UNIVERSITI KUALA LUMPUR
INSTITUTE OF MEDICAL SCIENCE TECHNOLOGY

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	HDB10602
COURSE TITLE	:	HUMAN BIOCHEMISTRY
PROGRAMME NAME	:	BACHELOR OF BIOMEDICAL SCIENCE (HONOURS)
DATE	:	24 JANUARY 2026
TIME	:	9:00AM - 11:00AM
DURATION	:	2 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*
9. Refer to the attached Formula/ Appendies. ☐ *Tick if applicable*

THERE ARE 14 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

1. Which change in the Michaelis–Menten curve occurs when an enzyme's Km decreases without a change in V_{max}?

   A. Curve shifts left, reaching half V_{max} at lower [S].

   B. No shift occurs.

   C. Curve shifts right.

   D. Curve becomes sigmoidal.

2. During glycolysis, NAD^+ is reduced to NADH in the reaction catalyzed by glyceraldehyde-3-phosphate dehydrogenase. Which consequence would occur if NAD^+ is depleted?

   A. ATP production would increase.

   B. Pyruvate would be converted to lactate automatically.

   C. Glycolysis would proceed normally.

   D. The conversion of glyceraldehyde-3-phosphate to 1,3-BPG would stop.

3. If phosphofructokinase is inhibited in a cell, which immediate effect would occur in glycolysis?

   A. Increased fructose-1,6-bisphosphate production.

   B. Stimulation of pyruvate kinase.

   C. Accumulation of fructose-6-phosphate.

   D. Enhanced ATP production.

4. Which function describes the primary role of the LDL receptor in lipoprotein metabolism?

   A. Mediating endocytosis of cholesterol-rich LDL particles.

   B. Activating reverse cholesterol transport.

   C. Hydrolyzing triglycerides in VLDL.

   D. Transporting dietary lipids from intestine.

5. During VLDL metabolism, which of the following describes the fate of IDL after hepatic lipase removes its remaining triglycerides and apoE?

   A. It becomes LDL.

   B. It converts to HDL.

   C. It forms chylomicron remnants.

   D. It is taken up by the liver.

6. The role of apolipoprotein C-II in lipoprotein metabolism is as _____.

   A. activation of LCAT

   B. activation of lipoprotein lipase

   C. structural stability of HDL

   D. a binding to LDL receptors

7. A patient has high LDL and low HDL levels. Which dietary or lifestyle factor is most likely to worsen their cardiovascular risk?

   A. High saturated fat intake.

   B. Increased omega-3 fatty acid intake.

   C. Regular aerobic exercise.

   D. Consumption of antioxidant-rich foods.

8. Identify the metabolic response differences between early fasting and refed state in liver.

   A. In both states, the liver absorbs dietary glucose equally.

   B. In early fasting, insulin is high; while in the refed state, glucagon is high.

   C. In early fasting, the liver releases glucose; while in the refed state, it stores glucose as glycogen.

   D. In early fasting, the liver synthesizes fatty acids; while in the refed state, it breaks down glycogen.

9. Calculate the $[H^+]$ of a solution with pH = 4.

   A. 10^4 M

   B. 10^{-7} M

   C. 10^{-4} M

   D. 10^{-10} M

10. Apply the Henderson–Hasselbalch equation to determine the pH when $[A^-] = [HA]$.

    A. pH = 7

    B. pH > pKa

    C. pH < pKa

    D. pH = pKa

11. During protein synthesis, if the A site of the ribosome is blocked, which process would be most directly inhibited?

    A. Binding of new aminoacyl-tRNA.

    B. tRNA release from the P site.

    C. Peptide bond formation.

    D. Initiation.

12. Excessive ethanol consumption leads to fatty liver disease. Which of the following mechanisms is most directly responsible for the accumulation of triglycerides in the liver?

    A. Increased gluconeogenesis from lactate.

    B. Activation of glycogen phosphorylase.

    C. Enhanced citric acid cycle activity.

    D. Inhibition of fatty acid oxidation due to high NADH.

13. A patient lacks the enzyme lactase in the small intestine. Based on carbohydrate digestion, which dietary change would be most necessary?

    A. Avoid dairy products containing lactose.

    B. Increase cellulose intake.

    C. Increase starch intake.

    D. Reduce sucrose consumption.

14. A patient with untreated Type I diabetes presents with high blood glucose and ketone bodies. Which combination of hormonal and metabolic states best explains this condition?

