Time : 60 Mins **27 MOLECULAR BASIS OF INHERITANCE 1** **Marks : 240**

1. What does "lac" refer to in what we call the lac operon?
   a) The number 1,00,000 **b) Lactose** c) Lactase d) Lac insect

   Solution : -
   The lac operon is a cluster of genes responsible for transport and metabolism of lactose sugar in Escherichia coli and some other bacteria. The mechanism of regulation of expression of genes, responsible for coding the involved enzymes was first explained by Francois Jacob and Jacques Monod. Lactase is an enzyme located in on the brush border of the small intestine of humans and other mammals that breaks down lactose, the milk sugar. Lac insect, Lacciferlacca, secretes a sticky, resin like material called lac which is used to produce shellac and a red dye. The number 1,00,000 is not associated with operon.

2. A tall true breeding garden pea plant is crossed with a dwarf true breeding garden pea plant. When the F_1 Plant were selfed the resulting genotype were in the ratio of:
   a) 1:2:1 :: Tall homozygous : Tall heterozygous : Dwarf
   b) 1:2:1 :: Tall heterozygous : Tall homozygous : Dwarf c) 3:1 :: Tall : Dwarf d) 3:1 :: Dwarf : Tall

3. The process of translation is_____
   a) ribosome synthesis **b) protein synthesis** c) DNA synthesis d) RNA synthesis

   Solution : -
   Translation is the process of protein synthesis in which the triplet base sequences of mRNA molecules is converted into a specific sequences of amino acids in a polypeptide chain, this occurs on ribosomes.

4. In which direction m-RNA is synthesised on DNA template?
   a) 5'→3' b) 3'→5' c) Both (a) and (b) d) Any

   Solution : -
   Formation of mRNA on DNA template is called Transcription. During transcription the synthesizing mRNA grows in $5' \rightarrow 3'$ direction on non coding strand, which is synonymous to the template strand. Non coding strand refers to the DNA strand which has similar base sequences like that of the mRNA strand, with the thymine only replaced with uracil. The synthesis of new DNA and RNA is always unidirectional, i.e, in the direction of $5' \rightarrow 3'$.

5. A colour blind man marries a woman with normal sight who has no history of colour blindness in her family. What is the probability of their grandson (son's son) being colour blind?
   a) 0.25 b) 0.5 c) 1 d) Nil

6. Which one is not a part of transcription unit in DNA?
   a) The inducer b) Promoter c) Terminator d) Structural gene

   Solution : -
   Inducer is a part of Lac operon.

7. During transcription, the DNA site at which RNA polymerase binds is called_____ .
   a) enhancer **b) Promoter** c) regulator d) receptor

   Solution : -

Transcription is when RNA is made from DNA. During transcription, RNA polymerase makes a copy of a gene from the DNA to mRNA as needed. During transcription, the DNA site at which RNA polymerase binds is called promoter. Transcription commences with one or more sigma factor protein binds to the RNA polymerase holoenzyme, allowing it to bind to promoter DNA. RNA polymerase creates a transcription bubble, which separates the two strands of the DNA helix. This is done by breaking the hydrogen bonds between complementary DNA nucleotides.

8. The transforming principle of Pneumococcus as found out by Avery, Mac Leod and McCarty was___
   a) mRNA **b) DNA** c) protein d) polysaccharide

   Solution : -
   Avery, MacLeod and McCarty [1944] showed the significance of DNA in hereditary transmission in bacteria Pneumococcus. They discovered the biochemical nature of gene.

9. If the sequence of bases in one strand of DNA is ATGCATGCA, what would be the sequence of bases on complementary strand?
   a) ATGCATGCA b) AUGCAUGCA **c) TACGTACGT** d) UACGUACGU

   Solution : -
   Adenine always pairs with thymine and cytosine always pairs with guanine. Thus, sequence of bases on complementary strand would be TACGTACGT.

