**TOPIC VIII: CELL PHYSIOLOGY II**

**Learning Outcomes:** Upon completion of Topic VIII (8), you should be able to

a) Define the terms metabolism, anabolism and catabolism
b) Define the terms transcription and translation.
c) Briefly describe the process of transcription.
d) Briefly describe the process of translation.
e) Define the terms codon and anticodon.
f) Explain the roles of tRNA and mRNA in protein synthesis.
g) Describe the possible fates of proteins after their synthesis.
h) Describe the characteristics of enzymes.
i) Explain the role of ATP in the cell.
j) Define the term cellular respiration.
k) Explain the process by which glucose is converted through metabolic pathways to carbon dioxide and water (e.g. glycolysis, Krebs cycle and electron transport chain).
l) Briefly describe the pathways by which fats and proteins can be used to synthesize ATP in a cell.

## A) Overview

- Cells = living building blocks of body
- chemical processes in body (performed by cells) = metabolism
    - anabolism = building molecules
    - catabolism = breakdown of molecules

## B) Basic Cell Processes:

1) Protein Synthesis:
    - proteins can be enzymes, structural etc
    - process of protein synthesis involves:
        a) DNA Transcription
            - DNA → mRNA (messenger RNA)
            - steps:
                i) DNA uncoils at site of gene to expose gene base sequence
                ii) RNA strand is formed, using code on DNA template to add complementary RNA nucleotides
                e.g. DNA Template . . . . . **A T C G C A**
                mRNA . . . . . **U A G C G U***
                * in RNA – uracil (not thymine)

b) Translation
- mRNA ⇒ proteins
- steps:
  i) mRNA associates with ribosomes
    - 3 bases on mRNA = base triplet = a codon (e.g. CUU, ACG, etc)
    - each codon codes for 1 amino acid (aa's can have more than one codon)
  ii) transfer RNA (tRNA) with specific aa and anticodon (complimentary bases to codon) binds to matching RNA
  iii) peptide bond is formed to attach aa to growing peptide chain

- so overall: sequence of DNA bases determines mRNA sequence → determines aa sequence for protein

c) After translation:
- proteins produced on free ribosomes - released into cytosol or go to nucleus or mitochondria
- proteins produced by ribosomes on ER (RER) - released into ER lumen
  - modified by addition of sugars (glycoprotein)
  - transferred to Golgi complex in vesicles
  - Golgi complex:
    i) further modifies protein by
      - carb changes/additions (act as an address to send them to the right destination)
      - lipid additions
    ii) packages modified proteins (in vesicles) and sends to destination: cell membrane, secretion, lysosomes
      § Lysosomes = membrane-bound organelles containing digestive enzymes (acid environment)

- <u>Enzymes:</u> (names end in ase)
  - increase reaction rates
  - not used up in reaction
  - very sensitive to pH, temperature
  - synthesis controlled by cell (proteins) – cell can vary activity
  - very specific

e.g. $CO_2$ + $H_2O$ ⟷ $H_2CO_3$

$CO_2$ + $H_2O$: substrates

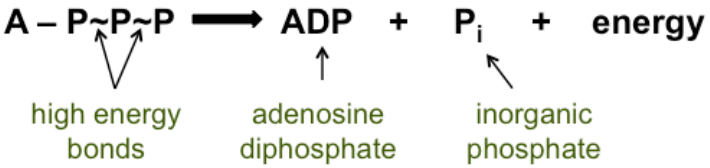
carbonic anhydrase (enzyme)

$H_2CO_3$: product

* this reaction can go in both directions – some can't

2. <u>ATP Catabolism</u>

- Adenosine Triphosphate (ATP)
  - adenine + ribose (= adenosine) + 3 phosphates
  - energy stored in phosphate bonds (covalent)




  - energy produced used for reactions (protein synthesis, active membrane transport, muscle contraction etc)

  - little ATP is stored, so constantly have to make it

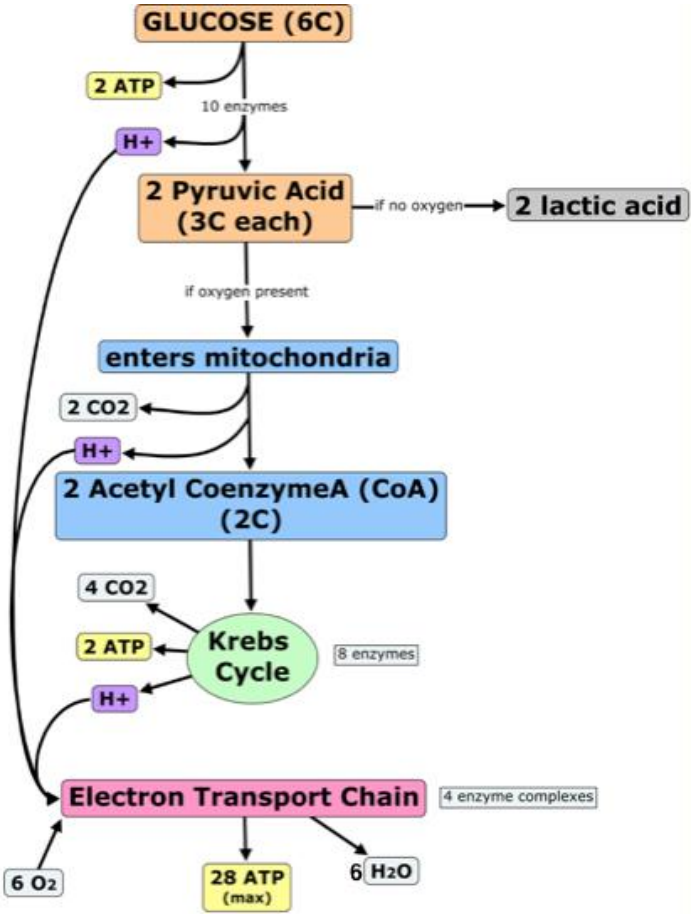
3) <u>Cellular Respiration</u>:

- production of ATP using glucose
  - glucose enters most cells by facilitated transport (may be ↑ in some cells by insulin)

- overall:

**1 glucose ($C_6H_{12}O_6$) + 6 $O_2$ ⇒ 6 $CO_2$ + 6 $H_2O$ + 32 (max) ATP + heat**

- steps:
  a) glycolysis (anaerobic) in cytosol
  b) enters mitochondria – becomes aerobic
  c) Krebs Cycle
  d) Electron Transport Chain




Glycolysis (glucose to pyruvic acid)

- <u>In the body:</u>

a) glycogen → glucose → ATP

b) proteins

- some aa can be converted to pyruvic acid or enter Krebs cycle
- depending on body's need may form new glucose (liver, kidney) or ATP (most cells)

c) fats

- primary storage form of energy in the body (triglycerides)
- broken down to form acetyl CoA → ATP