PART A: MULTIPLE CHOICE QUESTIONS (60 MARKS)

Read each question carefully and select the best answer from the options provided.

1. Statements listed below are portions of a cell theory **EXCEPT**:
   A. All cells have nucleus.
   B. All organisms are composed of cells.
   C. New cells arise from preexisting cells.
   D. Cells are the basic functional unit of living things.

2. Which of the following clues would tell you whether a cell prokaryotic or eukaryotic?
   A. The presence or absence of ribosomes.
   B. The presence or absence of a rigid cell wall.
   C. Whether or not the cell contains DNA.
   D. Whether or not the cell is partitioned by internal membranes.

3. Which if the following are true about the functions of cytoskeletons?
   I. They provide mechanical support to the cell, preventing tissues from collapsing.
   II. They involve in transporting vesicles both towards the cell's plasma membrane and away from plasma membrane.
   III. Absence or abnormal arrangement of cytoskeleton would greatly impair chromosomes separation in cell division.
   A. I and II
   B. I and III
   C. II and III
   D. I, II and III

4. Which biomolecule is distributed more widely in a cell?
   A. Chloroplast
   B. RNA
   C. DNA
   D. Lipid

5. Disulphide bonds may be formed in a protein's:
   I. Primary structure
   II. Secondary structure
   III. Tertiary structure
   IV. Quaternary structure
   A. I and II
   B. II and III
   C. II and IV
   D. III and IV

6. After a long period of fasting (not consuming any food), a person's urine sample is found to have high levels of nitrogen. What is the most likely explanation for this finding?
   A. Breakdown of body's protein
   B. Excessive secretion of insulin

C. Hydrolysis of carbohydrates
D. Breakdown of body's lipid

7. Which of the following contains a five-carbon sugar?
   I. DNA
   II. RNA
   III. Maltose
   IV. Glycogen
   A. I and II
   B. III and IV
   C. II, III and IV
   D. I, II, III and IV

8. Beta amylase is an enzyme that breaks down polysaccharides into component monosaccharides, are present in yeasts, bacteria and plants, but is absent in humans. Beta amylase is most effective in digesting which of the following?
   A. Glucose
   B. Starch
   C. Glycogen
   D. Cellulose

9. A frozen lake in winter with fish swimming below the surface is possible because of which property of water?
   A. Cohesion
   B. Adhesion
   C. Low molecular weight
   D. Universal solvent

10. Which structure is unique to plant cells and not found in most animal cells?
    A. Nucleus
    B. Cell wall
    C. Mitochondrion
    D. Endoplasmic reticulum

11. What is the role of the lysosomes in a cell?
    A. Synthesize proteins
    B. Detoxify poisons
    C. Digest macromolecules
    D. Store genetic information

12. What is the main difference between the smooth ER and rough ER?
    A. Smooth ER is involved in protein synthesis, while rough ER is not.
    B. Rough ER has ribosomes on its surface, while smooth ER does not.
    C. Smooth ER contains DNA, while rough ER contains RNA.
    D. Rough ER is only found in plant cells, while smooth ER is found in animal cells.

13. What is an allele?
    A. The location of a gene on a chromosome
    B. A heritable unit consisting of a specific nucleotide sequence

C. The observable characteristics of an organism
D. An alternative form of a gene for a trait occupying the same locus on homologous chromosomes

14. What does Mendel's First Law, the Law of Segregation, state?
    A. Alleles of two different genes get sorted into gametes independently of each other.
    B. Genetic material from two parents blends together to form offspring.
    C. During the formation of gametes, each gene separates so that each gamete carries only one allele for each gene.
    D. Genes are always inherited together if they are located close to each other on the same chromosome

15. What is a test cross used for?
    A. To determine the genotype of an organism with a dominant phenotype
    B. To blend the genetic material of two parents
    C. To observe independent assortment of alleles
    D. To create a Punnett square

16. What is the concept of a gene pool?
    A. The collection of all genes in an individual.
    B. The aggregate of all copies of every type of allele at all loci in every individual in a population.
    C. A group of individuals of different species that interbreed.
    D. The study of genes in a laboratory setting.

17. In a population of 10000 individuals with genotypes AA, Aa, and aa, where 6000 have genotype AA, 2000 have genotype Aa, and 2000 have genotype aa, what is the total number of alleles in the gene pool for this character?
    A. 10000
    B. 20000
    C. 30000
    D. 40000

18. What is the frequency of the B allele in a population of rabbits where there are 40 black rabbits (BB), 30 black rabbits (Bb), and 10 white rabbits (bb)?
    A. 0.25
    B. 0.50
    C. 0.6875
    D. 0.3125

19. If the frequency of a recessive allele (q) in a population is 0.4, what is the frequency of the dominant allele (p)?
    A. 0.6
    B. 0.4
    C. 0.8
    D. 1.0

20. What does the study of population genetics focus on?
    A. The study of genetic variability in a population and the forces that act on it.
    B. The study of individual genetic makeup.
    C. The study of non-inheritable traits.
    D. The study of genes within a single organism.

