huntington's disease, affected persons are heterozygous (Hh) and unaffected are homozygous for normal allele h. The pedigree is as follows because (2nd INBO)



- (a) it shows both males and females affected by Huntington's disease
 (b) either person 5 or 6 should have the disease, if individual 17 shows the disease
 (c) at least one of the 4 children (10, 11, 12 and 13) should have a disease (probability : 25%)
 (d) All of the above

3. Following is given a cladogram based on biochemical events. The numbered boxes indicate (2nd INBO)



- | | | |
|----------------|-----------------|-----------------|
| (a) Aves | Marsupials | True placentals |
| (b) Aves | Protoreptiles | True placentals |
| (c) Monotremes | True placentals | Marsupials |
| (d) Marsupials | Aves | True placentals |

Genetics and Evolution

4. The frequency of recessive sex linked gene for colour blindness in a human population is 0.02, whereas the frequency of its normal allele is 0.98. proportion of colourblind and carrier in this population would be (4th NSEB) 04 and 0.0392

- (b) 0.04 and 3.92
(c) 0.004 and 3.92
(d) 4.0 and 39.2

5. Which statement is false?

- (a) Non-disjunction refers to the failure of a pair of chromosomes to segregate during meiosis
(b) Karyotype refers to the number, forms and types of chromosomes in a cell
(c) Autosomes are cytoplasmic organelles that contain DNA and are capable of self-replication
(d) Prophase refers to the onset of nuclear division
(e) Centromere refers to the region where sister chromatids join

6. The order of appearance of the main groups of organisms during evolution can best be described as follows :

- (a) Autotrophic, anaerobic heterotrophic, aerobic heterotrophic
(b) Aerobic heterotrophic, anaerobic heterotrophic, autotrophic
(c) Anaerobic heterotrophic, aerobic heterotrophic, water oxidizing autotrophic
(d) Anaerobic heterotrophic, water oxidizing autotrophic, aerobic heterotrophic

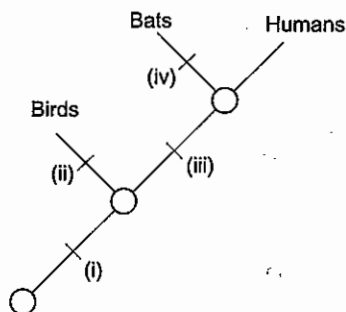
7. The main trend in the evolution of land plant was

- (a) a sharp demarcation of the phases of sporophyte and gametophyte
(b) a shortening of the haploid phase
(c) a shortening of the asexual phase
(d) an increase in the complexity of the gametophyte

8. Below are listed some pairs of characters. The homologous pair is (2nd INBO)

- (a) forelimbs of dog and camel
(b) insect wing and bat wing
(c) feathers of birds and fins of fish
(d) lens of vertebrate and arthropod

9. Consider the cladogram below. (2nd INBO)



Mark the correct option.

(a)	Feathers	Amnion membrane	Hair	Wing structure
(b)	Amnion membrane	Feathers	Hair	Wing structure
(c)	Limbs	Amnion membrane	Mammary glands	Wings
(d)	Wings and feathers	Limbs	Mammary glands	Limbs with feathers

10. Cladograms are drawn using evolutionary relationships between different groups. Complete the following table by assigning marks against each animal for each morphological trait based on the following rules (2nd INBO)

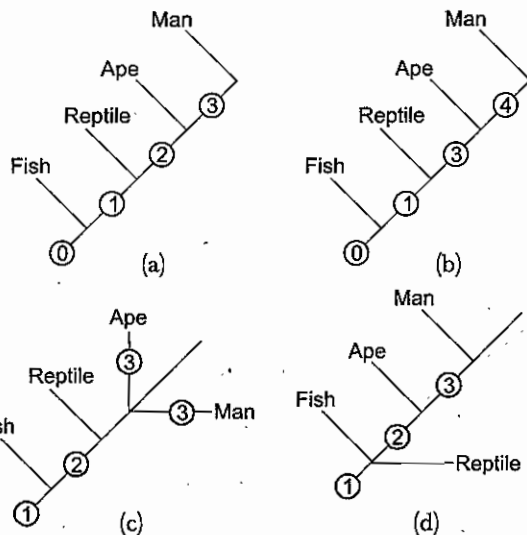
I. Presence of ancestral trait : 0 mark and absence : 1 mark

II. Presence of advanced trait (i.e., a character that has appeared later in the evolution) : 1 mark and absence : 0 mark

(a few blocks have been assigned the marks for your reference).

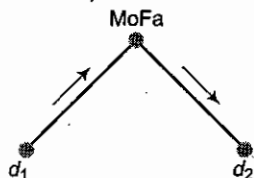
	Tetrapody	Fur	Tail	Bipedal Walking
Fish	0	0	—	0
Reptile	—	0	—	—
Ape	1	—	—	—
Man	1	—	—	1

Then add up the marks to get the total and based on this total, the correct cladogram is



11. The genetic relatedness between a child and a parent is always $1/2$ as the child shares 50% of the genes of either parent. One can calculate the genetic relatedness of other family members as follows :

Consider a couple with two daughters d_1 and d_2 . First calculate the genetic distance between d_1 and d_2 . For this, start from d_1 , climb up the family tree and down to d_2 . Total number of steps required (X) here are 2. Genetic relatedness of each step (Y) is $1/2$. Number of common ancestors (Z) here are 2 (Mo and Fa).



Therefore, genetic relatedness $d_1 d_2$
 $= Y^X \times Z = (1/2)^2 \times 2 = 1/2$

- Genetic relatedness of first cousins would be
 (a) $1/8$ (b) $1/4$ (2nd INBO)
 (c) $1/8$ (d) $1/16$

12. A scientist measures the average tail length of a wild population of birds over a period of 10 generations. During this period, he observes a gradual increase in average tail length. Which process could account for this increase?

- I. Genetic drift II. Emigration
 III. Natural selection IV. Immigration

- (a) I only (b) I and III
 (c) II and IV (d) I, II, III and IV
 (e) III and IV

13. What form of inheritance does a trait in humans have, which is found in the siblings of parents, where the female has the trait, but is never found in siblings of parents, where only the male has the trait?

