Review of unit content

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1. Proteins and Enzymes

Protein structure and enzyme function

- basic Michaelis-Menton type enzyme kinetics.

Key points covered include:

- Structure and properties of amino acids found in proteins including some “non-standard” amino acids, and chirality of amino acids.
- Definition and properties of a peptide bond
- Definition of primary, secondary, tertiary and quaternary structure of proteins, including protein structural domains

1. Proteins and Enzymes

- Protein analysis
  - Stability e.g. salting-in
  - Protein folding and denaturation
  - Protein purification
  - Sequencing methods such as Edman degradation, MS-MS
  - Chromatography
  - Salting out
  - UV-Vis
  - Overview of structural determination methods: electron microscopy, NMR, X-ray crystallography
  - Gel electrophoresis
    - pI based on pK values

1. Proteins and Enzymes

- Enzyme activity and models of enzyme activity
  - Catalytic site and enzyme mechanisms
  - The six primary classes of enzymes
  - Enzyme inhibition
    - Competitive
    - Noncompetitive
    - Uncompetitive
  - Allosteric regulation
- Review of basic thermodynamics and chemical equilibria (refer to Lecture 1)

2. Biochemical signalling

- Biological membranes
- Signal transduction basics
- Hormones and Endocrine Signalling
  - Pancreatic hormones insulin and glucagon
  - Adrenal medulla hormines epinephrine (adrenalin) and norepinephrine (noradrenalin)
  - Effect of hormones on cellular regulation
- Kinases and phosphatases for adding and removing phosphate groups
- RTKs and GPCRs

3. Metabolism

- Principles of metabolism and how cell structure may influence metabolism within cells
- Types of metabolic strategies that mammals utilize
  - Energy source
  - Reducing agnets
  - Carbon source
- The link between catabolism and biosynthesis
  - Reducing equivalents (NADH/NADPH)
  - Coupling reactions to make them favourable (ATP)
  - Carbon and nitrogen sources and other nutrients

3. Metabolism

- Compartmentation of enzymes and pathways
  - Also see integration of mammalian metabolism
- Clustering of enzyme activities
- Regulation of multi-step pathways

4. Energy metabolism

- Glycolysis and gluconeogenesis
  - Emphasis is on the key regulatory steps, mechanism of these enzymes and compartmentation of sections of the gluconeogenesis pathway in mammals
- Glycogen metabolism
- Pentose phosphate pathway
  - *links to other metabolic pathways*
- CAC
  - *Regulation of enzymes within the CAC*
  - *Acetyl-CoA (link to lipid synthesis)*
  - *Importance of succinate dehydrogenase – link to ETC/OxPhos.*
- Glyoxalate cycle

4. Energy metabolism

- Electron Transport Chain and Oxidative Phosphorylation
  - mitochondrial structure and electron carriers,
  - what is E^o
  - Flow of electrons from “high” to “low” –E^o values.
  - P/O ratio for different substrates
  - Complexes involved and their exact role
  - Role of uncouplers
  - Chemiosmotic theory: charge, pH and concentration
  - ATP synthase - 2 roles: synthase and proton pump
- Links between glycolysis, CAC and OxPhos

5. Amino acid metabolism

- Amino acid metabolism
  - Catabolism
    - Removal of nitrogen: Urea cycle & links to other metabolic pathways
    - Recycling of C chain: glucogenic and ketogenic amino acids
    - Diseases of defective aa catabolism
  - Biosynthesis
    - Essential and non-essential aas
    - Transamination reaction
      - Nitrogen cycle and Nitrogen fixation
    - Families of amino acids
    - Regulation

6. Lipid metabolism

- Fatty acid degradation and synthesis
  - Energy output from fats
  - Transport of fatty acids
  - Involvement of hormones (cAMP)
  - Transport of fatty acids to mitochondria for oxidation
    - 4 systems involved and products formed
  - Link to TCA and OxPhos
  - Requirements of fatty acid synthase (FAS)
  - acetyl-CoA carboxylase
  - Steps involved in fatty acid synthesis

7. Nucleic Acid metabolism

- Nucleic acid bases
  - Bases: Purines, pyrimidines, Sugars: ribose, deoxyribose
  - Nucleoside, nucleotide
  - Structure of RNA
  - Structure of DNA: complementary base pairing
  - Chargaff's rules
- Metabolism
  - Purines, pyrimidines: *de novo* and salvage biosynthetic pathways and catabolism
  - Diseases associated with nucleic acid metabolism

8. Integration of mammalian fuel metabolism

- Overview of different organs and their fuel needs
- Effect of the same hormones on different energy sources:
  - sugar (glucose and glycogen)
  - amino acids
  - lipids (fatty acids and adipose tissue stores)
- Links between nutrient imbalance and metabolic diseases