21. Which condition will cause a population to evolve and change allele frequencies?
    A. Genetic equilibrium
    B. No mutation
    C. No migration
    D. Natural selection

22. Which of the following statements best describes the Central Dogma of molecular biology?
    A. Genetic information flows from RNA to DNA and then to protein.
    B. Genetic information flows from DNA to RNA to protein.
    C. Genetic information flows from protein to RNA and then to DNA.
    D. Genetic information flows from RNA to protein and then to DNA.

23. What is the role of helicase in DNA replication?
    A. It synthesizes RNA primers.
    B. It unwinds the parental DNA double helix and separates the DNA strands.
    C. It relieves the strain of unwound DNA by breaking and rejoining DNA strands.
    D. It catalyzes the formation of phosphodiester bonds between Okazaki fragments.

24. Which process is responsible for the removal of introns and recombination of exons in pre-mRNA?
    A. Transcription
    B. Translation
    C. DNA replication
    D. RNA splicing

25. Which of the following best defines a mutation?
    A. A temporary change in the amount, arrangement, or structure of DNA.
    B. A permanent change in the amount, arrangement, or structure of DNA.
    C. A temporary change in the chromosome number of an organism.
    D. A permanent change in the phenotype of an organism.

26. What is a mutagen?
    A. An organism that has undergone mutation.
    B. A physical or chemical agent that increases the rate of mutation.
    C. A type of mutation that involves a change in the chromosome number.
    D. An enzyme that repairs mutations in DNA.

27. Which of the following is NOT a type of chromosomal aberration?
    A. Translocation
    B. Inversion
    C. Duplication

D. Point mutation

28. What is the definition of recombinant DNA technology?
    A. The process of sequencing DNA from different organisms
    B. The technique to splice together DNA from two different organisms to produce a new genetic combination
    C. The method of extracting DNA from a single organism for study
    D. The technique of editing genes within a single organism to correct mutations

29. What is the role of a cloning vector in recombinant DNA technology?
    A. To cut DNA at specific sequences
    B. To carry foreign DNA fragments into a host cell
    C. To modify the sequence of target DNA
    D. To replicate target DNA outside a cell

30. What is a characteristic feature of plasmids that makes them useful as cloning vectors?
    A. They contain an origin of replication
    B. They are linear pieces of DNA
    C. They can replicate only within eukaryotic cells
    D. They always cause mutations in the host cell

31. What is the primary role of cellular respiration in living organisms?
    A. To produce oxygen
    B. To generate ATP and heat
    C. To break down fat
    D. To synthesize glucose

32. What is the end product of glycolysis?
    A. Lactate
    B. Carbon dioxide
    C. Pyruvate
    D. Water

33. What is the net gain of ATP molecules per glucose molecule in glycolysis?
    A. 1 ATP
    B. 2 ATP
    C. 4 ATP
    D. 6 ATP

34. Which enzyme catalyzes the conversion of glucose to glucose-6-phosphate in glycolysis?
    A. Phosphofructokinase
    B. Hexokinase
    C. Pyruvate kinase
    D. ATP synthase

35. Which pigment is primarily responsible for absorbing light in photosynthesis?
    A. Carotenoids
    B. Chlorophyll a

C. Chlorophyll b
D. Xanthophylls

36. During the light-dependent reactions of photosynthesis, what is produced?
    A. ATP and NADPH
    B. Glucose and oxygen
    C. Carbon dioxide and water
    D. ADP and NADP+

37. In which part of the chloroplast do the light-independent reactions (Calvin cycle) occur?
    A. Thylakoid membrane
    B. Stroma
    C. Grana
    D. Thylakoid lumen

38. What is the role of the pigment molecules in the light-harvesting complexes of the photosystems?
    A. To split water molecules
    B. To absorb and transfer light energy to the reaction-center chlorophyll
    C. To produce ATP directly
    D. To release oxygen

39. Which of the following best describes the mechanism of negative pressure breathing?
    A. Air is pushed into the lungs
    B. Air is pulled into the lungs by expanding the thoracic cavity
    C. Air is absorbed through the skin
    D. Air is diffused directly into the bloodstream

40. Which phase is NOT part of the gas exchange process in humans?
    A. Breathing
    B. Gas transport by the circulatory system
    C. Exchange of gases with body cells
    D. Photosynthesis

41. What is the role of the diaphragm in the respiratory system?
    A. To absorb oxygen
    B. To separate the thoracic cavity from the abdominal cavity and assist in lung ventilation
    C. To produce mucus
    D. To filter air

