Let us Practice

Exercise I

1. The biochemical component of erythrocyte membrane determining blood group is (3rd NSEB)
   (a) lipoprotein (b) glycoprotein
   (c) phosphoprotein (d) haemoprotein

2. If two genes are very closely set on a chromosome, the crossing over between the two is (2nd NSEB)
   (a) impossible (b) very rare
   (c) frequent (d) uncertain

3. If the haploid number for a species is three, each dividing diploid cell during mitosis will have how many chromatids at anaphase?
   (a) 3 (b) 6
   (c) 9 (d) 12
   (e) 18

4. The statement "All biological catalysts are proteins" is no more valid because of the discovery of (FINBO)
   (a) ribonuclease (b) ribozymes
   (c) lysozymes (d) enzymes

5. In a living cell, the site of anaerobic respiration is (1st NSEB)
   (a) cytoplasm (b) mitochondria
   (c) cell membrane (d) cell wall

6. Glutathione (G-SH) is present in high concentration in red blood cells and performs major function of
   (a) reducing agent
   (b) oxidizing agent
   (c) enzyme co-factor
   (d) oxygen coupler

7. The enzymes of Krebs' cycle are localized in the
   (a) mitochondrial matrix
   (b) perimitochondrial chamber
   (c) inner mitochondrial membrane
   (d) outer mitochondrial membrane

8. In the cell cycle, replication of chromosomal DNA takes place in (1st NSEB)
   (a) prophase (b) anaphase
   (c) interphase (d) telophase

9. Synthetic DNA template when mixed with an enzyme phosphatase, will give (1st NSEB)
   (a) nucleotide (b) nucleoside
   (c) nucleosome (d) nitrogenous base

10. Biochemical reagents are widely used for detection of biomolecules. A reagent that specifically detects a carbonyl group (C=O) in a biomolecule will yield a positive test with
    (a) protein (b) fatty acid (1st NSEB)
    (c) carbohydrate (d) All of these

11. Cholesterol
    (a) plays an important role in controlling the fluidity of cell membranes
    (b) holds membrane bound proteins within the lipid bilayer
    (c) often has a role as a hormone receptor on the surface of membranes
    (d) is a water soluble molecule found in both prokaryotes and eukaryotes
    (e) is a toxic molecule not found in the body of healthy humans

12. A high surface area to volume ratio in cells is important because it
    (a) enables efficient transfer of wastes, nutrients and gases across the cell membrane
    (b) prevents overproduction of cell proteins due to structural limitations
    (c) allows many antigens on the surface for identification of self and non-self
    (d) provides for better structural support to cope with external physical pressure
    (e) allows for cell division

13. Endocytosis is a process whereby a cell
    (a) digests itself
    (b) engulfs and internalizes material using its membrane
    (c) identifies other cells within its immediate surroundings
    (d) enables the extracellular digestion of large molecules
    (e) divides its cytoplasm during mitosis

14. Which statement is false?
    (a) During the process of exocytosis, the lumen [illegible] the inside of the plasma (cell) membrane
    (b) Cilia, microtubules and flagella are all associated with movement in cells
    (c) A function of the nucleus is duplicating the genes for cell division
    (d) Proteins that are to be secreted by the cell are generally synthesized by membrane-bound ribosomes
    (e) Active transport involves movement of molecules into a cell against their concentration gradient

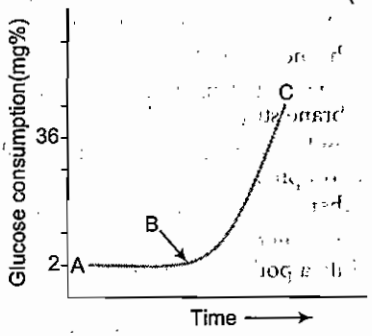
15. A molecular biologist is doing some experiments with nucleotide bases of *m*RNA. He inserts three nucleotides, *i.e.*, cytosine (C) between the third and fourth bases. The resulting RNA chain will transcribe for a protein (1st NSEB)
    (a) which will be very different
    (b) which is essentially the same as before
    (c) non-protein will be transcribed
    (d) a hybrid protein will result

16. A unit composed of sugar and nitrogen base linked by glycosidic bond is
    (a) purine (b) glycoside
    (c) nucleoside (d) nucleotide

17. Krebs' cycle is a
    (a) catabolic pathway (b) anabolic pathway
    (c) amphibolic pathway (d) None of these

18. Cyanide had a direct action upon (3rd NSEB)
    (a) glycolysis
    (b) cytochrome oxidase
    (c) membrane transport
    (d) flavoprotein

19. Animal cells are suspended in a culture medium that contains excess glucose. The graph below shows glucose utilization under different growth conditions. (A), (B), and (C) in the graph indicate (2nd INBO)



    (a) A–Anaerobic respiration
        B–Introduction of O_2 to culture medium
        C–Aerobic respiration
    (b) A–Aerobic respiration
        B–Introduction of CO_2 to culture medium
        C–Anaerobic respiration
    (c) A–Aerobic respiration
        B–Supply of organic triphosphate
        C–Aerobic respiration
    (d) A–Aerobic respiration
        B–Introduction of —CO
        C–Anaerobic respiration

20. The cell membrane of eukaryotic cells can not
    (a) be involved in receptor mediated endocytosis
    (b) undertake pinocytosis
    (c) undertake phagocytosis
    (d) stop the diffusion of water

21. Which of the following statements are correct for mammalian cell membranes?
    I. There are two phospholipid layers coating a layer of protein.
    II. They contain cholesterol to moderate fluidity.
    III. They are supported on the inner cellular layer by a thin peptose layer. (2nd ABO)
    (a) I only (b) II only
    (c) I and II (d) I, II and III

22. Hexose monophosphate shunt is an additional pathway for oxidation of glucose. It generates NADPH essential for fatty acid synthesis. This pathway predominates in all except one of the following tissues. This tissue is (2nd NSEB)
    (a) adipose tissue
    (b) lactating mammary gland
    (c) adrenal cortex
    (d) skeletal muscle

23. Organisms surviving at very high and very low temperatures show various adaptations. Plasma membrane of these organisms show marked difference in (2nd NSEB)
    (a) content of phospholipids
    (b) content and type of integral proteins
    (c) content and type of peripheral proteins
    (d) content of unsaturated fatty acids

24. All of the followings are accurate regarding the processes of transcription and translation, except
    (a) transcription and translation take place outside the nucleus
    (b) transcription and translation are the processes for making enzymes

(c) transcription and translation are the procesess for making proteins

(d) transcription and translation occur when a cell is doing its regular cell work

25. Conside al cell of dimensions 'm' units. It occupies ne of m^3 and its surface area is $6 m^2$. Another cell that has a same volume, shows a long thready structure with length 16 m. The surface area of the latter cell will be (2nd INBO)

(a) more by the factor of 2.69

(b) less by a factor of 0.37

(c) same as cubical cell

(d) different by a factor of 16.1

26. Telomeres are the nucleotide sequences located at the extremity of the chromosome. The length of telomeres diminishes automatically at each cell division by a simple mechanical effect linked to the replication of genome. The telomere reduces to a critical length, which does not allow replication anymore. The cell has a particular enzyme, telomerase which can lengthen telomeres. Then (2nd INBO)

(a) activation of telomerase antibodies can result in cellular immortalization

(b) recovery of telomere length can result in cell death

(c) killer T-cells that are directed against telomerase expressing cells can destroy cancer cells

(d) None of the above

27. Which statement best describes the process of endocytosis?

(a) A vesicle within a cell fuses with the plasma membrane and releases its contents to the outside

(b) Solid particles or liquids are taken up by a cell through invagination of the plasma membrane

(c) Investment in one cytosis reduces the ability of the parent to assist another cytosis

(d) One region of an embryo directs the development of a neighbouring region of an embryo through movement of cells

(e) An organism obtains its energy from light and organic compounds

28. Choose the answer that has the following events of protein synthesis in the proper sequence.

I. An aminoacyl *t*RNA binds to the A site

II. A peptide bond form.

III. *t*RNA leaves the P-site and the P-site remains vacant.

IV. Small ribosomal sub-unit associates with *m*RNA.

V. Translocation of the *t*RNA to the P-site.

(a) I, III, II, IV, V (b) II, IV, V, I, III

(c) IV, I, II, V, III (d) IV, I, III, II, V

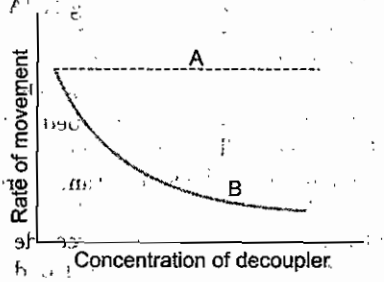
(e) V, IV, III, II, I

29. Smooth endoplasmic reticulum is specialized for the synthesis of lipids and steroids. These organelles are found predominantly in

(a) pancreas (b) ovary (4th NSEB)

(c) reticular cells (d) blood

30. The graph depicts the effect of decoupler on the movement of solutes across a membrane. 'A' and 'B' represent (4th NSEB)