- (a) X linked inheritance
 (b) Y linked inheritance
 (c) Autosomal inheritance
 (d) Maternal (extra nuclear) inheritance

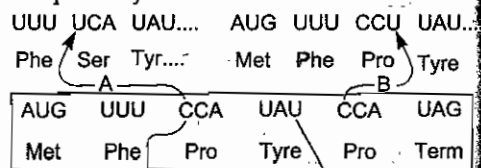
14. Some statements about evolution are made below. Mark the incorrect statement.

- (a) Mutations are the raw materials of evolution, a minority of which are beneficial
 (b) Biological evolution leaves observable signs, evidence of its effects on life in the past and present
 (c) Natural selection occurs through the interaction between environment and the variability inherent among organisms
 (d) Darwin envisioned life as evolving by rapid accumulation of minute changes

15. Two plants of genotype $Ss Tt$ (S = sweet fruit, T = height) are crossed with each other. The probability of its offsprings to carry only one dominant character is

- (a) $9/16$ (b) $3/4$
 (c) $1/16$ (d) $6/16$

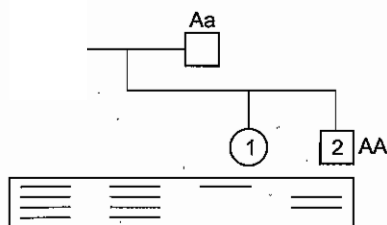
16. A mRNA with 6 codons (for chain initiation, termination and amino acid) is included in the rectangle shown in the given figure. The different types of mutations, indicated as A, B, C and D are respectively



.....UUU GCC AUA UCC AUA..... CCA UAG CCA
Phe Ala Ile Ser Ile.... Pro Term

- (a) silent, mis-sense, non-sense and frameshift
 (b) silent, mis-sense, frameshift and non-sense
 (c) mis-sense, silent, non-sense and frameshift
 (d) mis-sense, silent, frameshift and non-sense

17. The pedigree and the corresponding autoradiograph of restriction map of a family with two children is shown below. The genotype of child 1 is (4th NSEB)



- (a) Aa (b) aa
(c) AA (d) Can't be determined

18. In a family, father has a blood group A and mother has a blood group B. Their children show 50% probability for a blood group AB indicating that (2nd NSEB)

- (a) father is heterozygous
(b) mother is heterozygous
(c) either of the parent is heterozygous
(d) father is homozygous

19. The chart shows the effect of temperature on curly winged trait of *Drosophila*.

	Normal winged		Curly winged	
	25°C		25°C	
Generation	♀ & ♂		♀ & ♂	
	16°C	25°C	16°C	25°C
	Normal ♀ & ♂	Normal ♀ & ♂	Normal ♀ & ♂	Curly winged ♀ & ♂
II	25°C Normal ♀ & ♂	25°C Normal ♀ & ♂	25°C Normal ♀ & ♂	25°C Normal ♀ & ♂
	25°C Normal ♀ & ♂	25°C Normal ♀ & ♂	25°C Normal ♀ & ♂	25°C Normal ♀ & ♂

Mark the correct option explaining the phenotypes

- (a) only heredity
(b) only environment
(c) Both (a) and (b)
(d) None of the above

20. The genetic concept of segregation and recombination are most likely to be associated with

- (a) meiosis and gamete formation
(b) meiosis and mitosis
(c) meiosis and cleavage
(d) meiosis and fertilization

21. In the European population, about 1 in 2500 people suffers from cystic fibrosis, a genetically determined autosomal disease. Healthy parents have a child suffering from cystic fibrosis. The woman remarries a healthy man. What is the chance of a child from this second marriage suffering from cystic fibrosis?

- (a) 1 : 25 (b) 1 : 50
(c) 1 : 100 (d) 1 : 625

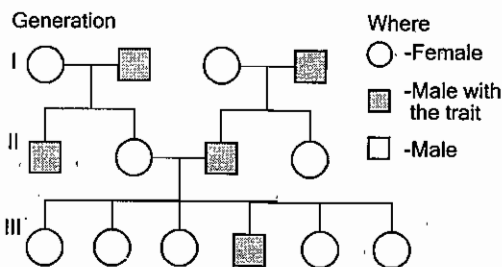
22. In *Drosophila*, the following crossing over percentages were found

Gene	Gene	Crossing Over %
bi	ec	1.4
bi	fa	3.9
wi	ec	4.0
wi	fa	1.5

What is the order of these genes?

- (a) bi-ec-fa-wi
(b) bi-ec-wi-fa
(c) ec-bi-fa-wi
(d) ec-bi-wi-fa

23. The pedigree shows a rare trait of extra fingers and toes. The inheritance pattern is



- (a) autosomal recessive
(b) autosomal dominant
(c) sex-linked recessive
(d) sex-linked dominant

24. A new characteristic usually appears in evolution as a result of

- (a) accumulation of point mutations in a gene which originally encoded for something else
(b) duplication of a gene and accumulation of point mutations in one of the copies coming from that duplication
(c) a mutation in a regulator gene
(d) genotypical recording of favourable phenotypical adaptations

25. How many different phenotypes can be expected in the F_2 of the crossing : $AA BB \times aa bb$ when

I. the genes are completely coupled and,
II. the genes inherit independently.

	I	II
A	3	4
B	3	9
C	4	9
D	4	16
E	9	16

- (a) A (b) B
(c) C (d) D
26. In corn, the trait for tall plants (T) is dominant to the trait for dwarf plants (t) and the trait for coloured kernels (C) is dominant to the trait for white kernels (c). In a particular cross of corn plants, the probability of an offspring being tall is 0.5 and the probability of a kernel being coloured is 0.75. Which of the following most probably represents the parental genotypes?

(a) $TtCc \times TtCc$
(b) $TtCc \times ttCc$
(c) $TtCc \times ttcc$
(d) $TTCc \times ttCc$
(e) $TTCc \times TtCC$

27. In the domestic cat, the autosomal locus white is dominant and epistatic; the locus orange is sex linked with allele O tabby and allele o red, while the heterozygous is tortoise. A white female mates with a tabby tom cat. The kittens turn out to be : 1 red male, 1 tortoise female, 1 tabby female, 1 white male, 1 white female.

