Mount Kenya University – Thika Campus

Medical School

Department of Medical Biochemistry

MBMB 1224: Enzymes, Vitamins and Minerals

Program: MBChB & BPHARM; Credits: Lecture 2 hrs/ week; **Lab** 3 hrs/ week.

Year 1 Semester 2: Jan – April 2023; **Meetings: Tue** 7- 9 am; **Room:** Auditorium

Lecturer: Dr Paul Sifuna; **Email address:** poshule@mku.ac.ke

Consultation hours: Room CTG:3 8.00 am - 5.00 pm with prior arrangements or appointment

COURSE OBJECTIVES:

By the end of the course student will be able to:

1. Explain why enzymes are the major and most versatile biological catalysts.
2. Differentiate enzyme (biocatalysts) from the chemical catalysts.
3. Describe the major classes of enzymes and the subclasses of some of them.
4. Given a list of reactions, identify the type of enzymes that catalyses them.
5. Summarize the key features of the active sites of enzymes.
6. Explain why enzymes do not alter the equilibrium of chemical reactions but only change the rates of chemical reactions.
7. Explain the raw law equation
8. Describe the order of an equations
9. Describe the formation of enzyme-substrate complex in catalysis.
10. Derive the Michaelis-Menten equation for a single substrate enzyme catalyzed reactions
11. Describe the Michaelis-Menten parameters, K_M and V_{max} and their significance.
12. Describe the transformation methods of Michaelis-Menten equation and outline the advantages and disadvantages of each method.

13. Explain the physiological and non-physiological factors that affect enzyme activity.
14. Distinguish between reversible and irreversible inhibition of enzyme activity.
15. Distinguish between the different types of reversible enzyme inhibition.
16. By relating the structure of the inhibitor to the active site of the enzyme, determine the type of inhibition exerted by the inhibitor.
17. Describe the major regulatory mechanisms that control enzyme activity.
18. Define allosteric enzymes and explain their properties.
19. Explain the cooperative kinetics of allosteric enzymes.
20. Describe the properties of isoenzymes.
21. Explain the use of enzymes and isoenzymes in medical practice.
22. Outline the general characteristics and functions of vitamins.
23. Classify the vitamins as fat soluble vitamins and water soluble vitamins.
24. Describe the role of both water and fat soluble vitamins in the body.
25. Distinguish between cofactors and coenzymes and describe their role in catalysis
26. Identify the precursors of the different coenzymes.
27. Outline the different forms of vitamin A.
28. Know the steps of activation of vitamin D.
29. Understand the role of vitamin D in calcium metabolism.
30. Understand the role of vitamin E as an anti-oxidant.
31. List the forms and sources of vitamin K.
32. Understand the mechanism of activation of the clotting factors by vitamin K.
33. Know the role of vitamin C in collagen formation and as an antioxidant.
34. Know the structure and different coenzymes derived from vitamin B.
35. Distinguish between clinical pictures of vitamin deficiencies.
36. List the major inorganic constituents of the body.
37. List the functions of calcium, phosphorous, magnesium, sodium, potassium and iron.
38. Describe the regulation of calcium phosphorous, magnesium, sodium, potassium & iron.
39. Define trace elements found in the body and their physiological functions.
40. List the function of copper, zinc, selenium, fluoride, and iodide.
41. Distinguish the clinical picture of deficiency of different minerals.