(a) facilitated diffusion and coupled transport respectively

(b) active transport and diffusion respectively

(c) coupled transport and facilitated diffusion respectively

(d) diffusion and active transport respectively

31. Carbonic anhydrase is an enzyme in red blood cells that catalyzes a reaction between carbon dioxide and

(a) bicarbonate (b) carbonic acid

(c) haemoglobin (d) oxygen

(e) water

32. Which one of the following pieces of evidence does not contradict the Davson-Danielli model of membrane structure?

(a) Lipids are arranged in a bilayer with hydrophobic groups in contact with each other

(b) Treatment of membranes with salts removes only a portion of the protein

(c) Freeze-fracture of membranes results in particle-studded membrane faces; particles are rarely present and ar membrane

(d) Proteins form α helical structures with hydrophobic groups that interact with the fatty acid chains of lipids

33. A mass of living cells are placed in a culture medium under aerobic conditions. The cells were supplied with labelled C_{14} glucose, as the sole source. Which one of the following is true? (1st NSEB)

(a) CO_2 will contain C_{14}
(b) Water molecules will have some radioactivity
(c) ATP will have some radioactivity
(d) Cells would burst open

34. Which of the following statements is correct about the expression of genes?

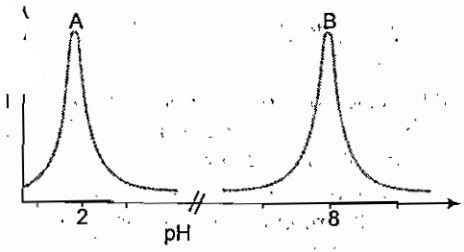
I. A single gene locus can never influence more than one trait or phenotype.
II. Several gene loci may influence the expression of a single trait or phenotype.
III. A gene will be expressed depending on environmental and life cycle factors.

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

35. Much of the DNA is localized in chromosomes of the nucleus. The other major constituent of the chromosomes is (2nd NSEB)

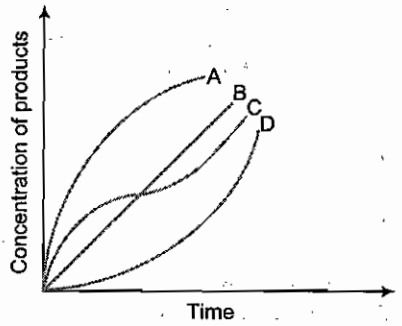
(a) RNA
(b) basic proteins
(c) acidic proteins
(d) None of these

36. A and B in the given graph are the action spectra of the two enzymes. The two enzymes are (2nd NSEB)



(a) A–Amylase B–Trypsin
(b) A–Pepsin B–Trypsin
(c) A–Chymotrypsin B–Renin
(d) A–Lactate dehydrogenase B–Amylase

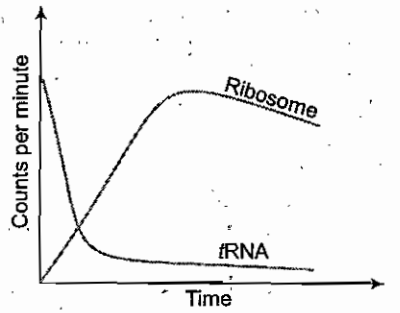
37. If the rate of a reaction is given as $K[A^-][XB]$ where $[A^-]$ and $[XB]$ are the concentrations of id if the ten constant, which of the following curve represents the correct variation of reaction rat with time? (3rd NSEB)



(a) A (b) B
(c) C (d) D

38. The accompanying graph shows time curve fo the transfer of ^{14}C labelled leucine fro prelabelled *t*RNA fraction to ribosomal fractio (*m*RNA-ribosome fraction).

What does the observation support? (2nd NSEB)



(a) Adaptor hypothesis of Crick
(b) Association of ribosomes with protein synthesis (Zamecnik)
(c) Wobble hypothesis of Crick
(d) Both (a) and (b)

39. If a polynucleotide strand has 250 nucleotide the number of ways in which the four types o nucleotides can be arranged is (3rd NSEB)

(a) 4 (b) 250^4
(c) 250 (d) 4^{250}

40. The number of chiasmata are (3rd NSEB)
(a) inversely proportional to the length of the cl ies
(b) di..., p..oportional to the length of the chromosomes
(c) independent of the length of the chromosomes
(d) more in bacteria

41. The conversion of ammonia to ammonium occurs
(a) on the ribosomes of cyanobacteria
(b) on the endoplasmic reticulum of green algae
(c) spontaneously when ammonia is in water
(d) on the dry surface of soil particles

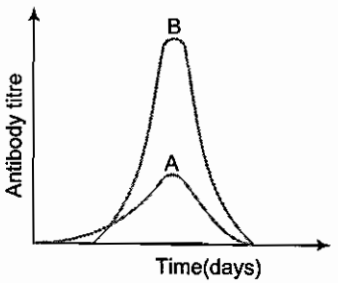
42. If cells in the process of dividing are subjected to colchicine, a drug that interferes with the functioning of the spindle apparatus, at which stage will mitosis be stopped?
(a) Anaphase (b) Prophase
(c) Interphase (d) Metaphase

43. Which statement about glycolysis is false?
(a) During glycolysis, glucose is metabolized to pyruvate with the formation of ATP and $NADH+H^+$
(b) The initial step in glycolysis requires the phosphorylation of glucose by the enzyme phosphoglucomutase
(c) The conversion of phosphoenolpyruvate to pyruvate is catalyzed by the enzyme pyruvate kinase and results in the formation of ATP
(d) The end product of glycolysis, pyruvate, can be used by yeast to produce ethanol during fermentation
(e) Glycolysis occur outside the mitochondria

44. Chloramphenicol, an inhibitor of protein synthesis, would inhibit protein synthesis in mitochondria but would not do so with regard to protein synthesis in the cytoplasm. This suggests that
(a) the mitochondrial protein synthesis and the cytoplasmic protein synthesis are of different types
(b) the enzyme machinery of protein synthesis in mitochondria function independently
(c) the mitochondria are semi-autonomous
(d) Both (b) and (c)

45. A scientist produced some mutant fungal cells that, under normal growth conditions, were much smaller, and which grew much more slowly than normal cells. When the mutant and normal cells were each grown in a glucose solution in a tightly sealed container and examined after one week, the two types of cells looked identical and had grown to the same extent. Which statement best explains these results?
(a) Each mutant fungal cell was lacking a Golgi apparatus
(b) Glucose is poisonous to fungal cells
(c) Glucose could not be used as an energy source by mutant fungal cells
(d) The mutant fungal cells had abnormal mitochondria
(e) The mutant fungal cells had abnormal lysosomes

46. Immune response in terms of antibody levels in blood is depicted below. Mark the correct interpretation (4th NSEB)



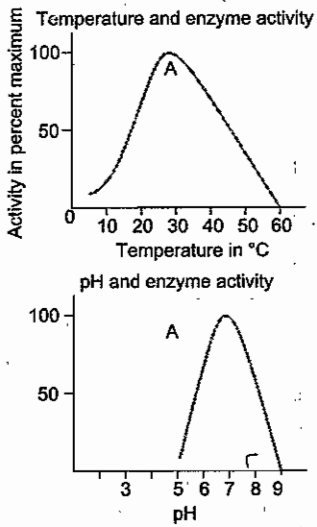
(a) 'A' and 'B' indicate response to two different antigens
(b) 'A' and 'B' indicate two different types of antibodies
(c) 'A' and 'B' indicate primary and secondary immunological response
(d) Both 'a' and 'b'

47. A scientist added a chemical (cyanide) to an animal cell to stop aerobic respiration. Which of the following is most likely to have been affected by this treatment?
(a) Active transport of substances across the plasma membrane
(b) Passive transport of substances across the plasma membrane
(c) Diffusion of substances across the plasma membrane
(d) The size of the ribosomes in the cytoplasm
(e) The thickness of lipid bilayers

48. You are given a nucleic acids that you think is single-stranded DNA, but you are not sure. You analyze the nucleotide composition of the sample. Which of the following compositions would confirm your thinking?

(a) Adenine 38%-Cytosine 12%-Guanine 12%-Uracil 38%
(b) Adenine 22%-Cytosine 32%-Guanine 17%-Uracil 29%
(c) Adenine 22%-Cytosine 32%-Guanine 17%-Thymine 29%
(d) Adenine 38%-Cytosine 12%-Guanine 12%-Thymine 38%
(e) None of the above

49. In experiments with an enzyme from a mammalian gut, the two curves labelled as A in the figures were obtained. At what temperature and pH would you perform experiments with this enzyme for optimum activity?