What is the genotype of the mother?

(a) $WW Oo$ (b) $Ww OO$
(c) $Ww Oo$ (d) $Ww oo$

Plants from true breeding line with round and yellow (both dominant) seeds were crossed with plants with wrinkled and green (both recessive) seeds to get dihybrid plants. Plants from F_2 generation that would give progeny identical to themselves are (2nd INBO)

(a) plants with round and yellow seeds
(b) plants with wrinkled and yellow seeds
(c) plants with round and green seeds
(d) plants with wrinkled and green seeds

29. Vertebrates vary widely in appearance and they are further divided into different classes according to some characteristics. The correct order of evolution of these characteristics is (2nd INBO)

(a) Jaws \rightarrow Lungs \rightarrow Hair \rightarrow Amniotic egg
(b) Teeth \rightarrow Paired appendages \rightarrow Legs \rightarrow Hair
(c) Teeth \rightarrow Lungs \rightarrow Paired appendages \rightarrow Hair
(d) Lungs \rightarrow Jaws \rightarrow Legs \rightarrow Teeth

30. To study the natural phenomena of inheritance Mendel selected the pea plants. Which of the following properties were suitable for his studies?

I. Plants were easily grown in garden soil with considerably shorter generation time.

II. Plants would easily self pollinate or cross pollinate in nature.

III. Many parts of the plant such as pod, seed, flower, cotyledons showed distinct phenotypes.

IV. Pea plants do not require the true-breeding lines for hybridization experiments. (2nd INBO)

(a) I, II and III
(b) I, III and IV
(c) II, III and IV
(d) I and III

32. A man is brought to court in a paternity case. He has blood type B, Rh positive. The mother has blood group B, Rh negative. The child's blood type is A, Rh negative. Which statement about the man is correct?

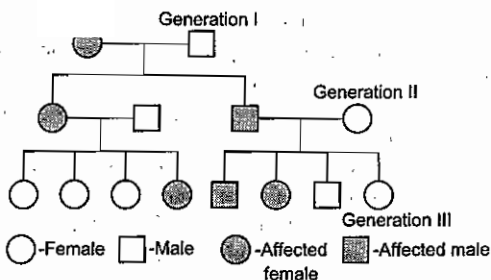
(a) He is the father
(b) He might be the father
(c) He is not the father
(d) He might not be the father
(e) There is not enough information to make a decision

31. You map four bacteriophage genes by recombination. The recombination frequencies between the four genes are shown in the table below. What is the order of the genes along the chromosome?

	A	B	C	D
A	—	0.18	0.1	0.2
B		—	0.15	0.37
C			—	0.24
D				—

- (a) ABCD (b) CBDA
(c) BADC (d) CABD
(e) DACB

33. A pedigree is shown below for a disease that is autosomal dominant. The genetic make up of the first generation is _____ (2nd NSEB)

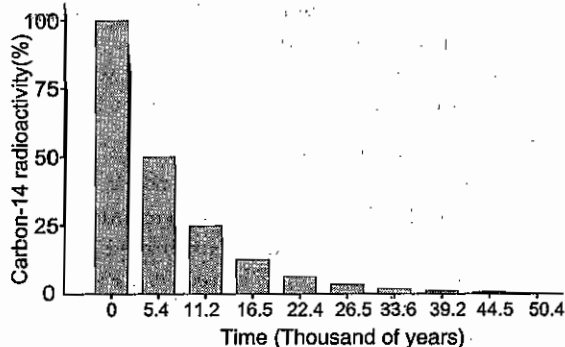


- (a) AA, Aa (b) Aa, aa
(c) Aa, AA (d) Aa, Aa

34. The ground finch uses its beak to crush seeds. The birds prefer small seeds, which are easier to crush, over the larger ones. During rains, only small seeds are eaten due to their abundance. However, when food is less in summer, these birds largely eat big seeds. The change in diet has brought about changes in the average thickness of the beaks. Explain this

- (a) Over long periods of time, the finches must have realised the advantage of strong beaks and worked themselves accordingly to get such beaks
(b) The trait of strong beak must have been inherited in certain group of finches. These had distinct advantage, with greater reproductive ability over years
(c) With obvious advantages, over a period of time, the finches have acquired this change. Those with stronger beaks manage to survive while others die out
(d) Strong or weak beak is all a matter of creation

35. An exponential decline in the radioactivity of carbon - 14 is depicted in a graph. C_{14} content of a fossil mammalian bone was found to be 16 times less than that found in the same bone of recently killed mammal. The estimated age of the fossil is _____ (2nd NSEB)



- (a) 16.8 thousand years (b) 22.4 thousand years
(c) 28 thousand years (d) 44.8 thousand years

36. Triplets of different related terms are given. Mark one triplets which is not related

- (a) Linkage map, cytological map, DNA nucleotides
(b) Sickle cell anaemia, thalassemia, Huntington chorea
(c) Recombination frequency, crossovers, linked genes
(d) Pleiotropy, epistasis, complete dominance

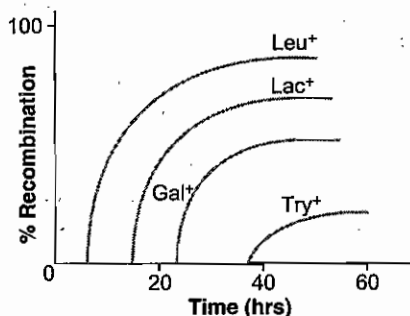
37. Study the two cases carefully. The correct interpretation of the two cases is _____ (4th NSEB)

Case	Mother	Father	Children
Case I	With disease	Normal	Sons always with disease
Case II	With disease	Normal	Sons and daughters could show disease