42. What is the main function of surfactants in the respiratory system?
    A. To transport carbon dioxide
    B. To prevent alveoli from sticking shut by reducing surface tension
    C. To absorb nutrients
    D. To initiate the breathing process

43. In a closed circulatory system, blood is:
    A. Mixed with interstitial fluid
    B. Kept within a set of closed tubes
    C. Pumped through open-ended tubes
    D. Free to flow among cells

44. The main function of the human lymphatic system is to:
    A. Transport oxygenated blood to tissues
    B. Return excess fluid to the blood circulatory system
    C. Transport lipids from the liver to the bloodstream
    D. Circulate hormones throughout the body

45. High blood pressure, or hypertension, is characterized by:
    A. Systolic pressure below 120
    B. Diastolic pressure above 90
    C. Systolic pressure below 80
    D. Diastolic pressure below 70

46. What is the function of capillaries in the circulatory system?
    A. To transport oxygen-rich blood away from the heart
    B. To allow exchange between blood and interstitial fluid
    C. To return deoxygenated blood to the heart
    D. To store blood for emergencies

47. Which of the following is a primary example of a negative feedback mechanism?
    A. Childbirth contractions
    B. Blood clotting
    C. Regulation of body temperature
    D. Fruit ripening

48. What role does the effector play in a homeostatic control system?
    A. Detects changes in the environment
    B. Analyzes information and determines the response
    C. Carries out the response to restore balance
    D. Transports hormones throughout the body

49. Which statement correctly describes the role of insulin in blood glucose regulation?
    A. Insulin increases blood glucose levels by stimulating gluconeogenesis
    B. Insulin decreases blood glucose levels by promoting glycogen synthesis
    C. Insulin converts glycogen into glucose for energy
    D. Insulin stimulates the release of glucagon

50. How does the body respond to a decrease in blood glucose levels?
    A. Pancreas releases insulin to increase glucose uptake
    B. Liver converts glucose into glycogen for storage
    C. Pancreas releases glucagon to stimulate glycogen breakdown
    D. Cells increase the rate of glycolysis

51. What is the primary function of the loop of Henle in the kidney?
    A. Filtration of blood plasma
    B. Concentration of urine
    C. Production of erythropoietin
    D. Regulation of blood pressure

52. Which part of the nervous system is responsible for voluntary movements?
    A. Autonomic nervous system
    B. Sympathetic nervous system
    C. Somatic nervous system
    D. Parasympathetic nervous system

53. What is the primary function of motor neurons?
    A. Transmit sensory information to the CNS
    B. Interpret sensory signals
    C. Send signals from the CNS to muscles and glands
    D. Maintain homeostasis

54. What is the main difference between synaptic transmission and impulse transmission along an axon?
    A. Synaptic transmission involves electrical signals, whereas axon transmission is chemical
    B. Synaptic transmission involves neurotransmitters, whereas axon transmission is electrical
    C. Synaptic transmission is faster than axon transmission
    D. Synaptic transmission occurs in the CNS only

55. The central nervous system (CNS) consists of which two main structures?
    A. Brain and spinal cord
    B. Brain and peripheral nerves
    C. Spinal cord and sensory neurons
    D. Sensory and motor neurons

56. Which ion is primarily involved in generating an action potential in neurons?
    A. Calcium ($Ca2^{+}$)
    B. Sodium (Na^{+})
    C. Potassium (K^{+})
    D. Chloride (Cl^{-})

57. What triggers the adaptive immune response?
    A. Physical barriers like skin and mucous membranes
    B. Exposure to specific pathogens
    C. Immediate response to infection
    D. Inflammation

58. Which of the following is NOT a part of vertebrate innate immunity?
    A. Skin and mucous membranes
    B. Natural killer cells
    C. T lymphocytes
    D. Complement system

59. Which cells are primarily involved in the inflammatory response?
    A. Erythrocytes
    B. Neutrophils and macrophages
    C. T cells and B cells
    D. Platelets

60. How do cytotoxic T cells destroy infected cells?
    A. By producing antibodies
    B. By engulfing pathogens
    C. By perforating the infected cell's membrane and triggering cell death
    D. By secreting mucous to trap pathogens

PART B: STRUCTURED QUESTIONS

This part consists of four (4) questions. Answer ALL questions.

QUESTION ONE (10 MARKS)

In the garden pea, yellow seeds are dominant to green seeds and round seeds are dominant to wrinkled seeds. A cross was made between pure breeding pea plants with yellow and round seeds with green and wrinkled seeds. The F1 offspring were then allowed to self-pollinate and the seeds produced were grown. Mendel selected 556 peas from F2 generation and the following results are obtained: -

315 round and yellow
101 wrinkled and yellow
108 round and green
32 wrinkle and green

a) Explain by using a cross diagram for the above result.