(a) 34°C, 7.2 pH
(b) 40°C, 8 pH
(c) 30°C, 6 pH
(d) 45° C, 7.8 pH

sequence of the *m*RNA transcribed by the
segment of DNA will be

5′ ATGTCCTTGCAACAT 3′- Sense strand
3′ TACAGGAACGTTGTA 5′ (2nd NSEB)

(a) 5′ AUGUCCUUGCAACAU 3′
(b) 5′ UACAACGUUCCUGAU 3′
(c) 5′ UACAGGAACGUUGTA 3′
(d) 5′ AUGUUGCAAGGACAU 3′

51. With respect to the process of aerobic respiration, which statement is correct?

(a) Entropy increases as the process takes place
(b) The reaction violates the second law of thermodynamics because the process is controlled by enzymes
(c) During the process, entropy is converted into free energy
(d) During the process, the free energy of the system increases
(e) During the process, the free energy remains constant

52. Which statement is correct?
During aerobic respiration
(a) the energy for oxidative phosphorylation comes from ATP
(b) the energy to make ATP comes from the potential difference in proton concentration across the inner mitochondrial membrane
(c) ATP is made by the transport of protons through a series of oxidation-reduction reactions, resulting in the transfer of electrons across the crista membrane of the mitochondrion
(d) a mole of glucose may yield from 40 to 50 moles of ATP
(e) Glucose is first converted to pyruvic acid in the mitochondrion

53. Enzymes of pentose phosphate pathway of aerobic respiration are found in
(a) mitochondria
(b) mitochondria and cytosol
(c) cytosol
(d) cytosol and ER

54. Which statement is false?
(a) NADH dehydrogenase is the terminal electron acceptor of the electron transport chain
(b) $O_2 + 4H^+ + 4e^- \longrightarrow 2\ H_2O$
(c) The electron transport chain uses electrons from the oxidation of glucose to drive proton pumps
(d) The ultimate acceptor of electrons harvested from pyruvate is oxygen gas which is reduced to form water
(e) The oxidation of glucose to two pyruvate molecules from glycolysis yields two ATP molecules

55. Which statement about starch metabolism is false?
(a) Starch is synthesized from an intermediate product of the Calvin cycle
(b) [illegible] e respiration of the breakdown of starch occurs in the cytosol (the soluble aqueous portion of the cytoplasm)
(c) Hydrolytic enzymes catalyze the breakdown of starch to free sugar
(d) Starch is a linear and/or branched polymer of glucose
(e) Amylase enzyme from human saliva degrades starch

56. Which statement about the light reactions of photosynthesis is false?
(a) Photosystems I and II are located in the stroma of the chloroplast
(b) Photosystem I and II are linked by a chain of electron carriers that is similar to that found in mitochondria
(c) During photophosphorylation, water is oxidized to form H^+ and O_2 yielding electron to photosystem II
(d) Chlorophyll pigments have an absorption spectrum with pronounced peaks in the red and blue wavelengths
(e) Protons diffuse through protein channels which are ATP-synthase molecules

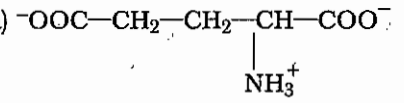
57. The synthesis of protein that have carbohydrates and lipid molecules attached is carried out by
(a) only ribosomes using especially modified amino acid with oligosaccharides and lipid attached
(b) ribosomes, the endoplasmic reticulum and lysosome
(c) ribosome and enzyme found within both the endoplasmic reticulum and mitochondria
(d) enzymes outside the cell membrane as only pure proteins molecules are able to be made within a cell

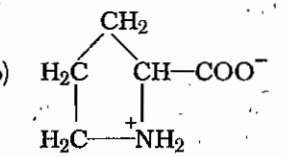
58. If one mole of glucose and six moles of oxygen yield six moles of carbon dioxide and six moles of water, when completely metabolized in a living cell, the net energy yield should be
(a) two ATP molecules
(b) two NADH and two ATP molecules
(c) six NADH and two $FADH_2$ molecules
(d) 686 kilocalories
(e) 686 kilocalories for each of the two turns of the Krebs' cycle (citric acid)

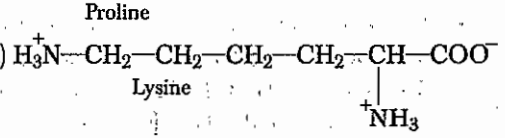
59. Once transcribed, eukaryotic *m*RNA typically undergoes substantial alteration that result primarily from
(a) excision of introns
(b) fusion into circular forms known as plasmids
(c) linkage into histone molecules
(d) union with ribosome

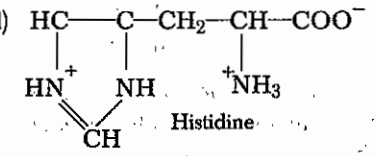
60. Which statement about the Calvin cycle is false?
(a) $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$
(b) The five-carbon sugar ribulose bisphosphate is the acceptor molecule for CO_2
(c) Two molecules of phosphoglyceraldehyde (PGAL) combine to form one molecule of glucose
(d) Phosphoglycerate molecules are phosphorylated using ATP and then reduced to PGAL by NADPH

61. Three properties (I, II, III) of an amino acid are given. Study the structure and mark one amino acid which has all the three properties.
I. Contain an imino group.
II. With ninhydrine formed a yellow derivative.
III. Is a non essential amino acid.

(a) 
Glutamic acid

(b) 
Proline

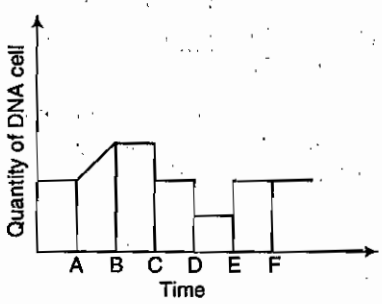
(c) 
Lysine

(d) 
Histidine

62. The chemiosmotic hypothesis attempts to explain
(a) the movement of water into the chloroplast and its use in photosynthesis
(b) the coupling of ATP formation to electron flow in an electron-transport chain
(c) the movement of lipid-soluble molecules through a membrane
(d) the movement of NADH from the cytoplasm into the mitochondrion
(e) the coupling of chemical gradients to osmosis

63. A bacterial *m*RNA with a length of 360 nucleotides in length codes for a protein of
(a) roughly 360 amino acids
(b) roughly 1080 amino acids
(c) exactly 120 amino acids
(d) less than 120 amino acids

64. What letter indicates the end of meiosis I?



(a) A (b) B
(c) C (d) D

65. In enzyme industry, glucose isomerase is effectively used for (2nd NSEB)
(a) hydrolysis of sucrose
(b) clarification of fruit juices
(c) fructose production from corn syrup
(d) deoxygenation of fruit juices

n the base composition of DNA from bacterium *Mycobacterium tuberculosis* was determined, 18% of the bases were found to be adenine. What is the [G] + [C] content?
(a) 18% (b) 32%
(c) 36% (d) 64%

67. The correct sequence of organelles without binding membrane and with single, double and triple binding membranes is (3rd NSEB)
I. sphaerosomes (plant lysosomes)
II. transposomes (in ovarian follicular cells)
III. ribosomes
IV. mitochondria
(a) III, I, IV, I
(b) II, I, IV, III
(c) III, I, IV, II
(d) II, IV, III, I

68. Which of the following statements is false? "For almost every foreign antigen you may encounter"
(a) a subset of β-cells already exists in your body specific to it
(b) a subset of T-helper cells already exists in your body that expresses a T-cell receptor specific to it
(c) a subset of phagocytes already exist in your body that phagocytizes only that antigens
(d) a subset of antigen-specific antibodies already exists, but are not yet producted in large numbers

69. Which of the following correctly ranks the following structures in terms of size, from smallest to largest? Antibody molecule (Ab), White blood cell (WBC), mitochondria (Mi), lymph node (LN), Spleen (S) and Antigenic determinant (Ad).
(a) Mi-Ab-Ad-WBC-S-LN
(b) Ad-Ab-Mi-WBC-LN-S
(c) Ab-Ad-WBC-LN-Mi-S
(d) Ad-Ab-WBC-Mi-S-LN

70. Which of the following is concerned with the synthesis and transport of lipids and steroid within a cell?
(a) Pinocytic vesicle
(b) Nuclear membrane
(c) Smooth endoplasmic reticulum
(d) Rough endoplasmic reticulum

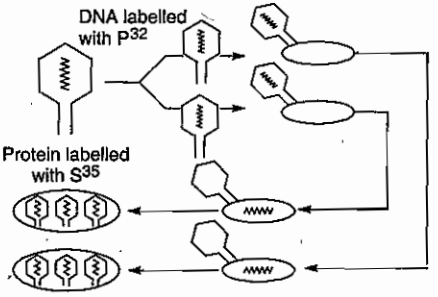
71. Which of these units concerned with regulation of transcription of constituent gene not considered as a part of operon? (3rd NSEB)
(a) Regulator gene
(b) Regulator gene and promotor gene
(c) Promoter gene and operator gene
(d) Operator gene

72. The mitotic apparatus in a dividing cell is best studied by
(a) phase contrast microscope, where phase of the li anged according to refractive index
(b) polarization microscope, where molecular arrangement affects speed and direction of polarized light
(c) electron microscope, where resolution is enhanced due to use of electrons
(d) scanning electron microscope, where electrons are scattered or emitted from specimen's surface

73. In a synthetic DNA template, every third purine base is replaced by another purine and pyrimidine by another pyrimidine. The resultant gene will code for a protein that is (1st NSEB)
(a) most likely to be identical to the one obtained before replacement
(b) is strikingly different in its amino acid composition
(c) is heat stable due to increased proline content
(d) will contain more percent of amino acids with non-polar *R* groups

74. The reappearance of nucleolus towards the end of mitosis is attributed to (3rd NSEB)
(a) nuclear envelope
(b) the specific region of chromosome
(c) the reassemblage of some macromolecules of nucleolus, lost during prophase
(d) the rearrangement of histones present in the nucleus