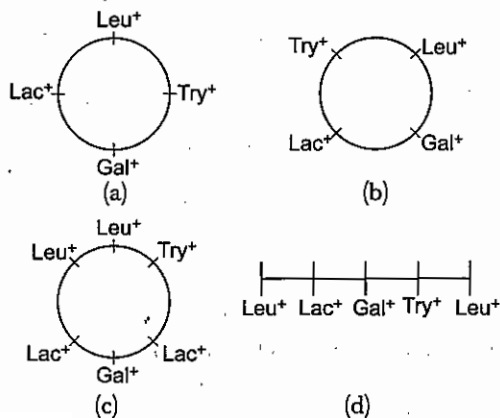
- (a) Case I : X-linked recessive disease
Case II : autosomal recessive disease
(b) Case I : Y-linked recessive disease
Case II : X-linked recessive disease
(c) Case I and II : X-linked recessive disease
(d) Case I : X-linked dominant disease
Case II : Autosomal dominant disease
38. The concept that formed the basis of Lamarck's theory of evolution and later disproved experimentally was _____ (2nd INBO)
- (a) environment plays an important role in producing phenotypic changes in an individual
(b) acquired traits of an individual in the lifetime are genetic and inherited

- (c) individuals within a population have a great reproductive potential
(d) individuals best adapted to their environment have a reproductive advantage

39. A donor bacterial cell with genotype $Leu^+ Lac^+ Gal^+ Trp^+$ was conjugated with recipient that was $Leu^- Lac^- Gal^- Trp^-$. Conjugation was interrupted at various intervals and transformed genes in recipient were tested. The results are shown in the graph below. (2nd INBO)



The genetic map of the donor cell will be



40. Susceptibility to many cancers is inherited, the fact that those who contract the disease usually die quickly. The evidence shows that the usual explanation for this is that people who are at a genetic risk for cancer inherit
- (a) a deficient RNA editing mechanism
(b) a predisposition (tendency) to avoid foods that prevent cancer
(c) one or two or more mutations necessary to cause the disease

- (d) a predisposition to expose themselves to chemical carcinogens, such as those found in tobacco
(e) a single cancer cell, which may or may not divide
41. A study of cliff swallows on Prince Edward Island found that the smallest and largest adult birds contribute relatively fewer offsprings to the next generation than those birds that are closer to the average size. These findings suggest that
- (a) this population is sexually dimorphic in body size
(b) artificial selection is acting on this population
(c) the mode of natural selection acting on this population is directional selection
(d) the mode of natural selection acting on this population is disruptive (or diversifying) selection
(e) the mode of natural selection acting on this population is stabilizing selection
42. To study chromosomes of a single organism, geneticists cut images of stained chromosomes from a micrograph and arrange them to produce a karyotype. Which statement concerning karyotypes is correct?
- (a) The length and shape of the chromosomes in a karyotype are the same
(b) Karyotypes are prepared from cells that are in any stage in the cell cycle
(c) Scientists examine the chromosomes under a microscope to determine the nucleotide sequence
(d) Normal individuals from the same species have the same number of chromosomes in a karyotype
(e) The sex chromosomes in a karyotype are all known as autosomes
43. Radioactive thymidine when added to a medium surrounding living mammalian cells gets incorporated into a newly synthesized DNA. Which of the following type of chromatin is expected to be radioactive if cells are exposed to radioactive thymidine as soon as they enter S-phase?
- (a) Heterochromatin
(b) Euchromatin
(c) Both (a) and (b)
(d) Neither heterochromatin nor euchromatin

44. A scientist found that a particular gene was mutated but the polypeptide coded by this gene had not changed. The mutation probably led which of the following?

deletion of one nucleotide
addition of a nucleotide

(c) Substitution of a nucleotide

(d) Addition of three nucleotides which form a codon

45. The gene for brown eyes is dominant over the gene for blue eyes. Following are given some statements.

- I. For the child to be blue-eyed, at least one parent should be blue-eyed.
- II. Both parents with blue eyes will have a blue-eyed child.
- III. Blue-eyed person will always show both the alleles different from brown-eyed person.
- IV. Identical twins of blue-eyed parents will both have either blue or brown eyes.
- V. For the child to be brown-eyed, at least one parent should be brown-eyed.

The correct statements are (2nd INBO)

(a) I, IV and V

(b) II, V

(c) II, III

(d) I, III and V

46. Of the various types of glycoprotein molecules that are present on the surface of red blood cells, two are considered here, namely M and N. Their presence is due to a pair of genes of which neither is dominant with respect to the other, so that when both are present, a mixed type occurs, i.e., both the antigens present on cell surface. A phenotype homozygous for allele M is indicated as 'M⁺N⁻' and phenotype homozygous for allele N is indicated as 'M⁻N⁺'. When these two homozygous types mate, the expected offspring genotype would be (2nd INBO)

(a) all the offsprings to be heterozygous

(b) 50% of the offsprings to be heterozygous

(c) 75% of the offsprings to be homozygous for allele M

(d) 25% of the offsprings to be homozygous for allele N

47. In one kind of gene interaction observed between different genes in flower colour of sweet pea, a coloured variety with genotype (AaBb) on selfing yields coloured : white type in ratio 9 : 7. The correct biochemical explanation for this expression is (2nd INBO)

(a) Precursor \rightarrow intermediate X $\xrightarrow[\text{Gene B}]{\text{Gene A}}$ red colour

(b) Precursor \rightarrow intermediate X $\xrightarrow[\text{Gene B}]{\text{Gene A}}$ white colour

(c) Precursor $\xrightarrow[\text{Gene B}]{\text{Gene A}}$ intermediate X $\xrightarrow[\text{Gene B}]{\text{Gene A}}$ white colour

(d) Precursor $\xrightarrow{\text{Gene B}}$ intermediate X $\xrightarrow{\text{Gene A}}$ intermediate Y $\xrightarrow{\text{Gene B}}$ red colour

48. A geneticist discovers a mutant plant with pale green leaves and subsequently determines that this mutant produces only half the normal amount of chlorophyll *a*. Which statement is the most accurate description of the impact of this mutation on photosynthesis?