10. If a hybrid DNA molecule is allowed to replicate twice in normal culture medium, the percentage of hybrid DNA will be
    a) 50% b) 12.5% **c) 25%** d) 75%

11. Genes do not occur in pairs in
    a) Zygote b) Somatic cell c) Endosperm cell **d) Gametes**

12. The wild type E. coli cells are growing in normal medium with glucose. They are transferred to a medium containing only lactose as sugar. Which of the following changes takes place?
    a) The lac operon is repressed b) All operons are induced **c) The lac operon is induced**
    d) E. coli cells stop dividing

    Solution : -
    Inducible genes are the genes which remain inactive or repressed in a cell and can be activated when a certain substrate is to be metabolised. It has been seen when lactose is added to the medium of E.coli the operon is induced and synthesis of enzymes required for degradation of lactose to glucose and galactose starts.

13. Chargaaf's rule is given as:
    a) Purines Pyrimidines b) A + U = G + C c) A + U = G + C **d) A + T/G + C = Const.**

14. Extranuclear inheritance occurs in_____
    a) peroxisome and ribosome **b) chloroplast and mitochondria** c) mitochondria and ribosome
    d) chloroplast and lysosome

    Solution : -
    The eukaryotic cell has a nuclear membrane that surrounds the nucleus in which well defined chromosomes are located. In eukaryotic cells, two cytoplasmic organelles, mitochondria and chloroplast of green plants, contain their own genetic materials.

15. Haemophilic gene does not transfer from:
    a) Haemophilic father to son b) Haemophilic mother to son c) Haemophilic father to daughter
    d) Haemophilic mother to son & daughter

16. DNA precipitation out of a mixture of biomolecules can be achieved by treatment with_____
    a) Chilled ethanol b) Methanol at room temperature c) Chilled chloroform d) Isopropanol

Solution : -

During the isolation of desired gene, chilled ethanol is used for the precipitation of DNA.

17. In negative operon _____

a) co-repressor binds with repressor b) co-repressor does not bind with repressor

c) co-repressor binds with inducer d) CAMP have negative effect on lac operon

Solution : -

The inducer is a molecule that regulates gene expression. An inducer can bind to protein repressors or activators. The lac operon is a negatively controlled inducible operon, where the inducer molecule is Lactose. If the inducer molecule is present, it binds to the repressor and changes its conformation so that it is unable to bind to the operator and thus gene expression is controlled.

18. The movement of a gene from one linkage group to another is called ___

a) Duplication **b) Translocation** c) Crossing over d) Inversion

Solution : -

Translocation is the movement of a gene from one linkage group to another linkage group. Translocation is a chromosomal abnormality occurs between nonhomologous chromosomes caused by rearrangement of parts of chromosomes.

19. Transformation experiment was first performed on which bacteria?

a) E.coli **b) Diplococcus pneumoniae** c) Salmonella d) Pasteurella pestis

Solution : -

Griffith's experiment was an experiment done in 1928 by Frederick Griffith. He performed experiments on two strains of Streptococcus pneumoniae or Diplococcuspneumoniae bacteria, a type III-S (smooth) which was virulent, and a type II-R (rough) strain which was nonvirulent. The experiment showed that bacteria bacteria are capable of transferring genetic information through a process known as transformation. Thus, the correct answer is 'Diplctcoccuspneumoniae',

20. Select the correct statement from the ones given below with respeect to dihybrid cross:

a) Genes loosely linked on the same chromosome show similar recombinatios as the tightly linked ones

b) Tightly linked genes on the same chromosome show very few recombinations

c) Tightly linked genes on the same chromosome show higher recombination

d) Genes far apart on the same chromosome show very few recombinations

21. In transgenics, expression of transgene in target tissue is determined by_____

a) enhancer b) transgene c) promoter **d) reporter**

Solution : -

A reporter gene is a gene cloned with a DNA sequence of interest inserted into an expression vector followed by transfer to target tissues. After transfer, the cells are assayed to detect the presence ofthe reporter by measuring the reporter protein or its enzymatic activity. A good reporter gene is identified easily and can be measured quantitatively when it is expressed in the tissue of interest. They are used as indicators to study gene expression in target tissue for pharmaceutical and molecular biology research.