75. Hershey and Chase's work in 1952 is summarized in the drawing given below. Study it and mark the most important feature of this work



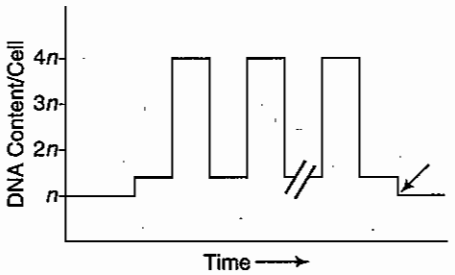
(a) T_2 particles were grown for the first times on *E. coli*
(b) Radioactive isotopes were used in this biological experiments
(c) Protein coat showed high level of S^{35}
(d) It was the phage DNA and not protein which entered the bacterial cell and gave rise to number of phage progeny

76. The *lac* operon needs a helper protein that, by binding to the promotor and facilitating attachment of RNA polymerase, accelerate the rate of transcription. This protein is called
(a) catabolic activator protein
(b) inactive repressor protein
(c) essential metabolic protein
(d) amino acid activating enzyme

77. Chromosome number is reduced during meiosis because the process consists of
(a) two cell divisions without any chromosome replication
(b) a single cell division without any chromosome replication
(c) two cell divisions in which half of the chromosomes are destroyed
(d) two cell divisions and only a single round of chromosome replication
(e) four cell divisions with no chromosome replication

Exercise II

1. Given diagram shows variations in the amount of DNA of a developing eukaryote. What the arrow denotes? (FINBO)



(a) First meiotic anaphase
(b) Second meiotic anaphase
(c) Mitotic anaphase
(d) Telophase

2. Following are some statements regarding the primary and secondary antibody response in humans. All the statements are correct, except (2nd INBO)
(a) lag period (time between the introduction of antigen and appearance of antibodies in blood) in primary response is longer than that in secondary response
(b) predominant iso-type produced in primary response is IgM while that in secondary response is IgG
(c) primary antibodies have a higher affinity for antigen as compared to secondary antibodies
(d) thymus independent antigens produce only IgM type of antibodies in both primary and secondary response

3. Following are some statements regarding replication of a DNA and transcription.
I. During the replication even the introns are replicated, whereas introns are not transcribed during the process of transcription.
II. Some of the bases that are incorporated during replication differ from those that are incorporated during transcription.
III. There is no need of unwinding of strands during transcription, whereas replication process needs the unwinding of DNA strands.
IV. DNA-RNA hybrid is formed at some stage during both the processes.
The correct statements are (2nd INBO)
(a) I and II (b) II and III
(c) I and IV (d) II and IV

4. A cell membrane contains 60% protein (density 1.33) and 40% phospholipid (density 0.92). When the membrane is centrifuged in NaCl solution of density 1.03 gm/cm^3, it will (1st NSEB)
(a) float
(b) sediment
(c) layer in the centre of the NaCl column
(d) fragments in the NaCl columns

5. Native DNA sample if first boiled for a few minutes and then cooled in a high salt concentration will show (2nd NSEB)
(a) initial rise and then fall in UV absorbance
(b) constant UV absorbance
(c) initial drop and then rise in UV absorbance
(d) steady drop in UV absorbance

6. The durations of mitotic stages in two situations are tabulated below.

Phase	Duration of Mitotic Stages (in Minutes)	
	A	B
Interphase	1356 (22.6 h)	870 (14.5 h)
Prophase	126	54
Metaphase	24	14
Anaphase	5	3
Telophase	22	11
Total	1533 (25.6 h.)	952 (15.9 h.)

Following are some inteperetations
I. 'A' and 'B' indicate the same plant tissue grown at higher and lower temperature respectively.
II. 'A' indicates a slow growing plant species and 'B' indicates a fast growing plant species.
III. 'A' and 'B' indicate mitosis taking place in the slow and fast growing cells respectively of the same plant.
IV. Both 'A' and 'B' indicate dormant plant tissues with excessively long interphase.
The correct interpretations is/are. (2nd INBO)
(a) I and IV (b) II and III
(c) only IV (d) only II

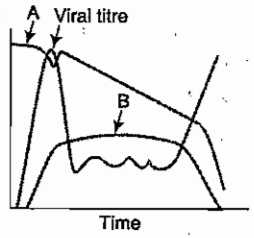
7. In a chloroplast devoid of photosystem-II, which of the following events will be absent? (1st NSEB)
(a) Photolysis of water
(b) Synthesis of ATP

(c) Photoexcitation
(d) Cyclic electron transfer

8. The conversion of pyruvate to acetyl Co-A and CO_2
(a) i le
(b) occurs in cytosol
(c) depends on the co-enzyme biotin
(d) involves the participation of lipoic acid

9. A large protein molecule, when dissolved in water with a pH of 4.0 has a + 2 charge. At pH 7.0, the molecule has no charge (neutral). What would you expect the charge on the molecule to be in water that has a pH of 20.0?
(a) A positive charge or unknown value
(b) + 2
(c) Between + 2 and neutral
(d) Neutral
(e) A negative charge of unknown value

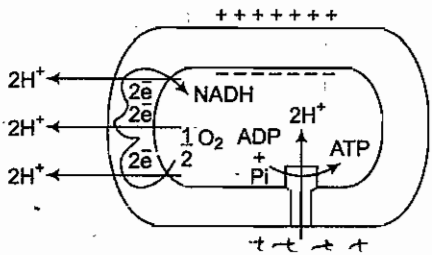
10. The course of infection with HIV is shown in the graph. Lines A and B indicate (4th NSEB)



[V. V. Good]

(a) A–Antigen concentration
B–Helper cell concentration
(b) A–Antigen concentration
B–Interferon concentration
(c) A–Interferon concentration
B–Antibody titre
(d) A–Helper cell concentration
B–Antibody titre

11. Mechanism of phosphorylation is depicted in the diagram below. Study it carefully and mark the correct option. (2nd INBO)



gradient

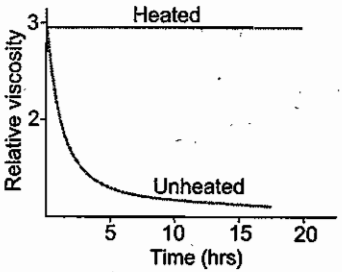
(a) The diagram depicts photosynthetic phosphorylation taking place in the chloroplast. The incident light should be shown in the diagram
(b) The diagram depicts oxidative phosphorylation taking place in mitochondria. However, the flow of electrons should be shown in reverse direction
(c) Diagram depicts the basic process of both oxidative as well as photosynthetic phosphorylation. However, the proton concentration should be high inside and low outside
(d) The diagram correctly depicts the oxidative phosphorylation occurring in all heterotrophic organisms

12. The development of the current idea that DNA is the genetic material was first demonstrated by Griffith in his famous experiment using smooth and rough strains of Pneumococci. DNA was then called as 'transforming principle'. Consider the following experiment in this connection.

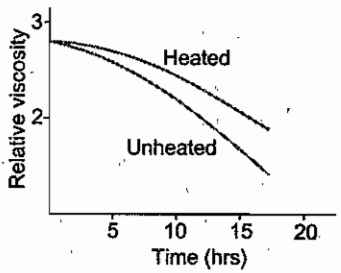
Steps

I. Pneumococci of smooth strains were first grown on culture media.
II. Cells were separated and lysed to collect cell free extract.
III. Transforming principal was isolated from the extract and distributed into two test tubes.
IV. To each test tube crude enzyme preparation containing depolymerase or deoxyribonucleate was added.
V. Only one test tube was heated to 65° C to after adding the enzyme depolymerase

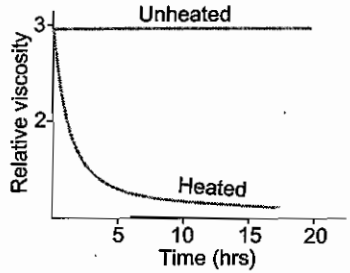
(a)



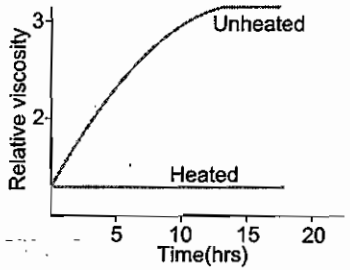
(b)



(c)



(d)



13. Normal concentration of solutes 'A' and 'B' in blood capillaries is 0.9% each. The data indicates that the solutes 'A' and 'B' pass the membrane by (4th NSEB)

Solute 'A'		Solute 'B'	
Amount of solute in food (g/100 mL)	Amount absorbed (g)	Amount of solute in food (g/100 mL)	Amount absorbed (g)
0.5	0.3	0.8	0
1.0	0.6	1.0	0.05
1.5	1.0	2.0	0.8

(a) simple diffusion
(b) capillary action
(c) active transport and simple diffusion respectively
(d) facilitated diffusion and carrier transport respectively

14. If the sequence of nucleotide on *m*RNA)-AUGCUGGCAUCUGUA-P, where resents phosphate radical and (OH)–hydroxyl, radical, in which direction translation will occur? (3rd NSEB)
(a) Left to right (b) Right to left
(c) Both (a) and (b) (d) Data is insufficient