(a) The plant can absorb only one half of the normal number of photons

(b) There will be no effect on the light reactions of photosynthesis because the regeneration of ribulose 1, 5-bisphosphate (RuBP) is the rate limiting step

(c) Synthesis of carotenoid pigments will compensate for the reduction in chlorophyll-*a*

(d) The chloroplast will have half the number of photosystem I complexes, but photosystem II will be unaltered

(e) A doubling of the levels of glyceraldehyde 3-phosphate (G3P) will compensate for the loss of chlorophyll-*a*

49. A mutant of an *E. coli* designated as arg⁺ try⁻ lacks the ability to synthesize tryptophan. Another mutant arg⁻ try⁺ lacks the ability to synthesize arginine. Mixture of both these bacteria were grown in a medium containing only glucose and essential salts. Cells that could grow in the media have a genotype (2nd NSEB)

(a) arg⁺ try⁻

(b) arg⁻ try⁺

(c) arg⁺ try⁺

(d) arg⁻ try⁻

50. All of the following are statements used as evidence that genes are on chromosomes, except

(a) the structure of DNA is a polymer of nitrogenous bases linked together by a 'backbone' of alternating phosphates and sugars

- (b) the correlation of the Mendelian law of segregation with the segregation of chromosomes in meiosis
- (c) the correlation of the Mendelian law of independent assortment of chromosomes in meiosis
- (d) the correlation of Down's syndrome in humans with an extra chromosome 21
- (e) the sex-linked inheritance of some forms of colour blindness in human males correlates with the inheritance of one X and one Y-chromosome in males

51. An organism can have genotypes CC, Cc, cc for coat-colour. Which one of the following genotype frequencies follow Hardy-Weinberg rule?

- (a) 0.29, 0.42, 0.20
(b) 0.25, 0.50, 0.25
(c) 0.36, 0.55, 0.09
(d) 0.20, 0.60, 0.20

52. Cross over value (COV) of genes A and B is 5% while COV of genes B and C is 15%. The possible sequence of these genes on chromosome is

(2nd NSEB)

- (a) A-B-C
(b) C-A-B
(c) B-C-A
(d) Both (a) and (b)

53. A test cross to determine the genotype of smooth yellow seed (both dominant characters) has to be performed. The required phenotype of seed to be used should be

(4th NSEB)

- (a) smooth yellow
(b) wrinkled green
(c) smooth green
(d) wrinkled yellow

54. The inactive X-chromosome in females is often called as a darkly stained Barr-body. Among different chromosomal compositions given below, which one will show the absence of Barr body?

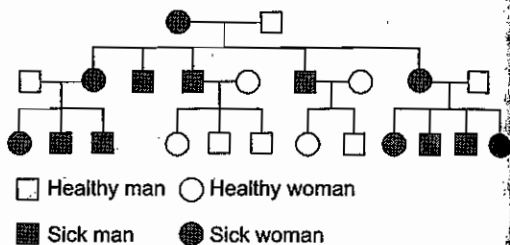
- (a) XX (b) XO
(c) XXY (d) XXX

55. Which form of natural selection can lead to differentiation in species and to polymorphism?

- (a) Directional selection
(b) Stabilizing selection

- (c) Disruptive selection
(d) Density dependent selection

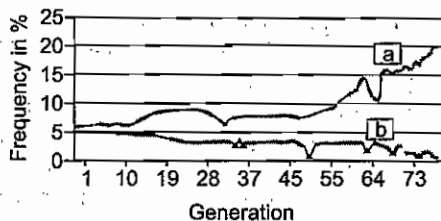
56. The pedigree (see figure) shows an inheritance of a rare form of muscular dystrophy.



The disease is probably caused by a mutation on one locus which is

- (a) recessive, autosomal
(b) dominant, autosomal
(c) recessive, related to the X-chromosome
(d) related to the Y-chromosome
(e) situated in the mitochondrial genome

57. In a long term experiment on a population of *Drosophila melanogaster*, the frequency of two alleles 'a' and 'b' of a multi-allelic locus X over time has been shown in the following graph.



6 students were asked to evaluate the observed patterns and their inferences are given below

Student 1 Environment is not uniformly selective

Student 2 Population may be under artificial selection

Student 3 Generic variability is progressively increased

Student 4 Generic variability is progressively reduced

Student 5 Mechanism such as genetic drift is operating from time to time

Student 6 Selection is favoring a particular genotype through directional selection.

The appropriate conclusions were drawn by

- Students 2, 5 and 6
- Students 1, 3 and 5
- Students 2, 4 and 6
- Students 1, 3 and 6

58. Mendel studied the inheritance patterns of 12 different characters of the pea plant. He could ascertain the independent assortment of only 7 of these 12 characters by repeated experiments.

A. What can be deduced from this?

- The pea plant could have at least seven pairs of chromosomes
- The pea plant can have a maximum of seven pairs of chromosomes
- The pea plant has exactly seven pairs of chromosomes
- The pea plant can have a haploid chromosome number between 7 and 12

B. It was later found that genes responsible for these 7 traits were located on four different chromosomes. This indicates that

- the pea plant has only four pairs of chromosomes
- as genes are often linked, the independent assortment of the traits observed by Mendel was due to chance alone
- although some genes were linked, they were located so far apart that they behaved as if they were present on separate chromosomes
- although some genes are linked, they showed results of independent assortment mainly because no meiotic recombination occurred

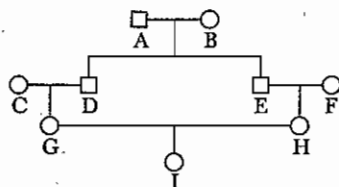
C. The genes for the seven traits were located as follows:

- Gene for seed texture (smooth/wrinkled)—located on one chromosome
- Gene for pod colour (yellow/green)—located on one chromosome.
- Genes for cotyledon colour and seed coat colour—located on one chromosome.
- Gene determining pod texture, flower position and stem length were located on one chromosome.

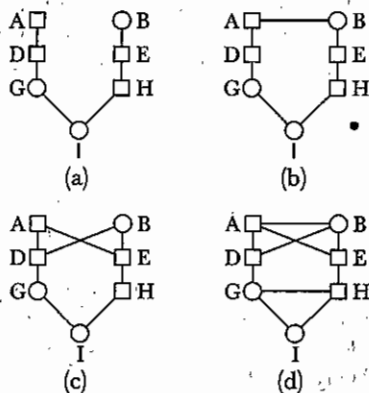
Which of these traits, if studied simultaneously, would give results that will not indicate independent assortment?