22. Select the correct match of enzyme with its related function.

a) DNA polymerase-Synthesis of DNA strands b) Helicase-Unwinding of DNA helix

c) Ligase-Joins together short DNA segments **d) All of these**

23. Gene regulation governing lactose operon of E.coli that involves the lac I gene product is _____ .

a) Negative and inducible because repressor protein prevents transcription.

b) Negative and repressible because repressor protein prevents transcription.

c) Feedback inhibition because excess of b - galactosidase can switch off transcription.

d) Positive and inducible because it can be induced by lactose

Solution : -

F. Griffith in the year 1928, discovered we phenomenon of transformation. In his experiment, he used two strain of Streptococcus pneumoniae (Rough strain and Smooth strain).

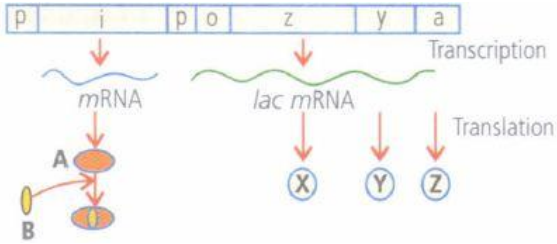
24. Genes are packaged into a bacterial chromosome by_____

a) histones **b) basic protein** c) acidic protein d) actin

Solution : -

Bacteria are prokaryotic organisms. Polyamine (basic proteins) like spermidine and cadaverine (instead histones) are associated with DNA packaging in bacteria.

25. The given figure shows lac operon and its functioning. Select the option which correctly labels A, B, X, Y and Z.



a)

A	**B**	**X**	**Y**	**Z**
Repressor	**Inducer**	**β-galacto-sidase**	**Permease**	**Transacetylase**

b)

A	**B**	**X**	**Y**	**Z**
Repressor	Inducer	Permease	β-galacto-sidase	Transacetylase

c)

A	**B**	**X**	**Y**	**Z**
Inducer	Repressor	β-galacto-sidase	Permease	Transacetylase

d)

A	**B**	**X**	**Y**	**Z**
Inducer	Repressor	β-galacto-sidase	Transacetylase	Permease

Solution : -

The lac operon consists of three structural genes (lac Z, lac Y, lac A). Lac Z codes for β-galactosidase which hydrolyses lactose to glucose and galactose. LacY codes for lac permease, a membrane-bound protein constituent of the lactose transport system which increase permeability of the cell to β-galactosides. Lac A codes of thiogalactoside transacetylase, an enzyme of uncertain metabolic function.

26. Which of the following may be true for RNA

a) A = U G = C **b) A ≠ U G ≠ C** c) A = U = G = C d) Purines = Pyrimidines

27. In Meselson and Stahl's experiment, heavy isotope ^{15}N was used In the form of

a) $Na^{15}NO_3$ **b) $^{15}NH_4Cl$** c) $K^{15}NO_3$ d) $NH_4{}^{15}NO_3$

28. If two genes are situated at some distance on chromosome such that crossing over can easily occur. Which of the following option will be true?

a) $\frac{1}{3}$of parental combination, $\frac{1}{3}$of new combination b) $\frac{3}{4}$of parental combination, $\frac{1}{4}$of new combination

c) $\frac{2}{4}$of parental combination, $\frac{2}{4}$of new combination d) $\frac{2}{4}$of parental combination, $\frac{1}{4}$of new combination

29. Which of the following nitrogen base is not found in DNA-

a) Thymine b) Cytosine c) Guanine **d) Uracil**

30. Which of the following statements is the most appropriate for sickle cell anaemia?

a) It cannot be treated with iron supplements. b) It is a molecular disease.

c) It confers resistance to acquiring malaria. **d) All of the above.**

Solution : -

Sickle cell anaemia is an autosomal hereditary disorder in which the erythrocytes become sickle shaped under oxygen deficiency as during strenuous exercise and at high altitudes. The disorder or disease is caused by the formation of an abnormal haemoglobin called haemoglobin-S. Sickle cell trait protect against malaria. Several studies have suggested that, sickle haemoglobin might get in the way of Plasmodium parasite infecting RBC's, reducing the number of parasites that actually infect the host cell and thus confer some protection against the disease.