    A. High insulin, high glucagon, enhanced glycogen storage.

    B. Low insulin, high glucagon, increased ketogenesis.

    C. High insulin, low glucagon, increased fatty acid synthesis.

    D. Normal insulin, low glucagon, inhibited gluconeogenesis.

15. Which situation would most likely inhibit the TCA cycle at the α-ketoglutarate dehydrogenase step?

    A. High ADP level.

    B. High ATP and high NADH.

    C. Increased Ca^{2+} level.

    D. Low NADH level.

16. Insulin stimulates glycolysis by increasing the level of which metabolite?

    A. NADH

    B. Citrate

    C. Fructose-1,6-bisphosphate

    D. Fructose-2,6-bisphosphate

17. Which metabolic process will decrease first if succinate dehydrogenase is inhibited?

    A. Pyruvate production.

    B. ATP from substrate-level phosphorylation.

    C. NADH production.

    D. $FADH_2$ formation and electron transport.

18. Which of the following phospholipids is involved in cell signaling pathways, especially after being cleaved by phospholipase C?

    A. Cardiolipin

    B. Phosphatidylserine

    C. Phosphatidylinositol 4,5-bisphosphate (PIP_2)

    D. Phosphatidylethanolamine

19. If a mutation prevents hexokinase from being inhibited by glucose-6-phosphate, which cellular metabolism outcome will be most likely happened?

    A. It will be continued stimulation of gluconeogenesis.

    B. It will be continued suppression of glycolysis activity.

    C. It will be increased glycogenolysis activity.

    D. It will be continuous trapping of glucose inside the cell.

20. Considering the metabolic profiles of the brain, muscle, and liver, which organ is most critical for maintaining blood glucose levels during starvation, and why?

A. Liver, because it performs gluconeogenesis.

B. Brain, because it consumes the most glucose.

C. Adipose tissue, because it releases fatty acids.

D. Muscle, because it stores the most glycogen.

21. Which condition will cause the most rapid activation of glycogen phosphorylase in muscle?

A. High insulin levels.

B. High level of epinephrine and elevated AMP level.

C. High glucose-6-phosphate level.

D. High ATP level and low Ca^{2+} level.

22. How does the role of salivary amylase differ from that of pancreatic amylase in carbohydrate digestion?

A. Salivary amylase works in the mouth, while pancreatic amylase acts in the small intestine.

B. Salivary amylase breaks down cellulose, while pancreatic amylase breaks down starch.

C. Only pancreatic amylase produces monosaccharides.

D. Both act on starch, but pancreatic amylase operates at a more acidic pH.

23. If an enzyme follows Michaelis-Menten kinetics, predict the effect on the initial reaction rate if substrate concentration is much lower than K_m?

A. Rate is directly proportional to substrate concentration [S].

B. Rate is independent of enzyme concentration.

C. Rate is zero-order.

D. Rate is near V_{max}.

24. Select the option that best describes the role of enzyme lipoprotein lipase (LpL) influence chylomicron metabolism?

A. Binds to LDL receptors in the liver.

B. Hydrolyzes triglycerides in chylomicrons to fatty acids.

C. Activates LCAT on HDL.

D. Synthesizes chylomicrons in the intestine.

25. Leptin and insulin are both involved in appetite control and energy homeostasis. Which would be the expected metabolic profile of a mouse lacking functional leptin receptors?

A. Increased insulin sensitivity and reduced adiposity.

B. Decreased food intake and increased energy expenditure.

C. Normal body weight with impaired glucose tolerance.

D. Hyperphagia, obesity, and decreased energy expenditure.

26. A mutant enzyme is created with tighter substrate binding (lower K_m) but unchanged k_{cat}. How would this affect the reaction rate of the enzyme at low substrate concentration [S] compared to the wild type?