- Seed texture and pod texture
- Pod colour and cotyledon colour
- Flower position and stem length
- Seed coat colour and pod texture

59. Following is a pedigree with marriage between first cousins



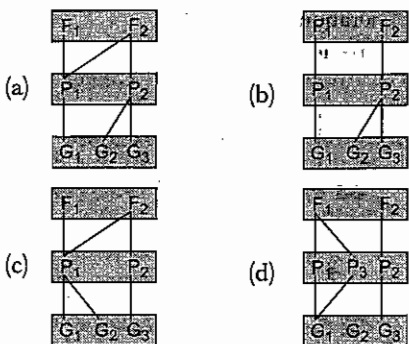
Choose the correct diagram representing the inheritance of alleles in this pedigree.



60. Silky fur is a recessive trait in a breed of cats. An amateur breeder has procured a stock of 1000 cats of which 160 are silky-furred. As he is away, his wife happily sells all these 160 cats for a handsome price. On his return, the husband is upset and has no option but to breed the remaining stock. What percentage of the next generation will be silky-furred?
- 16%
 - 8%
 - 4%
 - 2%

61. Genotypic variation (G), phenotypic variation (P) and fitness (F) are closely related to each other. The figures below show the possible relationship between these three parameters under constant environmental conditions.

Choose the most appropriate representation of this relationship from the following figures.



62. A recessive allele in homozygous condition causes dwarfism. In a mainland population, this condition is known to occur in 1 out of 1000 individuals. Among the tribal population of 12000 individuals living on a nearby island, this condition is known to occur in 1 in 14 individuals. All these individuals are descendants of 30 people, who migrated from the mainland to the island.

- This is an example of
(a) bottleneck effect
(b) founder effect
(c) non-random mating
(d) natural selection

63. Which of the following structures are 'homologous' from the evolutionary point of view?

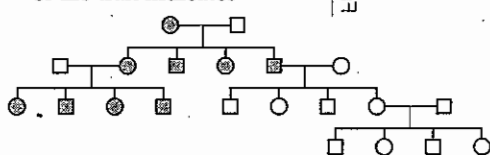
- (a) Petals of rose and the another of an apple blossom
(b) Wings of a bird and wings of a butterfly
(c) Spines of a cactus and spines of a porcupine
(d) Flagellum of *Euglena* and the cilium of *Paramecium*

64. Which of the following ways is most likely to decrease the genetic diversity in a population?

- gene mutation
genetic recombination
stabilizing natural selection

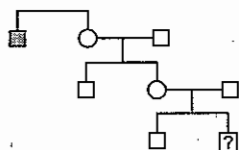
- (a) immigration of individuals

65. Study the following pedigree. The transmission of the trait indicates

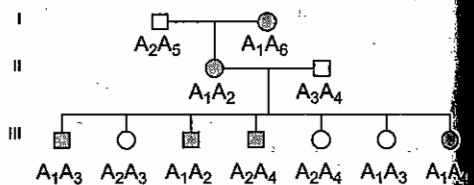


- (a) autosomal dominance
(b) maternal imprinting
(c) paternal imprinting
(d) mitochondrial inheritance

66. In the following pedigree, the black square indicates the male affected with haemophilia which is a X-linked recessive trait. What is the probability that the proposed child, which is male (indicated as ?), will carry the disease?

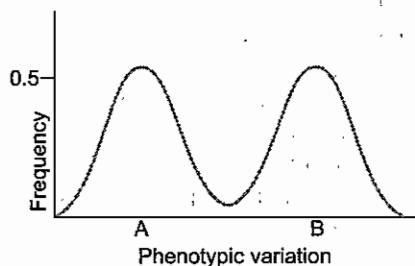


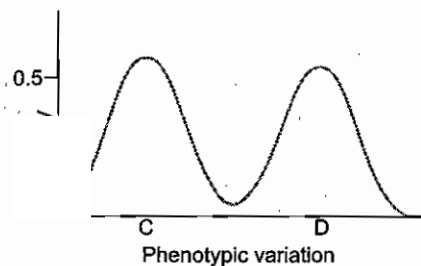
67. Following is a pedigree for a family for Variable Number Tandem Repeats (VNTRs) A1 to A6 and a genetic disorder (shaded symbols).



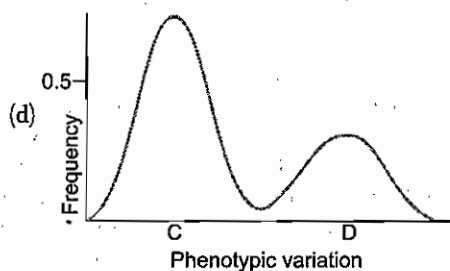
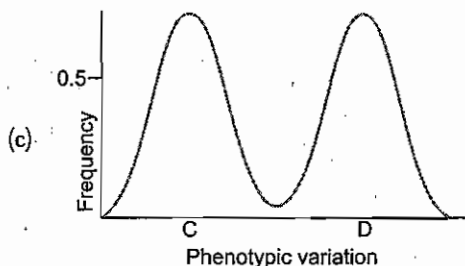
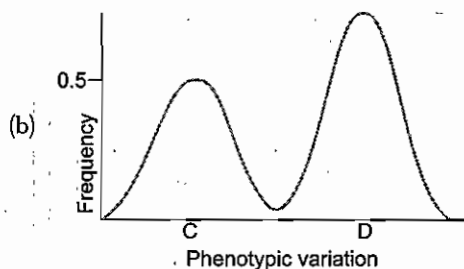
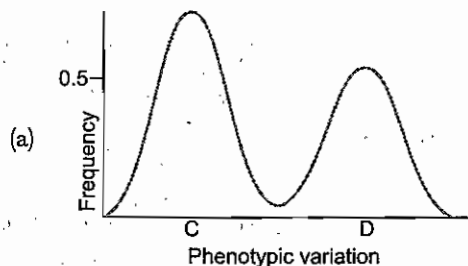
What is the percent recombination frequency between the VNTR and disease loci? Write your answer only upto two decimal places.