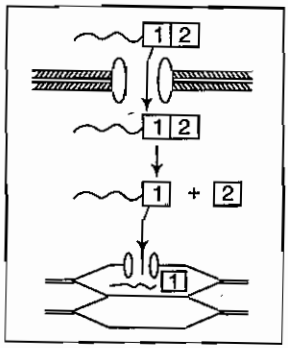
15. An animal was discovered which had DNA that contained an additional two nucleotide bases. These two nucleotide bases form a base pair, so that the DNA contains six different bases which form three base pairs. What would be the maximum number of amino acids that its DNA could code for, assuming that there are three stop codons that do not code for an amino acid and that there are the normal three bases per codon?
(a) 61 (b) 65
(c) 125 (d) 141
(e) 213

16. The description of 'gate type' of amino acids is appropriate in the case of
(a) valine and alanine
(b) serine and methionine
(c) glutamic acid and aspartic acid
(d) methionine and citrulline

17. The figure shows the movement of chromosome during mitosis. Curve A shows the mean distance between the centromeres of the chromosome and the corresponding pole of the spindle. At what time did the anaphase start?
(a) 0 minute
(b) Somewhere between 0 and 10 minutes
(c) 10 minutes
(d) After more than 10 minutes

18. Curve B represents the distance between
(a) the chromosomes in the metaphase
(b) the centrioles
(c) chromatids of a chromosome
(d) homologous chromosomes during the anaphase

19. Given figure depicts transport of plastocyanin from cytosol to chloroplast. The sequence (1) in the figure is (2nd NSEB)

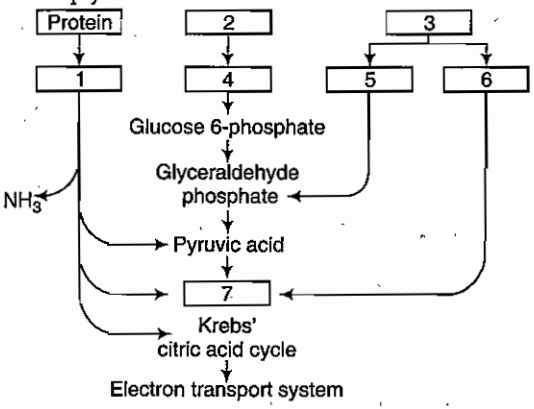


(a) stromal import sequence
(b) thylakoid targetting sequence
(c) chlorophyll precursor molecule
(d) receptor transport protein

20. Oxygen content reduction makes the glycolyse (glycogenesis) intensity increased due to
(a) increase of ADP concentration in cell
(b) increase of NAD^+ concentration in cell
(c) of ATP concentration in cell
(d) of concentration of peroxides and free radicals

21. Which of the following types of amino acids will show the least interaction with water molecules? **(FINBO)**
(a) Neutral polar (b) Neutral non-polar
(c) Aliphatic (d) Aromatic charged

22. The following flowchart represents the cellular respiration and its fuels. Identify the substances in empty boxes



(a) Amino acids, carbohydrate, fats, glucose, glycerol, fatty acid, acetyl Co-A
(b) Fats, acetyl Co-A, amino acid, fatty acid, carbohydrate, glycerol, glucose
(c) Fatty acid, glucose, acetyl, Co-A, glycerol, fats, carbohydrate, amino acid
(d) Carbohydrate, fats, glycerol, fatty acids, amino acid, glucose, acetyl Co-A

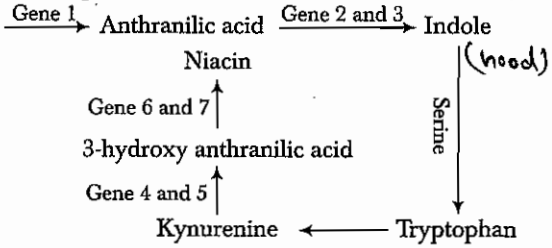
23. Coupled biochemical reactions are important in determining thermodynamic order within cells. Consider the following two reactions that occur simultaneously in cells

1, 3 biphosphoglycerate → phosphoglycerate + P_i — ($\delta G^\circ = -49$kJ)

ADP + Pi → ATP — ($\delta G^\circ = +31$ kJ)

Which of the following concerning the above partial reaction is false?
(a) The energy change of the coupled reaction, or net reaction is the sum of the energy changes of the two partial reactions and is $\delta G^\circ = -418$ kJ
(b) The coupled reaction is driven toward ATP, or occurs because the sum of the two free energy changes of the partial reactions is a negative value and yields energy to drive the reaction
(c) The overall reaction : 1, 3 – biphosphoglycerate → 3-phosphoglycerate + ATP is endergonic; it requires + 18 kJ and thus can not occur spontaneously
(d) The reactions occur during glycolysis
(e) ATP mediates the transfer of energy between exergonic reactions (that normally have relatively high free energies of phosphate transfer) and endergonic reactions

24. Niacin is an important growth factor for plants, animals and fungi. Shown below is a biochemical pathway for synthesis of Niacin in the fungus *Neurospora crassa* **(2nd INBO)**



If the fungus with mutated Gene 2 is grown on a culture containing a small amount of tryptophan
(a) fungus will not grow as no niacin will be formed
(b) fungus will grow only if supplemented with serine
(c) fungus will grow with an accumulation of anthranilic acid
(d) fungus will grow only if supplemented by both serine and indole

25. Mammals contain White Adipose Tissue (WAT) and Brown Adipose Tissue (BAT). WAT is the primary source of lipid used to produce energy in the form of ATP, whereas BAT is the primary source of thermogenesis under cold stress. Which of the following features of the mitochondrial inner membrane of BAT contributes to this effect?
(a) Increased permeabilty for protons
(b) Less of ATP synthase embedded in the membrane
(c) Absence of electron transport chain
(d) Presence of inhibitors of electron transport chain

26. Among carbohydrates, lipids, proteins and ATP, the relative energy yield in kcal per gram in best represented by
(a) lipids > carbohydrates > ATP
(b) ATP > lipids > proteins
(c) lipids > ATP > carbohydrates
(d) lipids > proteins > ATP

27. Following is the picture of a microsatellite gel of two loci from a chick, its mother and 6 males from a population. Can the biological father of the chick be ascertained from the data?

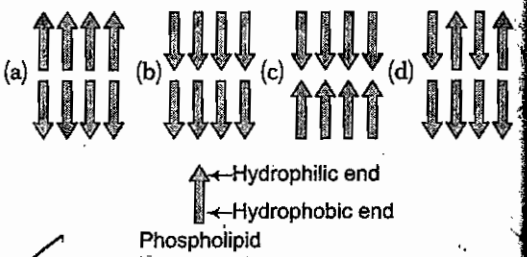
C-Chick, Mo-Mother, M-Male

(a) Yes, the biological father is male 5
(b) Yes, the biological father is male 1
(c) Yes, the biological father could either males 2 or 3
(d) No, at least three loci need to be shown for the decision

28. Which one of the following is made up of only one type of macromolecule?
(a) Virus
(b) Plasmid
(c) Ribosome
(d) Nucleosome

29. A scientist introduced bacterial plasmids into bakers' yeast. However, the cells lost these ; over a period of time. Which of the g needs to be inserted into the bacterial plasmid to overcome this problem?
(a) Centromere
(b) Yeast orgin of replication
(c) Telomere
(d) Bacterial origin of replication

30. A red blood corpuscle (RBC) was kept in a solution and treated so that it became inside-out. What will be the polarity of the phospholipid bilayer in this cell?



31. Some vitamins need to be supplied regularly i our daily diets while others may be supplie intermittently. Examples of these two type respectively, are
(a) Vit-C and Vit-D (b) Vit-A and Vit-B_6
(c) Vit-D and Vit-E (d) Vit-B_6 and Vit-B_{12}

32. Which of the following pathways depicts th generalized glycolytic scheme most accurately?
(a) Glucose → a → b → c → d → f → g → h; c → e → Pyruvate
(b) Glucose ↔ a ↔ b ↔ c ↔ d ↔ f ↔ g ↔ h; c ↔ e → Pyruvate
(c) Glucose → a ↔ b → c ↔ d ↔ f ↔ g ↔ h; c ↔ e → Pyruvate
(d) Pyruvate → Glucose → a → b → c → d → e → f → g → h

33. Membrane compositions of three cell types a tabulated below.

Cell Type	Membrane Composition (%)		
	Protein	Phospholipid	Ste
Rat liver cell	46	30	20
Maize leaf cell	40	35	8
E. coli	74	26	0

The percentage composition of inn mitochondrial membrane is likely to be
(a) 40 : 30 : 20 (b) 42 : 33 : 9
(c) 43 : 33 : 15 (d) 76 : 24 : 0

34. Which of the following facts supports t hypothesis that "viruses are not the fore-runn of cellular organisms but are derived fr them"?
(a) Viruses use the same genetic code as cellular organisms

(b) Viral proteins have the same basic amino acids as cellular organisms

(c) Viruses need the cellular machinery for replication

(d) En sential for viral replication are ide... ...o those needed for cellular replication

35. Following radioactive precursors were used to label different macromolecules in the cells. These precursors are incorporated during active synthesis of the macromolecules.