31. Following statements describe the characteristics of the enzyme Restriction Endonuclease. Identify the incorrect statement.

    a) he enzyme binds DNA at specific sites and cuts only one of, the two strands.

    b) The anzyme cuts the sugar-phosphate backbone at specific sites on each strand.

    c) The enzyme recognises a specific palindromic nucleotide sequence in the DNA.

    d) The enzyme cuts DNA molecule at identified position within the DNA.

    Solution : -

    Restriction enzymes cut DNA molecules at a particular point by recognising a specific sequence. Each restriction endonuclease functions by inspecting the length of a DNA sequence. Once it finds its specific recognition sequence, it will bind to the DNA and cut each of the two strands of the double helix at specific points in their sugarphosphate backbone.

32. Telomerase is an enzyme which is a_____

    a) simpleprotein b) RNA **c) ribonucleoprotein** d) repetitive DNA

    Solution : -

    Telomerase was discovered by Carol W. Greider in 1984. It is a ribonucleoprotein which synthesise the rich strand of telomers in DNA the telomeres contain condensed DNA material, giving stability to the chromosomes.

33. The number of base substitution possible in amino acid codons is____

    a) 261 b) 264 c) 535 **d) 549**

    Solution : -

    There are 64 codons out of which 61 codes for amino acid. Each codon possess 3 bases which can undergo transition and transversion, so the number of base substitution possible in amino acid codons is $61 \times 3^2 = 549$.

34. Which was the last human chromosome to be completely sequenced?

    a) Chromosome 1 b) Chromosome 11 c) Chromosome 21 d) Chromosome X

    Solution : -

    The sequence of chromosome 1 was completed in May 2006. This was the last of the 24 human chromosomes -22 autosomes and X and Y - to be sequenced.

35. Gene which is responsible for the synthesis of a polypeptide chain is called:

    a) Promotor gene **b) Structural gene** c) Regulator gene d) Operator gene

36. Read the following statements

    (i) One codon codes for only one amino acid.

    (ii) Some amino acids are coded by more than one codon.

    (iii) The sequence of triplet nitrogenous bases in DNA or mRNA corresponds to the amino acid sequence in the polypeptide chain

    Give suitable terms for the characteristics of 'genetic code' as per the above statements.

a)

Degeneracy	Colinearity	Unambiguous
(i)	(iii)	(iii)

b)

Degeneracy	Colinearity	Unambiguous
(iii)	(ii)	(i)

c)

Degeneracy	Colinearity	Unambiguous
(ii)	**(iii)**	**(i)**

d)

Degeneracy	Colinearity	Unambiguous
(i)	(ii)	(iii)

37. Antiparallel strand in DNA is due to
    a) Disulphide linkage b) Hydrogen bond **c) Phosphodiester bond** d) Ionic bond

38. Escherichia coli fully labelled with N^{15} is allowed to grow in N^{14} medium. The two strands of DNA molecule of the first generation bacteria have_____
    a) different density and do not resemble parent DNA **b) different density but resemble parent DNA**
    c) same density and resemble parent DNA d) same density but do not resemble parent DNA

    Solution : -
    When E. coli fully labelled with N^{15} is allowed to grow in N^{14} medium, then after first generation of replication one of the two strands would have N^{15} and the other strand would have N^{14}. The resulting molecule would have a density which is intermediate between N^{15} DNA and N^{14} DNA. These two molecules of DNA will be similar but not same in density.