68. The environment in which a species lives exerts selective pressure on its individuals. In a pair of forest, many different species of butterfly exist. Among these, two butterfly species, A and B exhibit two different colour patterns and are very distasteful to their predators. There exist two more butterfly species, C and D, which exhibit very similar colour patterns as that of A and B, respectively, but are highly palatable. The frequency distribution of these butterflies is shown in the two graphs below.

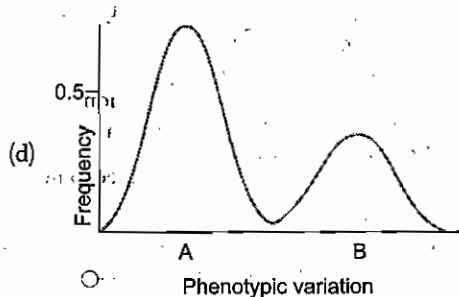
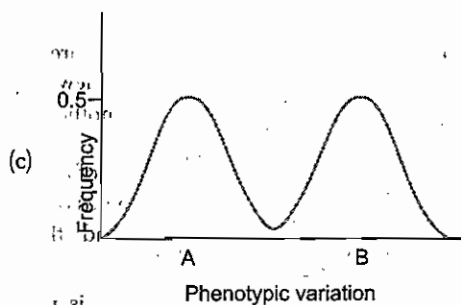
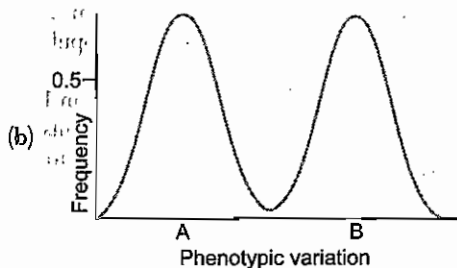
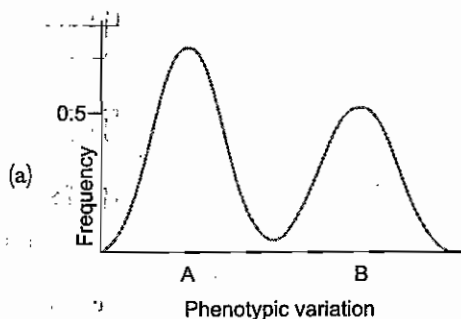




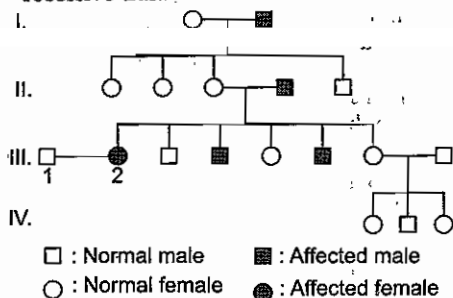
- A. In one situation, butterflies of species A become much more common than species B. What is the most likely effect of this on species C and D after many generations?



- B. In another situation, number of butterflies of species 'C' suddenly came down in one generation. What is the most likely effect of this on species 'A' and 'B' after many generations?



69. Study the following pedigree for an autosomal recessive trait.



The probability that the couple III-1 and III-2 will have an affected child is

- (a) $\frac{1}{8}$ (b) $\frac{1}{2}$
(c) $\frac{1}{16}$ (d) $\frac{1}{4}$
70. How many different kinds of
I. F_1 gametes
II. F_2 genotypes
III. F_2 phenotypes would be expected from the cross $AABBCC \times aabbcc$?
- (a) I-16 II-24 III-16
(b) I-8 II-27 III-8
(c) I-8 II-64 III-16
(d) I-8 II-32 III-16

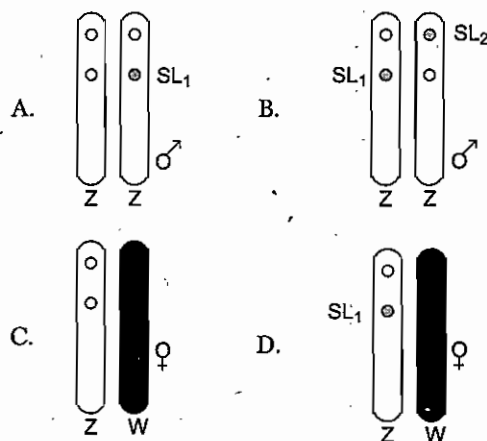
71. In grasshopper, rosy body colour is caused by a recessive mutation. The wild-type body colour is green. If the gene for body colour is on the X-chromosome, what kind of progeny would be obtained from a mating between a rosy female and a wild-type male?

- (a) All the daughters will be green and all the sons will be rosy
(b) 50% daughters will be green and 50% sons will be rosy
(c) All offsprings will be green irrespective of sex
(d) All offsprings will be rosy irrespective of sex

72. The length of a river exists a species of fish. In order to provide electricity to the adjoining villages, a hydroelectric dam is built that separates the lower river area from a newly formed lake above. After many, many years, the *Catla* fish in the river and lake are sampled and found to be phenotypically very different. Which of the scenarios listed below is the best hypothesis to explain the observed changes?

- (a) The presence of the dam increased the amount of random mating that occurred between the river and lake fish, and natural selection selected for the best-fit organisms in both the populations
(b) The newly built dam caused a genetic drift and the two different founder populations diverged extensively leading to the appearance of two different species
(c) The electricity produced in the dam caused mutations in the river fish, and natural selection selected for the best-fit organisms in both locations
(d) The dam caused different environmental conditions to be formed in the lake *versus* the river, populations accumulated mutations, and natural selection selected for the best-fit organisms, which survived in both environments

73. Males of silkworm *Bombyx mori* are known to produce more silk per unit quantity of leaf consumed. Hence, they are preferably bred in sericulture industry. Which of the following genotypes should be crossed in order to get maximum fraction of male insects? Fill your answer in the answer sheet.