Precursors	Macromolecules
(^{3}H) Thymidine	DNA
(^{14}C) Uridine	RNA
(^{35}S) Methionine	Protein

A. In which of the following mammalian cell types would these precursors be incorporated? Indicate by using (+) for incorporation and (–) for no incorporation in the table given below.

Cell Type	(^{3}H) Thymidine	(^{14}C) Uridine	(^{35}S) Methionine
Intestinal mucosal cells			
Reticulocytes			
Neurons			
RBC			

B. If the above cell types are exposed briefly to ionizing radiations, what would be the pattern of incorporation of these precursors? Indicate by using (+) for incorporation and (–) for no incorpration in the table given below.

Cell Type	(^{3}H) Thymidine	(^{14}C) Uridine	(^{35}S) Methionine
Intestinal mucosal cells			
Reticulocytes			
Neurons			
RBC			

36. Read the following obsevations and some interpretations.

Observations

1. To preserve the sweet taste of a freshly picked corn, it is immersed in boiliing water for a few minutes.
2. The sweetness of honey decreases if it is heated.
3. Commercial fructose cannot be used as a sweetener of hot drinks.

Interpretations

I. The properties of sugar vary with temperature.

II. Enzyme that converts starch to glucose is activated due to rise in temperature.

III. Some sugars are thermostable hence their properties do not change with change in temperature.

IV. Enzyme that converts glucose to starch is destroyed due to rise in temperature.

Mark the correct interpretation against each observation.

1. _____

2. _____

3. _____

37. Malarial parasite, *Plasmodium falciparum*, is extremely sensitive to any oxidative stress in the cell. The antimalarial drug 'Primaquine' is known to induce formation of H_2O_2 and other reactive oxygen species. Fava beans are also known to contain a chemical which is responsible for raising the concentration of reactive oxygen species. Glucose-6-phosphate-dehydrogenase (G6PD) is an enzyme that helps cells produce a reductant NADPH which protects cells from oxidative damage caused by H_2O_2 and other reactive species.

Indicate whether the following statements are true or false by putting a tick mark (√) in the appropriate boxes in the table.

A. G6PD deficient individual is unlidely to develop *P. falciparum* infection.

B. Primaquine treatment in G6PD normal person is more harmful to the individual than that in G6PD-deficient person.

C. Eating Fava beans would be more beneficial for a malaria patient who is G6PD deficient than one who has normal G6PD.

D. In areas where malaria is endemic, natural selection would eliminate individuals with G6PD deficiency.

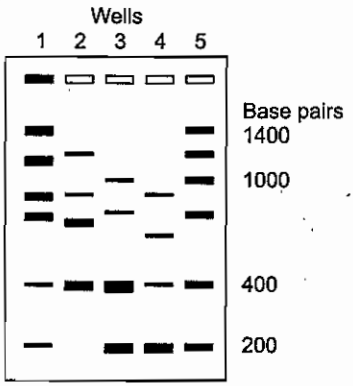
Statement	True	False
A		
B		
C		
D		

38. Dinitrophenol is a chemical that inhibits the F_0-F_1 ATP synthase molecule, located in the inner wall of mitochondrion. What would be the effects of accidental consumption of this chemical? Put tick marks (√) in the appropriate boxes in the table given below.

Effects	True	False
Increased glycongen and fat biosynthesis		
Decreased rate of metabolism		
Increased sweating		
Decreased mean body temperture		
Increase in heat production		
Decreased cardiac output		

39. Rat cell nuclei were isolated and mixed with nuclease. The DNA was then extracted and run on agarose gel. The results obtained are shown in the diagram below. The wells 1-4 represent four such DNA samples while lane 5 indicates the molecular weight markers. Mark the correct interpretation of the results by putting a tick mark (√) in the appropriate box in the table. Select from the options given below

(a) DNA from four different tissues of rat
(b) DNA mixed with nuclease for the different periods of time
(c) DNA at different stages of cell cycle
(d) Varying content of single and double stranded DNA in the cells



the cell. Three such cell lines (I, II and III) having this defect have been identified.
In order to detect the exact cause of he defect following experiments were done

No.	Experiment	Result
1.	Supernatant from I added to II.	Defect corrected
2.	Supernatant from II added to III.	Defect corrected
3.	Supernatant from II added to I.	Defect not corrected
4.	Supernatant from I added to III.	Defect corrected
5.	Supernatant from III added to I.	Defect not corrected
6.	Supernatant from III added to II.	Defect corrected

Which are the most likely causes of the defect? Put a tick mark (√) in the appropriate box in the answer sheet.

(a) I–Deficiency of enzyme PT and PG
II–Deficiency of enzyme PT
III–Deficiency of enzyme PG
(b) I–Deficiency of enzyme PT
II–Receptor of deficiency
II–Deficiency of enzyme PG
(c) I–Deficiency of enzyme PG
II–Receptor deficiency
II–Deficiency of enzyme PT
(d) I–Receptor deficiency
II–Deficiency of enzyme PT or PG
III–Deficiency of enzyme PG or PT

(a)	
(b)	
(c)	
(d)	

40. Following is the list of biomolecules that can diffuse through a synthetic lipid bilayer to a varying extent. Arrange them in the decreasing order of this ability and fill your answers in the answer sheet.

1. Ethanol
2. Water
3. O_2
4. K^+
5. DNA
6. Glucose

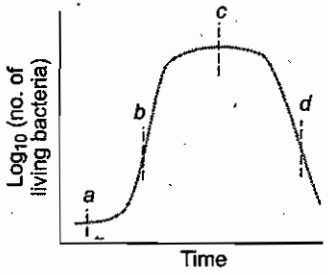
41. Lysosomes are cell organelles filled with hydrolytic enzymes. These enzymes are delivered to lysosomes through ER and Golgi apparatus. 'M6P' is a unique marker group att ese enzymes that is recognized by the receptors. Two enzymes namely, PI nvert mannose to M6P as follows

M: Intermediate $\xrightarrow{PG}$ M6P

Patients with 'I-cell disease' produce perfectly healthy hydrolases but instead of being delivered to lysosomes, in these patients, they are delivered outside

(a)	
(b)	
(c)	
(d)	

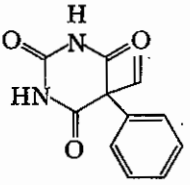
42. A typical growth curve of a bacterial population is shown. Four stages in the growth curve are marked as a, b, c and d. Match them against the correct population (P, Q, R, S). Fill in your answers in the table given below.



Population	Number of cells (in millions)	
	Living	Total
P	10	11
Q	400	450
R	225	950
S	550	950

Population	Stage
P	
Q	
R	
S	

43. Phenobarbital is a compound that is highly effective as an anticonvulsant agent. It has a pk_a of 7.41.



Using Henderson Hasselbach equation, $pH = pk_a + \log [(A^-) / (HA)]$, calculate the ratio of drug ionized to unionized in

(Fill your answers in the answer sheet.)

A. stomach (pH 2)

B. duodenum (pH 6.0)

C. jejunum (pH 7.4)

D. Which of the above pH values, is the most appropriate for the drug absorption?

E. A person has accidentally consumed the drug in higher amounts. In order to increase the excretion of the drug from renal tubules, which of the following measures will help the most? Put a tick mark (✓) in the appropriate box in the answer sheet.

(a) Administering urinary acidifiers.

(b) Administering urinary alkalinizers

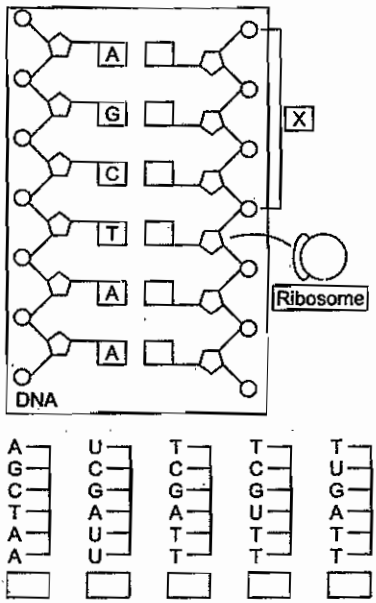
(c) Ingestion of excess water.

(d) Administering anti-diuretic drugs.

44. Match each item in column A with one in column B to which it is most closely associated.

Column A	Column B
A. Leucoplasts	1. Krebs'cycle
B. Rough ER	2. Bacterial DNA anchorage
C. Genome	3. Microtubule-organizing centre
D. Mitochondria	4. Protein modification and targeting
E. Centriole	5. Complete set of genetic instructions
F. Mesosome	6. Starch storage
G. Lysosome	7. Immunoglobulin
H. Microfilament	8. Lipid synthesis
I. Smooth ER	9. Digestive enzymes
J. Golgi apparatus	10. Cytoskeleton

45. The diagram represents a function of the nucleic acid, DNA. Based on the diagram, what is the most likely nucleotide sequence of the messenger RNA. Put an X in the appropriate box.



A	U	T	T	T
G	C	C	C	U
C	G	G	G	G
T	A	A	U	A
A	U	T	T	T
A	U	T	T	T

46. For an exponentially growing culture of micro organisms, the specific growth rate (μ) is a parameter that gives the cell biomass (g) synthesized per gram of existing cell biomass per unit of time (usually, per hour). This rate (μ) is inversely related to the doubling time of the culture, $t_d : \mu = \ln 2/t_d \approx 0.7 / t_d$. Hence, the shorter the doubling time of cells, the higher is the specific growth rate of the culture.