[8 marks]

b) From this result, Mendel had created a Law. State and explain the Law.

[2 marks]

QUESTION TWO (10 MARKS)

FIGURE 1 below summarizes the process of translation.

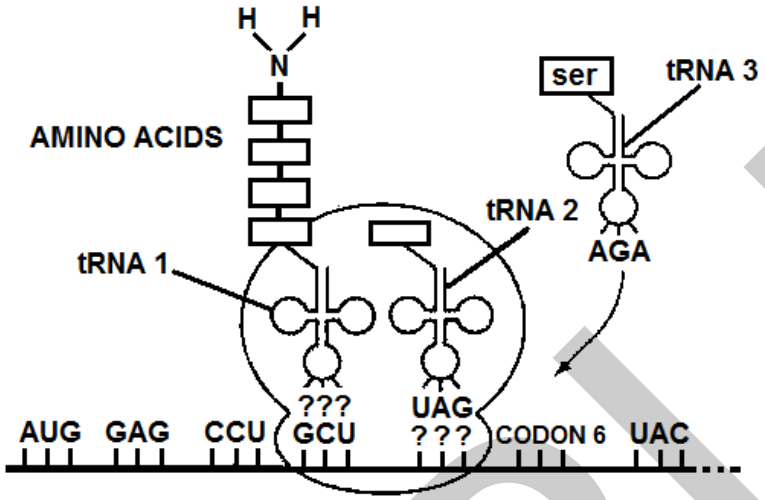

FIGURE 1

a) Name the stage of translation process shown in the above figure.

[1 mark]

b) Which is the first codon used in protein synthesis from this mRNA?

[1 mark]

c) What is the anti-codon sequence in tRNA 1?

[1 mark]

d) tRNA 1 has a 5' – phosphate end and a 3' – hydroxyl end. What is the function of 3'OH end in tRNA 1?

[1 mark]

e) Name the enzyme that catalyzes the formation of the peptide bond between amino acids carried by tRNA 1 and tRNA 2.

[1 mark]

f) According to the figure, explain what will occur to allow codon 6 to be translated.

[3 marks]

g) List **TWO** ways in which transcription differs from translation process.

[2 marks]

QUESTION THREE (10 MARKS)

Mutation is the changes that happen to genetic materials, the chromosomal genes. These changes can occur spontaneously but the rate can be increased by mutagen. There are two types of mutation, gene mutation and chromosomal mutation. Chromosome mutation involves aberration and changes in the number of the chromosomes.

Based on the explanation above, answer these questions.

a) Give an example for each of these mutagens:
   i. Physical agent:
   ii. Chemical agent:

[2 marks]

b) Sickle cell anemia is a disease because of gene mutation.
   i. Name the type of mutation that causes the disease.

[1 mark]

   ii. Explain how this disease occurs.

[2 marks]

c) What is the meaning of chromosome aberration?

[1 marks]

d) Draw a diagram to show how aberration in **translocation** and **inversion** occurs:

[2 marks]

e) If a diploid number (2n) of a species is 24, determine the number of chromosome if the species undergoes the following condition:
   i. Monosomy
   ii. Triploid

[2 marks]

QUESTION FOUR (10 MARKS)

….T A G A A T T C G T G A A T T C…..
….A T C T T A A G C A C T T A A G…..

Donor DNA

….T C G A A T T C C G…..
….A G C T T A A G G C…..

Plasmid DNA

FIGURE 2

a) A restriction enzyme is used to cut the DNA donor and plasmid in **FIGURE 2**.

i. The base sequence which is being recognized by the enzyme is

[1 *mark*]

ii. Name the restriction enzyme which can cut the donor DNA and the plasmid.

[1 *mark*]

iii. Name the origin of your answer in (a) ii

[1 *mark*]

b) Donor DNA can be digested into several fragments by a restriction enzyme.

i. Draw a line(s) to show the exact place where the restriction enzyme will cut in the figure below:

[1 *mark*]

….T A G A A T T C G T G A A T T C…..
….A T C T T A A G C A C T T A A G…..

ii. Make a drawing to show a DNA restriction fragments produced after digestion from b (i).

[1 *mark*]

c) Plasmid will also be digested by the same restriction enzyme.

i. Draw a line(s) to show the exact place that will be cut by restriction enzyme within the plasmid sequence below.

[1 *mark*]

….T C G A A T T C C G…..
….A G C T T A A G G C…..

ii. Make a drawing of the above digested plasmid.

[1 *mark*]

d) Draw a correct figure showing how both donor DNA and plasmid are combined to form recombinant DNA.

[1 *mark*]

e) List down 2 importance of recombinant DNA technology in agriculture.

[2 *marks*]