SL_1 and SL_2 are two sex linked recessive lethal mutations

74. Read the following statements and determine whether they suggest pre-zygotic or post-zygotic barriers. Put tick marks (✓) in the appropriate boxes in the table given in the answer sheet.
- I. Male Jackals only mate with domestic dogs. if the Jackal pups are raised by a domestic dog

- II. Lions and tigers must overcome behavioural (courtship) barriers, but produce fertile offspring and sterile make offspring
- III. s of genus *Aquilegia* have long floral nes. Flowers of *Aquilegia pubescens* are upright in position and pollinated by hawkmoths, while flowers of *A. formosa* are angling type and pollinated by humming bird. The hybrids of these plants. Although fertile, are rarely found in nature.
- IV. In *Heliconius* butterflies, fertile hybrids are common, which can breed with other hybrids, or with either parent species. However, pure-bred *Heliconius* butterflies have warning colouration to ward off predators, while hybrids have intermediate patterns, which are not recognized

Description	Whether description suggests	
	Pre-zygotic barrier	Post-zygotic barrier
(a)		
(b)		
(c)		
(d)		

75. Bathypelagic fish (those, which live at around 1000-2000 metres of depth in ocean) show

varying adaptations as compared to mesopelagic fish (that live at around 200-700 metres of depth). Which of the statements correctly generalize body features in these two groups? Indicate whether each statement is true or false by putting tick marks (✓) in appropriate boxes in the table given in the answer sheet.

- (a) Bathypelagic fishes are mostly black in colour as against variably coloured mesopelagic fishes
- (b) Bathypelagic fishes have relatively long jaws as compared to mesopelagic fish
- (c) Mesopelagic fish have fairly large eyes in as compared to bathypelagic fishes
- (d) Mesopelagic fishes have retina predominantly containing rod cells as compared to retina with more cone cells in bathypelagic fishes
- (e) Well-developed gill system in mesopelagic fishes as compared to bathypelagic fishes

Statement	True	False
(a)		
(b)		
(c)		
(d)		
(e)		

Answers

Exercise I

1. (b) 2. (c) 3. (e) 4. (a) 5. (e) 6. (a) 7. (e) 8. (a) 9. (a) 10. (b)
 11. (c) 12. (b) 13. (b) 14. (a) 15. (a) 16. (d) 17. (d) 18. (b) 19. (d) 20. (a)
 21. (b) 22. (a) 23. (c) 24. (c) 25. (d) 26. (b) 27. (e) 28. (e) 29. (c) 30. (a)
 31. (c) 32. (a) 33. (e) 34. (a) 35. (d) 36. (a) 37. (c) 38. (a) 39. (a) 40. (d)
 41. (e) 42. (c) 43. (c) 44. (c) 45. (c) 46. (d) 47. (d) 48. (b) 49. (c) 50. (b)
 51. (c) 52. (d) 53. (a) 54. (c) 55. (a) 56. (d) 57. (b) 58. (d) 59. (c) 60. (a)
 61. (a) 62. (d) 63. (d) 64. (b) 65. (e) 66. (b) 67. (c) 68. (b) 69. (e) 70. (c)
 71. (a) 72. (e) 73. (c) 74. (c) 75. (d) 76. (c) 77. (e) 78. (e) 79. (a) 80. (b)
 81. (a) 82. (c) 83. (d) 84. (c) 85. (c) 86. (d) 87. (b) 88. (a) 89. (d) 90. (c)
 91. (a) 92. (d) 93. (e) 94. (b) 95. (a) 96. (c) 97. (b) 98. (e) 99. (c) 100. (c)
 101. (b) 102. (b) 103. (c) 104. (a) 105. (b) 106. (a) 107. (a) 108. (a) 109. (b) 110. (b)
 111. (a)

Exercise II

1. (d) 2. (b) 3. (c) 4. (a) 5. (c) 6. (d) 7. (b) 8. (a) 9. (b) 10. (d)
 11. (c) 12. (d) 13. (d) 14. (d) 15. (d) 16. (d) 17. (b) 18. (c) 19. (c) 20. (d)
 21. (c) 22. (a) 23. (b) 24. (b) 25. (b) 26. (b) 27. (c) 28. (d) 29. (a) 30. (d)
 31. (c) 32. (e) 33. (b) 34. (c) 35. (b) 36. (a) 37. (a) 38. (b) 39. (d) 40. (c)
 41. (e) 42. (d) 43. (b) 44. (c) 45. (b) 46. (a) 47. (d) 48. (a) 49. (c) 50. (a)
 51. (b) 52. (d) 53. (b) 54. (b) 55. (c) 56. (e) 57. (c) 58. (*) 59. (c) 60. (b)
 61. (b) 62. (b) 63. (d) 64. (c) 65. (d) 66. (*) 67. (*) 68. (**) 69. (d) 70. (b)
 71. (a) 72. (d) 73. (***)

Explanations

62. A founder effect occurs when a new colony is started by a few members of the original population. This small population size means that the colony may have

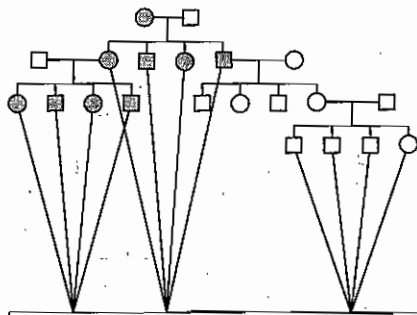
- Reduced genetic variation from the original population.
- A non-random sample of the genes in the original population.

63. Organisms are grouped according to their similarities and differences. Some structures are similar because they have been inherited from a common ancestor. These are said to be homologous structures.

64. Stabilizing selection, also referred to as purifying selection or ambidirectional selection, is a type of natural selection in which genetic diversity decreases as the population stabilizes on a particular trait value.

65. In higher animals, mitochondria usually show **maternal inheritance** or **mitochondrial inheritance**, which means genetic transmission only through the female. The mitochondria are typically maternally inherited because the egg is the major contributor of cytoplasm to the zygote. The pedigree given in the question, is a typical pattern of maternal inheritance of mitochondria because males

do not transmit the pattern to their progeny, & females transmit the pattern to all of their progeny.



All the progeny of a particular female have the same pattern of mitochondrial DNA bands as the mother.

67. 28.571 or 29%

68. A-(d), B-(c, d)

73. II and III

74. (a) Pre zygotic barrier
(b) Pre and Zygotic barriers
(c) Pre zygotic barrier
(d) Post zygotic barrier

75. (a), (b), (c), (e) are true and (d) is false.