Two microorganisms, 'A' and 'B', were inoculated each in a fresh growht medium with an initial optical density (OD) of 0.1. A lag phase of 1 h duration was observed for both cultures. Three hours after inoculation, the OD of culture A was while that of the culture B was 1.6.

stimate the specific growth rate for culture A

stimate the specific growth rate for culture B

47. Calculate the intracellular millimolar (mM) concentration of potassium in *Escherichia coli*. If the measured potassium content is 7.8 micrograms permilligram of dry cell mass. Assume all potassium lions are free in the cytosol (not bound to macromolecules), and that the intracellular volume is 2 microlitresper milligram of dry cell mass. The atomic weight of potassiun is 39 Daltons.

48. A species of fungus can dissimilate glucose an produce ATP in two ways.

Aerobically :

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

Anaerobically :

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

This fungus is cultivated in a glucose-containin medium. Half of the total ATP production anaerobic.

1. What is the ratio between the rates of aerobi and anaerobic catabolism of glucose?
2. What is the expected oxygen consumptio (moles per mole of consumed glucose)?
3. What is the expected CO_2 evolution (mole per mole of consumed glucose)?

For calculations, assume that glucose fermented *via* the usu Embden-Meyerhof-Parnas glycolytic pathwa and that oxidative phosphorylation proceed with maximum effeciency.

49. The growth of bacteria is studied, for a period o exactly one duplication, the sample is move from an environment with a light nitroge isotope (^{14}N) to an environment with hea nitrogen isotope (^{15}N). After this, the sample again transferred to the enviroment with lig nitrogen for a period of two duplications.

1. What is the composition of double-strand DNA (in %) of light and heavy nitrog isotopes after the experiment?

A. Only light B. In between C. Only heavy

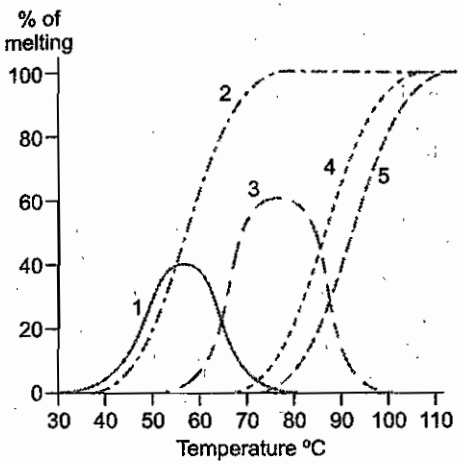
From these cells two types of *m*RNA {*m*RNA and *m*RNA (B),respectively, expressed from t different genes} were isolated. Both *m*RNAs we found to contain an identical number nucleotides. The nucleotide composition of ea mRNA was estimated as (see the table).

*m*RNA	A%	C%	G%	T%	U%
A	17	28	32	0	23
B	27	13	27	0	23

2. What is the nucleotide composition double-stranded genomic DNA in the codi part of the genes A and B, respectively.

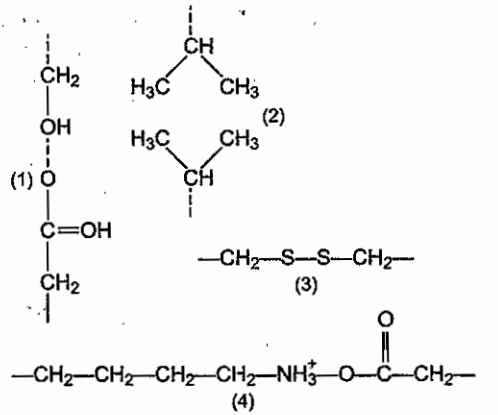
dsDNA	A%	C%	G%	T%	U%
A					
B					

3. W ve in the plot below represents the D lting profile of the coding part of g(nd B, respectively?



50. Genetic engineers construct recombinant DNA molecules using two enzymes restriction endonuclease and DNA ligase. What do these two enzymes do?
(a) They catalyze different reactions : restriction endonuclease joins fragments into larger molecules–DNA ligase hydrolyses DNA into smaller fragments
(b) They catalyze different reactions–restriction endonuclease hydrolyses DNA into smaller fragments–DNA ligase joins fragments into larger molecules
(c) They both hydrolyse DNA into smaller fragments
(d) They both join fregments of DNA into larger molecules
(e) They catalyze different hydrolysis reactions–restriction endonuclease hydrolyses bacterial plasmid DNA; DNA ligase hydrolyses DNA from eukaryotic cells

51. Various forces are important in the interactions contributing to the tertiary structure of a protein. The figure shows several possible interactions. Match the numbered interactions with their correct names.



(a) Hydrogen bond
(b) Hydrophobic interaction
(c) Peptide bond
(d) Disulphide bond
(e) Ionic bond

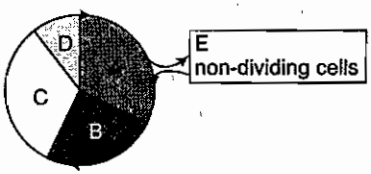
52. Treatment with anitbiotic drugs helps overcome many bactarial infections. Why is penicillin toxic to many bacteria?
(a) It interferes with DNA replication
(b) It inhibits transcription
(c) It disrupts translation
(d) It blocks protein synthesis
(e) It inhibits cell wall formation

53. A yeast extract contains all the enzymes required for alcohol production. The extract is incubated under anaerobic conditions in 1 litre of medium containing : 200 mM glucose, 20 mM ADP, 40 mM ATP, 2 mM NADH, 2 mM NAD^+ and 20 mM Pi (inorganic phosphates). Ethanol production can be summarized by the following equation

$$C_6H_{12}O_6 \longrightarrow 2\,C_2H_5OH + 2\,CO_2 + 2ATP$$

What is the maximum amount of ethanol that can be produced under these conditions?
(a) 2 mM (b) 20 mM
(c) 40 mM (d) 200 mM
(e) 400 mM

54. The diagram represents an eukaryotic cell cycle divided into 5 phases.



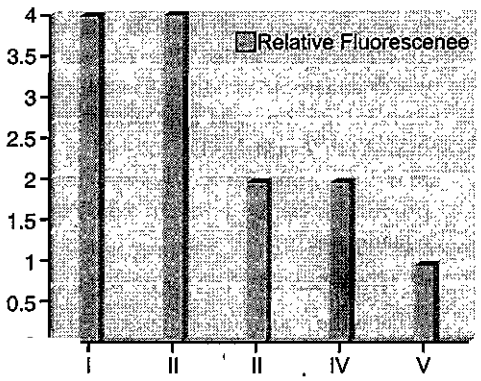
Match phases A-E of the diagram with the cell cycle stages shown in the table and match the processes F-J with the appropriate cell cycle stage shown in the Table.

F.	Cytokinesis
G.	Main growth period of the cell
H.	Duplication of DNA
I.	Quiescent cells
J.	Last stage of interphase

	Cell cycle stage	Phase [A, B, C, D, E]	Function [F, G, H, I, J]
1.	G_2		
2.	M		
3.	G_1		
4.	S		
5.	G_2		

55. The amount of DNA in a cell can be determined by measuring the fluorescence of a dye that binds in direct proportion to the amount of DNA.

The histogram below represents the fluorescence of an eukaryotic germ cell during different stages of cell division (I, II, III, IV and V).

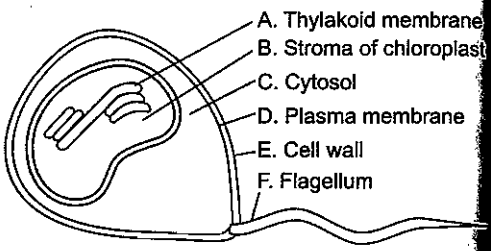


Which of the following sequences represents the correct match of stages I-V with the division stages numbered 1-5?

1. Anaphase-I of meiosis
2. Anaphase-II of meiosis
3. Cytokinesis following telophase-II
4. Prophase-II of meiosis
5. Prophase-I of meiosis

	1	2	3	4	5
(a)	II	IV	V	III	I
(b)	I	II	III	IV	V
(c)	V	IV	III	II	I
(d)	I	II	IV	III	V
(e)	IV	I	II	III	V

56. The diagram shows a single-celled green microalga from the ocean. Its single chloroplast and several other cellular components are labelled. Which components contain the following



		Answer [A/B/C/D/E/F]
1.	orange and yellow carotenoids that harvest light energy for photosynthesis	
2.	starch	
3.	macromolecular polymers that prevent the cell from bursing if it is placed in fresh water	
4.	mitochondria	

57. A widely-held theory is that mitochondria evolved from endosymbiotic bacteria. Indicate which statements support this theory by answering Yes (Y) or No (N).