39. Which one of the following is wrongly matched?
    a) Transcription - Writing information from DNA to tRNA.
    b) Translation - Using infomation in mRNA to make protein
    c) Repressorprotein- Binds to operator to stop enzyme synthesis
    d) Operon - Structural genes, operator and prouoter

    Solution : -
    Transcription - Writing information from DNA to tRNA. This is wrongly matched, Transcription is process of copy information from DNA template to mRNA by using RNA polymerase for protein synthesis, It is completed in three steps - Initiation, elongation and termination.

40. DNA replication takes place at_____ phase of the cell cycle.
    a) G_1 **b) S** c) G_2 d) M

    Solution : -
    In eukaryotes, the replication of DNA takes place at S-phase of the cell cycle. The replication of DNA and cell division cycle should be coordinated. A failure in cell division after DNA replication results into chromosomal anomaly.

41. How many character of pea were chosen by Mendel:
    a) 7 b) 2 c) 4 d) 3

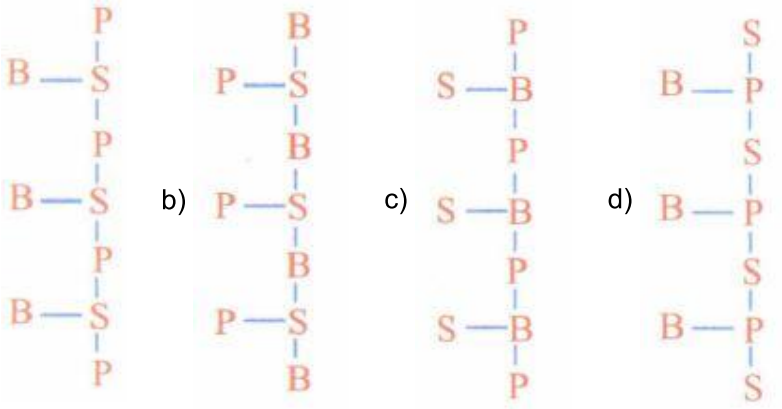
42. A gene showing codominance has:
    a) both alleles independently expressed in the heterozygote b) one allele dominant on the other
    c) alleles tightly linked on the same chromosome d) alleles that are recessive to each other

43. The first amino acid in any polypeptide chain of prokaryote is always
    a) Formylated methionine b) Formylated arginine c) Lysine d) Methionine

44. The approximate number of genes contained the genome of Kalpana Chawla was
    a) 40000 **b) 30000** c) 80000 d) 100000

45. Chemically, RNA is_____(i)_____reactive and_____(ii)_____ stable as compared to DNA.
    a) (i) equally, (ii) equally **b) (i) less, (ii) more** c) (i) more, (ii) less d) (i) more, (ii) equally

46. Which of the following shows the correct positions of the phosphate (P), sugar (S) and base (B) molecules in the given line diagrams representing the structure of DNA?



a) b) c) d)

Solution : -

DNA helix is made up of two polynucleotide chains, where the backbone is constituted by sugar-phosphate and the bases project inside.

47. DNA differs from RNA in

a) Only Sugar b) Nitrogen base only **c) Nitrogen base and sugar** d) None

48. How does steroid hormone influence the cellular activities?

a) Changing the permeability of the cell membrane

b) Binding to DNA and forming a genehormone complex

c) Activatiug cyclic AMP located on the cell membrane d) Using aquaporin channels as second messenger

Solution : -

Steroid hormones directly enter into the cell and bind with intracellular receptors in nuclétis to form hormone receptor complex. Hormone receptor complex interacts with the genome.

