Indian Association for the Cultivation of Science
(Deemed to be University under *de novo* Category)
Integrated Bachelor's-Master's Program
End-Semester Examination-Spring 2025

Subject: Biochemistry, Genetics and Evolution ***Subject Code(s): BIS1201***
Full Marks: 50 ***Time Allotted: 3 h***

Part - A

1. Answer All: **1×20=20**

a. Gluconeogenesis primarily occurs in the:
A. Brain
B. Liver
C. Muscle
D. RBCs

b. Which enzyme bypasses the irreversible glycolytic step catalyzed by PFK-1?
A. Pyruvate carboxylase
B. PEP carboxykinase
C. Glucose-6-phosphatase
D. Fructose-1,6-bisphosphatase

c. Which vitamin is a cofactor for pyruvate carboxylase?
A. Riboflavin
B. Thiamine
C. Biotin
D. Niacin

d. Gluconeogenesis is stimulated by:
A. Insulin
B. Glucagon
C. Fructose
D. ATP depletion

(See the following page)

e. Which of the following is NOT a gluconeogenic precursor?

A. Lactate
B. Glycerol
C. Alanine
D. Acetyl-CoA

f. Which of the following is true about the energy investment phase of glycolysis?

A. It produces 2 NADH
B. It generates 4 ATP
C. It consumes 2 ATP but prepares intermediates for energy harvesting
D. It directly produces pyruvate

g. Why does glycolysis proceed faster in anaerobic conditions despite lower energy yield?

A. Because ATP is not needed
B. Because glycolytic enzymes are oxygen-sensitive
C. Because NAD^+ is regenerated rapidly via lactate formation
D. Because PFK-1 is inhibited by oxygen

h. Which glycolytic enzyme catalyses a reaction that involves substrate-level phosphorylation?

A. Enolase
B. Pyruvate kinase
C. Aldolase
D. PFK-1

i. How many net NADH are generated per glucose molecule through one turn of the TCA cycle?

A. 3
B. 4
C. 6
D. 3 (per turn), 6 (per glucose)

j. Which intermediate is both a TCA cycle component and a precursor for amino acid biosynthesis?

A. Malate
B. α-Ketoglutarate
C. Fumarate
D. Citrate

(See the following page)

k. What happens to oxaloacetate levels during fasting?
A. It accumulates and enhances gluconeogenesis
B. It is diverted to glycolysis
C. It is depleted to support gluconeogenesis
D. It forms ketone bodies

l. Why is the TCA cycle considered amphibolic?
A. Because it only oxidizes nutrients
B. Because it functions in both anabolic and catabolic pathways
C. Because it is anaerobic
D. Because it produces only energy

m. Which ETC component is lipid-soluble and moves freely within the inner mitochondrial membrane?
A. Cytochrome c
B. Coenzyme Q (ubiquinone)
C. Complex III
D. NADH dehydrogenase

n. Why does $FADH_2$ contribute fewer ATP molecules than NADH?
A. It enters at Complex I
B. It enters at Complex II, which does not pump protons
C. It produces more ROS
D. It is unstable

o. What would happen if the inner mitochondrial membrane becomes permeable to protons?
A. Electron flow would stop
B. ATP synthesis would halt despite continued electron transport
C. Oxygen would not be reduced
D. NADH would not be oxidized

p. Which of the following components contains iron-sulfur (Fe-S) clusters?
A. Complex IV only
B. Only cytochrome c
C. Complex I, II, and III
D. Only NAD^+

(See the following page

q. Why is oxygen essential in the ETC?

A. It activates Complex
B. It accepts electrons from Complex IV to form water
C. It produces ATP directly
D. It is needed for proton pumping

r. Which of the following is **not** a product of one cycle of β-oxidation?

A. NADH
B. $FADH_2$
C. CO_2
D. Acetyl-CoA

s. What is the fate of odd-chain fatty acid oxidation products?

A. Only acetyl-CoA is formed
B. Propionyl-CoA is converted to succinyl-CoA
C. Ketone bodies are directly formed
D. Converted to glucose

t. What is the purpose of converting oxaloacetate to malate in gluconeogenesis?

A. To generate NADH
B. To transport oxaloacetate out of mitochondria
C. To oxidize acetyl-CoA
D. To bypass PFK-1

2. Answer any five: **3×5=15**

a. How are ketone bodies synthesized from acetyl-CoA?

b. What role does biotin (vitamin B7) play in gluconeogenesis?

c. What is the carnitine shuttle (carnitine cycle), and how does it function?

d. Describe the "binding change mechanism" of ATP synthesis.

e. What are the structural subunits of ATP synthase?

f. How is cytosolic NADH (from glycolysis) transferred into the mitochondria for the electron transport chain?

g. Why can't animals convert fatty acids into glucose, while plants can? Explain the underlying reason.

h. Calculate the total energy yield (in ATP equivalents) from the complete β-oxidation and degradation of a saturated fatty acid with 20 carbon atoms (C20:0).

(See the following page)

Part - B

3. Define the following (any two): $1\times2=2$

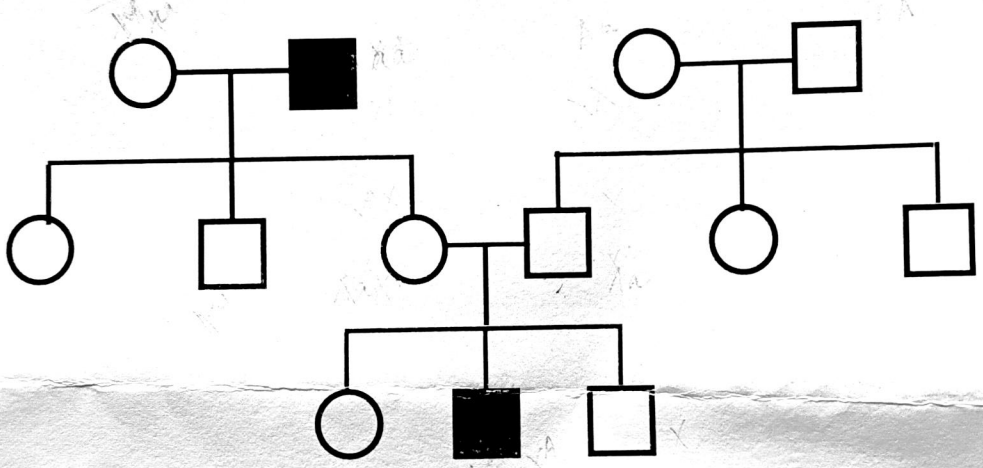
a. Mendelian population
b. Genetic drift
c. Allele frequency

4. Answer the following (any three): $3\times3=9$

a. State the Hardy-Weinberrg law mentioning its assumptions. Represent the Hardy-Weinberrg equilibrium in terms of frequency of genotypes. 2+1=3

b. Describe the main types of selection pressures in the natural selection. 3

c. Pedigree chart for a disease 'A' in a family is given below. Analyze it explaining each symbol and identify the type inheritance of the diseased gene for the disease 'A'. 2+1=3



d. A disease 'X' in cattle is found to affect every generation of it. Affected animals may give rise to unaffected offspring but unaffected animals cannot give rise to affected offspring. Males and Female cattle are affected equally. A random sample of 100 cattle is taken from a population in Hardy-Weinberrg equilibrium. It is found that 9 cattle are only unaffected. What is the frequency of disease allele in the population? 3

5. Explain the following (any two): $2\times2=4$

a. Characteristics of the pedigree chart for the mitochondrial inheritance.
b. Sympatric speciation can occur through polyploidy.
c. During speciation, Hardy-Weinberg law is violated.