A. Rate of reaction would remain the same.

B. Rate of reaction becomes zero-order.

C. Rate of reaction would increase.

D. Rate of reaction would decrease.

27. A mutation in the gene encoding ubiquitin-protein ligase (E3) would most likely result in _____.

A. increased ubiquitin activation by E1

B. accumulation of non-degraded proteins

C. decreased protein synthesis

D. enhanced protein degradation

28. Which lipoprotein is primarily responsible for reverse cholesterol transport?

A. HDL – picks up cholesterol from peripheral tissues.

B. LDL – delivers cholesterol to tissues.

C. Chylomicrons – transports dietary lipids.

D. VLDL – transports endogenous triglycerides.

29. If initial reaction rate is plotted against enzyme concentration at saturating substrate levels, which shape of the graph would be expected?

A. Parabolic

B. Linear

C. Hyperbolic

D. Sigmoidal

30. Predict the changes on V_{max} if the concentration of enzyme was increase while the substrate concentration remain.

A. V_{max} remain unchanged.

B. V_{max} become zero.

C. V_{max} halves.

D. V_{max} doubles.

31. A drug increases the activity of pyruvate dehydrogenase kinase (PDH kinase). Predict the immediate change in metabolic activity.

A. It will cause accumulation of pyruvate and lactate.

B. It will cause increased ATP production.

C. It will cause increased conversion of pyruvate to acetyl-CoA.

D. It will enhanced TCA cycle flux.

32. In lipid digestion, which component is not absorbed directly by intestinal cells but is instead recycled?

A. Fatty acids

B. Bile salts

C. Cholesterol

D. 2-monoacylglycerol

33. Which situation would most likely inhibit the TCA cycle at the α-ketoglutarate dehydrogenase step?

A. Low NADH level.

B. High ATP level and high NADH level.

C. Increased Ca^{2+} level.

D. High ADP level.

34. Which of the following cellular outcome will be most likely happen if mutation occur on hexokinase?

A. Increased glycogenolysis process.

B. Continuous trapping of glucose inside the cell.

C. Glycolysis will be suppressed.

D. Gluconeogenesis will be stimulated.

35. If a marathon runner depletes both muscle glycogen and blood glucose during a race, which fuel source will become the primary supplier of ATP for muscle contraction in the late stages of the race?

A. Fatty acids from adipose tissue.

B. Amino acids from muscle breakdown.

C. Lactate from anaerobic glycolysis.

D. Creatine phosphate.

36. During elongation in protein synthesis, the peptidyl transferase activity is responsible for _____.

A. forming a peptide bond between amino acids

B. moving tRNA from A site to P site

C. binding mRNA to the ribosome

D. releasing the polypeptide chain

37. Which statement is best to explain protein degradation in proteosomes considered irreversible and tightly regulated?

A. It only happens during cell division.

B. It uses ATP.

C. It requires mRNA signaling.

D. It involves ubiquitin tagging and occurs in a specialized compartment.

38. Which metabolic shift occurs in the liver during fasting when glucagon level is high?

A. Increased of glycogen synthesis activity.

B. Increased of Fructose-1,6-bisphosphatase activity.

C. Increased of glycolysis activity.

D. Increased of PFK-1 activity.

39. If an enzyme has a high k_{cat} and high K_m, predict its catalytic efficiency at low substrate concentrations.

A. Highly efficient.

B. Moderately efficient.

C. Low efficiency.

D. Efficiency is substrate-independent.

40. Which scenario would most effectively inhibit glycolysis at the phosphofructokinase-1 (PFK-1) step?

A. Increased AMP level and decreased ATP level.

B. Increased fructose-2,6-bisphosphate level.

C. Increased citrate level and high ATP level.

D. Increased insulin level.

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

Analyze how the physical and chemical properties of water contribute to its role as a universal solvent in biological systems.

(20 marks)

Question 2

Explain the statement "High LDL and low HDL levels are primary risk factors for atherosclerosis" in detail.

(20 marks)

Question 3

Discuss the reciprocal regulation of glycolysis and gluconeogenesis in the liver. In your explanation, describe how energy charge, hormonal signals, and allosteric effectors coordinate these pathways to maintain blood glucose levels including the roles of key enzymes and the impact of insulin and glucagon.

(20 marks)

Question 4

A solution is prepared by dissolving 0.365 g of HCl (molar mass of HCl = 36.5 g/mol) in water to make 500 mL of solution. Calculate:

(a) The molarity of the HCl solution.

(7 marks)

(b) The pH of the solution.

(6 marks)

(c) The pOH of the solution.

(4 marks)

(d) The $[OH^-]$ concentration.

(3 marks)

END OF EXAMINATION PAPER