		Y/
1.	Mitochondria have their own DNA	
2.	Mitochondria have their own ribosomes	
3.	Mitochondria are derived from pre-existing mitochondria by division	
4.	Human mitochondrial genes lack introns	
5.	Some mitochondrial gene DNA sequences are fimilar to those of certain aerobic bacteria	

(Good)

58. Considering the roles of membrane lipids and proteins, and the functions of the following membr atch the protein/lipid ratios given below t llowing membranes.
A. Sch ell membrane (myelin sheath)
B. Ery e (red blood cell) membrane
C. Inner mitochondrial membrane

	Protein/Lipid Ratio	Answer [A/B/C]
1	1. 1 : 1	
2	2. 4 : 1	
3	3. 1 : 4	

59. In a laboratory of Molecular Biology, the amino acids sequence of an armadillo intestine protein has been partially determined. The *t*RNA molecules used in the synthesis have the following anticodons.

3′UAC5′ 3′CGA5′ 3′GGA5′ 3′GCU5′
3′UUU5′ 3′GGA5′

Mark the DNA nucleotide sequence of the complementary chain to the DNA chain that encodes for the armadillo intestine protein.
(a) 5′-ATG-GCT-GGT-CGA-AAA-CCT-3′
(b) 5′-ATG-GCT-CCT-CGA-AAA-CCT-3′
(c) 5′-ATG-GCT-GCT-CGA-AAA-GCT-3′
(d) 5′-ATG-GGT-CCT-CGA-AAA-CGT-3′

60. In the following table, some components, processes and structures of mitochondria are presented. Match both columns and identify the correct comnbination.

1.	Porin	I.	Outer mitochondrial membrane
2.	Enzymes of mitochondrial RNA synthesis	II.	Inner mitochondrial membrane
3.	ATP synthase	III.	Mitochondrial matrix
4.	Monoamine oxidase		
5.	Enzymes of fatty acid oxidation		
6.	Coenzyme Q		
7.	Enzymes of citric acid cycle		

	I	II	III
(a)	02, 06, 07	01, 04, 07	01, 05
(b)	01, 05, 06	02, 03	02, 04, 07
(c)	01, 04	03, 06	02, 05, 07
(d)	02, 05	01, 03, 07	06, 07

(done but good)

Answers

Exercise I

1.	(b)	2.	(a)	3.	(d)	4.	(b)	5.	(a)	6.	(c)	7.	(a)	8.	(c)	9.	(b)	10.	(b)
11.	(c)	12.	(a)	13.	(b)	14.	(a)	15.	(b)	16.	(c)	17.	(c)	18.	(b)	19.	(a)	20.	(c)
21.	(a)	22.	(d)	23.	(d)	24.	(a)	25.	(a)	26.	(c)	27.	(b)	28.	(c)	29.	(b)	30.	(d)
31.	(e)	32.	(d)	33.	(a)	34.	(c)	35.	(b)	36.	(b)	37.	(a)	38.	(d)	39.	(d)	40.	(b)
41.	(c)	42.	(d)	43.	(b)	44.	(d)	45.	(d)	46.	(c)	47.	(a)	48.	(c)	49.	(a)	50.	(a)
51.	(a)	52.	(b)	53.	(c)	54.	(a)	55.	(b)	56.	(a)	57.	(a)	58.	(d)	59.	(a)	60.	(a)
61.	(b)	62.	(b)	63.	(d)	64.	(c)	65.	(c)	66.	(d)	67.	(c)	68.	(c)	69.	(c)	70.	(c)
71.	(a)	72.	(b)	73.	(a)	74.	(b)	75.	(d)	76.	(a)	77.	(d)						

Exercise II

1.	(b)	2.	(c)	3.	(d)	4.	(b)	5.	(d)	6.	(d)	7.	(a)	8.	(d)	9.	(e)	10.	(d)
11.	(b)	12.	(a)	13.	(c)	14.	(b)	15.	(e)	16.	(c)	17.	(c)	18.	(c)	19.	(c)	20.	(a)
21.	(b)	22.	(a)	23.	(c)	24.	(d)	25.	(a)	26.	(c)	27.	(a)	28.	(b)	29.	(b)	30.	(a)
31.	(a)	32.	(c)	33.	(d)	34.	(c)												

Explanations

25. **Brown Adipose Tissue** (BAT) or brown fat is one of two types of fat or adipose tissue (the other beign white adipose tissue) found in mammals. It is especially abundant in newborns and in hibernating mammals. Its primary function is to generate body that heat in animals or newborns that do not shiver. Its contrast to white adipocytes (fat cells), which contain a single lipid droplet, brown adipocytes contain numerous smaller droplets and a much higher number of mitochondria, which contain iron and make it brown. Brown fat also contains more capillaries than white fat, since it has a greater need for oxygen than most tissues.

The mitochondria in an eukaryotic cell utilize fuels to produce energy (in the form of ATP). This process involves storing energy as a proton gradient, also known as the proton motive force (PMF), across the mitochondrial inner membrane. This energy is used to synthesize ATP when the protons flow across the membrane (down their concentration gradient) through the ATP synthase enzyme; this is known as **chemiosmosis**.

In warm-bloolded animals, body heat is maintained by signaling the mitochondria to allow protons to run back along the gradient without producing ATP. This can occur since an alternative return route for the protons exists through an uncoupling protein in the inner membrane. This protein, known as uncoupling protein 1 (thermogenin), facilitates the return of the protons after they have been actively pumped out of the mitochondria by the electron transport chain. This alternative route for protons uncouples oxidative phosphorylation and the energy in the PMF is instead released as heat.

To some degrees, all cells of endotherms give off heat, especially when body temperature is below a regulatory threshold. However, brown adipose tissue is highly specialized for this non-shivering thermogenesis. First, each cell has a higher number of mitochondria compared to more typical cells. Second, these mitochondria have a higher-than-normal concentration of thermogenin in the inner membrane.

26. Carbohydrate contains 15.8 kilojoules (3.75 kilocalories) and proteins 16.8 kilojoules (4 kilocalories) per gram, while fats contain 37 kilojoules (9 kilocalories) per gram. In the case protein, this is somewhat misleading as on some amino acids are usable for fuel. Th standard amount of energy released fro hydrolysis of ATP can be calculated from th changes in energy under non-natural (standar conditions, then correcting to biologic concentrations. The net change in heat energ (enthalpy) at standard temperature and pressu of the decomposition of ATP into hydrated AD and hydrated inorgainc phosphate is −20 kJ/mol, with a change in free energy of 3 kJ/mol. The energy released by cleaving either phosphate (P_i) or pyrophosphate (PP_i) unit fro ATP at standard state of 1 M are

$$ATP + H_2O \longrightarrow ADP + P_i$$

$\Delta G^\circ = -30.5\ kJ / mol\ (-7.3\ kcal/mol)$

$$ATP + H_2O \longrightarrow AMP + PP_i$$

$\Delta G^\circ = -45.6\ kJ / mol\ (-10.9\ kcal/mol)$

35. **A.**

Cell Type	(^{3}H) Thymidine	(^{14}C) Uridine	(^{35}S) Methioni
Intestinal mucosal cells	+	+	+
Reticulocytes	+	+	+
Neurons	−	+	+
RBC	−	−	+

B.

Cell Type	(^{3}H) Thymidine	(^{14}C) Uridine	(^{35}S) Methioni
Intestinal mucosal cells	+	+	+
Reticulocytes	+	+	+
Neurons	+	+	+
RBC	−	−	+

36. 1. IV, 2. I, 3. I

37.

Statement	True	False
A	✓	
B		✓
C		✓
D		✓

38.

No.	Effects	T	F
1.	d glycogen and fat biosynthesis		✓
2.	ed rate of metabolism		✓
3.	Increased sweating	✓	
4.	Decreased mean body temperature		✓
5.	Increase in heat production	✓	
6.	Decreased cardiac output		✓

39. (b)

40. 3 > 2 > 1 > 6 > 4 > 5

41. (d)

42.

Population	Stage
P	a
Q	b
R	c
S	d

43. A. 1 : 257000 or 3.89×10^{-6} to 4×10^{-6} or $10^{-5.41}$ or 99% or $1/10^{5.41}$

B. 1 : 25 or 1 : 26 or (3.84×10^{-2} to 4×10^{-2}) or $10^{-1.41}$ or 96% or $1/10^{1.41}$

C. 1 : 1.02 or 0.97 to 1.00

D. pH2 or A or stomach

E. (b)

44. A-6, B-7, C-5, D-1, E-3, F-2, G-9, H-10, I-8, J-4

45. UCGAUU

46. 1. $\mu(A) = 0.7$ g/gh;
2. $\mu(B) = 1.4$ g/gh

47. 100 nm

48. 1. 1, 16 or 1, 18 or 1, 19
2. 0, 30 or 0, 32 or 0, 353
3. 2, 2 or 2, 21 or 2, 24

49. 1. A = 75%, B = 25%, C = 0%
2. Gene A : A = 20%, C = 30%, G = 30%, T = 20%, U = 0%
Gene B : A = 30%, C = 20%, G = 20%, T = 30%, U = 0%
3. A = 5, B = 4

50. (b)

51. 1 → (a), 2 → (b), 3 → (d), 4 → (e)

52. (e)

53. (b)

54. 1–C–J, 2–D–F, 3–A–G, 4–B–H, 5–E–I

55. (a)

56. 1–A, 2–B, 3–E, 4–C

57. 1-5 : Yes

58. 1–B, 2–C, 3–A

59. (b)

60. (c)