COURSEDESCRIPTION

Enzymes: Historical perspective, terminologies, nomenclature & classification, properties, mode of action, activity and specificity. **Enzyme manipulations**: Sub cellular distribution, isolation, purification, criteria of homogeneity. **Enzyme substrate interactions**: ES complex, binding, active and allosteric sites. **Enzyme- substrate binding hypothesis**; Fischer, Koshland's, Jacob-Onod. **Mechanism of enzyme action**: ES complementarity, Stereochemistry ES action, catalytic efficiency. **Enzyme kinetics**: rates of chemical reactions, turnover number, **Factors affecting rate of catalysis**- Collision and transitional state theories, temperature, pH, substrate concentration, enzyme concentration, enzyme inhibitors, allosteric effects, steady, pre–steady and equilibrium–state kinetics. Single substrate enzyme catalyzed reactions: **Michaelis-Menten equation**, transformations and application. M.M equation primary and secondary plots, importance of Km and Vmax. bi-substrate and multi-substrate reaction. **Enzyme inhibitions**: Irreversible inhibitors, suicide inhibitors, reversible (competitive, uncompetitive, uncompetitive etc), determination of K_i. **Clinical utility of enzyme inhibitions:** drugs as enzyme inhibitors. **Enzyme regulation mechanisms**: allosterism, covalent modification, induction, compartmentations, hormonal, organ specialization, multi-enzyme complexes. **Co-factors in enzyme action**: types, functions. Clinical significance of enzymes. snake venom enzymes, marker enzymes, isoenzymes and their clinical applications. Vitamins; classification, coenzymes, sources, chemistry, physiological function, deficiency symptoms and risk groups. **Minerals and trace elements** – general functions, macro and microelements. **Biochemical role of vitamins** and minerals as coenzymes and cofactors.

COURSE OUTLINE

Week	Topic	Sub-Topic
1	Minerals	✓ Biochemistry of dietary minerals
2	Vitamins	✓ Classification, Sources, Chemistry, Physiological and Biochemical functions, Deficiency symptoms and Related Disorders
3	Co-enzymes and Co-factors	✓ Types, Roles and functions of co-enzymes and co-factors
4	Introduction to Enzymes	✓ Historical Perspective, Terminologies, Nomenclature, classification, and Properties
5	Enzyme Isolation and Purification	✓ Sub-cellular distribution, isolation, purification, criteria of homogeneity and purity
6	Mechanisms Enzyme Substrate Interactions and Specificity	✓ ES complex Formation, Substrate Binding on active and Allosteric sites, Stereochemistry, ES-binding Hypothesis; Fischer, Koshland's, Jacob-Onod.
7	Enzyme Catalysis I	✓ Collision and Transitional state theories, Temperature, pH, Substrate Concentration, Enzyme concentration, Enzyme Inhibitors and Allosteric effectors

	Enzyme Catalysis II	✓ Types of Catalytic Mechanisms**;** Acid-base catalysis**,** Covalent catalysis**,** Metal ion catalysis**;** Proximity and orientation effects**;** Preferential binding of the transition state
8	Enzyme Kinetics I	✓ Rates of Chemical Reactions, Turnover number and Order of the Reaction ✓ Kinetics of single substrate enzyme catalysed reactions ✓ Michaelis-Menten (M.M) equation and its transformations.
9	Enzyme Kinetics II	✓ Mechanism of Bi-substrate and Multi-substrate reactions. Ping-Pong, Random, Order and Compulsory order Mechanism. Mechanism Co-cooperativity and the Hill Plot
10	Enzyme Inhibition and its Significance in Medicine	✓ Reversible inhibitors ✓ Irreversible, Suicidal inhibitors ✓ Determination of Ki ✓ Drugs as enzyme inhibitors
10	Regulation of Enzyme activity	✓ Proteolytic cleavage of Zymogens, ✓ Allosterism, Covalent modification
11	Clinical applications of Enzymes and Isoenzymes	✓ Marker Enzymes of Tissue Damage in diagnosis ✓ Therapeutic enzymes
12	REVISION	
13	**END TERM EXAM**	

Learning and teaching methodologies: Lectures, tutorials, practical sessions

Assessment: Continuous Assessment Test

Practical: (3 HRS/ LAB)

REFERENCES

i. Nelson DL & Cox MM (2013). Lehninger: Principles of Biochemistry, 6th ed. Macmillan, 0-333-94657-X

ii. Stryer L. (1995), Biochemistry 4th ed. WH Freeman, 0-7167-2009-4

iii. Wilson K. & Walker J. (2009). Principles and Techniques of Biochemistry and Molecular Biology 7th ed. Cambridge University Press. 05214176941994

iv. Vasuden D. M., Sreekumari S. and Vaidyanathan K. (2011). A Textbook of Biochemistry for Medical Students, 6th Edition. Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.