49. Synthesis of DNA on RNA template was first observed in

a) Bacteria b) Plant **c) Virus** d) Both (1) & (2)

50. A single strand of nucleic acid tagged with a radioactive molecule is called

a) Plasmid **b) Probe** c) Vector d) Selectable marker

51. A parent having autosomal dominant disease then what will be the probability of diseased offspring (irrespective of sex of the chlid):

a) 90% b) 10% c) 75% **d) 100%**

52. Which of the following steps in transcription is catalysed by RNA polymerase?

a) Initiation **b) Elongation** c) Termination d) All of the above

Solution : -

There is single DNA-dependent RNA polymerase that catalyses transcription of all types of RNA in bacteria. RNA polymerase binds to promoter and initiates transcription (Initiation). It uses nucleoside triphosphates as substrate and polymerises in a template dependent fashion following the rule of complementarity. It somehow also facilitates opening of the helix and continues elongation. Only a short stretch of RNA remains bound to the enzyme. Once the polymerases reaches the terminator region, the nascent RNA falloff, so also the RNA polymerase. This results in termination of transcription. The RNA polymerase is only capable to catalysing the process of elongation. It associates transiently with initiation-factor (cr) and termination-factor (p) to initiate and terminate the transcription respectively. Association with these factors alter the specificity of the RNA polymerase to either initiate or terminate.

53. The net electric charge on DNA and histones is

a) both positive b) both negative **c) negative and positive, respectively** d) zero

Solution : -

DNA is much more organised in eukaryotic chromatin and is associated with a variety of proteins most prominent of which are histones. Histones are rich in the basic amino acid residues lysines and arginines. Both the amino acid residues carry positive charges in their side chains. Histones are organised to form a unit of eight molecules called as histone octamer. The negatively charged DNA is wrapped around the positively charged histone octamer to form a structure called nucleosome.

54. You have created a fusion between trp operon and lac operon which encodes the enzymes for tryptophan biosynthesis, under the regulatory control of the lac operator. Under which of the following conditions will tryptophan synthase be induced in the strain that carries the chimeric operator fused operons?

a) Only when both lactose and glucose are absent. b) Only when both lactose and glucose are present.

c) Only when lactose is absent and glucose is present

d) Only when lactose is present and glucose is absent.

Solution : -

As the chimeric operon is under control of operator gene of lac operon, it will be functional only in the conditions required for lac operon to be functional. In lac operon lactose function as inducer hence its presence in medium is essential for proper functioning while glucose inhibits its function. So, the chimeric operon will produce tryptophan only when lactose is present and glucose is absent in the medium.

55. The length of DNA molecule greatly exceeds the dimensions of the nucleus in eukaryotic cells. How is this DNA accommodated?

a) deletion of non-essential genes **b) super-coiling in nucleosomes** c) DNase digestion

d) through elimination of repititive DNA

Solution : -

According to nucleosome model the packaging of histone proteins and DNA in the chromatin material which forms the chromosomes.

56. Phenotype of an organism is the result of-

a) Mutations and linkages b) Cytoplasmic effects and nutrition

c) Environmental changes and sexual dimorphism **d) Genotype and environment interaction**

57. Which one is not applicable to RNA?

a) Complementary base pairing b) 5'phosphoryl and 3' hydroxyl ends c) Heterocyclic nitrogenous bases

d) Chargaff's rule

Solution : -

For a double stranded DNA, the ratios between Adenine and Thymine and Guanine and Cytosine are constant and equals one is Chargaff's rule.

58. In the genetic dictionary, there are 64 codons as_____

a) 64 amino acids are to be coded b) 64 types of tRNAs are present

c) there are 44 non-sense codons and 20 sense codons **d) genetic code is triplet**

Solution : -

It has been found that a sequence of 3 consecutive bases in a DNA molecule codes for one specific amino acid. So, genetic code is a triplet code and there are 64 triplets which are called codons 4 x 4 x 4 =64 of nitrogen bases for protein synthesis.

59. A molecule that can act as a genetic material must fulfill the traits given below, except:

a) It should be able to generate its replica **b) It should be unstable structurally and chemically**

c) It should provide the scope for slow changes that are required for evolution

d) It should be able to express itself in the form of Mendelian characters

Solution : -

Fact.

60. DNA elements, which can switch their position, are called_____ .

a) exons b) introns c) cistrons **d) transposons**

Solution : -

Transposons are genetic elements varying from 750 base pairs to 40 kilo base pairs in length and can move from a site in one genome to another site in the same or in a different genome.