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Department: Radiology 2nd

Section: A

Subject: Biochemistry

Q1. Explain the process of "ATP synthesis coupled with electron flow?

Ans:- ATP Synthesis:

ATP synthase moves H+ions that were pumped out of the matrix by the electron transport chain back into the

matrix. The energy from the influx of protons into the matrix is used to generate ATP by the phosphorylation

(addition of a phosphate) of ADP. The movement of ions across the selectively permeable mitochondrial

membrane and down their electrochemical gradient is called chemiosmosis.

ATP Synthesis couple to respiratory Electron flow:

We now turn to the most fundamental question about mitochondrial oxidative phosphorylation: how does the flow of electrons through the respiratory chain channel energy into the synthesis of ATP.We have seen that electron transfer through the respiratory chain releases more than enough free energy to form ATP. Mitochondrial oxidative phosphorylation therefore poses no thermodynamic problem. However, one cannot deduce from thermodynamic considerations the chemical mechanism by which energy released in one exergonic reaction (the oxidation of NADH by O2) is channelled into a second, endergonic, reaction (the condensation of ADP and Pi). To describe the process of oxidative phosphorylation completely, we need to identify the physical and chemical changes that result from electron flow and cause ADP phosphorylation - the mechanism that couples oxidation with phosphorylation.

We begin our discussion by considering the stoichiometry of oxidation and phosphorylation in isolated mitochondria and the evidence for obligatory coupling of the two processes. The chemiosmotic interpretation of oxidative phosphorylation is then presented, with the major lines of evidence that

support it. The enzyme ATP synthase, which is directly responsible for ATP synthesis, is the equivalent of an F-type ATP-dependent proton pump working in reverse; *the flow of protons down their electrochemical gradient through this "pump" drives the condensation of Pi and ADP. We describe also the membrane transport systems that move substrates, products, and reducing equivalents between the cytosol and the mitochondrial matrix. Having looked in detail at the coupling of ATP synthesis to electron flow, we will see that in the mitochondria of some tissues the two processes are deliberately "uncoupled" to produce heat.*

We conclude with a summary of the overall regulation of ATP producing processes in the cell, and a look at two further interesting aspects of mitochondria: the mitochondrial genome (and the effects of mutations therein) and the likely evolutionary origins of these organelles.

Q2. Write the reactions that are catalyzed by the following enzymes.

i. Acyl CoA dehydrogenase:

Ans:- Acyl-CoA dehydrogenases (ACADs) are a class of enzymes that function to catalyze the initial step in each cycle of fatty acid β-oxidation in the mitochondria of cells. Their action results in the introduction of a trans double-bond between C2 (α) and C3 (β) of the acyl-CoA thioester substrate[1] Flavin adenine dinucleotide (FAD) is a required co-factor in addition to the presence of an active site glutamate in order for the enzyme to function.

ii. Adenosine deaminase:-

Ans:- Adenosine deaminase is an enzyme involved in purine metabolism. It is needed for the breakdown of adenosine from food and for the turnover of nucleic acids in tissues. Its primary function in humans is the development and maintenance of the immune system.

iii. Nucleotidase:-

Ans:- *A Nucleotidase is a hydrolytic enzyme that catalyze the hydrolysis of a nucleotide into a nucleoside and a phosphate. A nucleotide + H_2O = a nucleoside + phosphate For example, it converts adenosine monophosphate to adenosine, and guanosine monophosphate to guanosine.*

iv. Gluconolactonase:-

Ans:- In enzymology, a gluconolactonase is an enzyme that catalyzes the chemical reaction D-glucono-1,5-lactone + H_2O D-gluconate Thus, the two substrates of this enzyme are D-glucono-1,5-lactone and H_2O, whereas its product is D-gluconate

v. Enoyl-CoA hydratase:-

Ans:-Enoyl-CoA hydratase or crotonase is an enzyme that hydrates the double bond between the second and third carbons on 2-trans/cis-enoyl-CoA: ECH is essential to metabolizing fatty acids in beta oxidation to produce both acetyl CoA and energy in the form of ATP.

Incorporates a water molecule into the fatty acid chain, thereby breaking the double bond between the α and β carbon atoms.

Q3. Define nucleotide, nucleoside and differentiate between DNA and RNA.

Ans:- nucleotide:- *A nucleotide is the basic building block of nucleic acids. RNA and DNA are polymers made of long chains of nucleotides. A nucleotide consists of a sugar molecule (either ribose in RNA or deoxyribose in DNA) attached to a phosphate group and a nitrogen-containing base.*

Both deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are composed of nucleotides. A nucleotide is composed of three smaller molecules; a five-carbon sugar, a phosphate group, and a nitrogenous base.

- A DNA nucleotide contains the five-carbon sugar deoxyribose, a phosphate group, and one of four nitrogenous bases; adenine (A), guanine (G), cytosine (C), and thymine (T).
- A RNA nuclotide contains the five-carbon sugar ribose, a phosphate group, and one of four nitrogenous bases; adenine (A), guanine (G), cytosine (C), and uracil (U). Uracil takes the place of thymine (T).

❖Both thymine and uracil pair with adenine.

So DNA and RNA nucleotides differ according to which five-carbon sugar is present, and whether the nitrogenous base thymine or uracil is present. DNA contains the sugar deoxyribose, while RNA contains the sugar ribose. DNA contains the nitrogenous base thymine, while RNA contains the nitrogenous base uracil.

Q4. Why Dickens and Horecker's Pathway is called HMP pathway. Enlist the enzymes used in PPP Pathway.

Ans:-HMP:-Hexose mano phosphate pathway

PPP:-pantose phosphate pathway.

The HMP pathway was proposed by two since test **(Dicken and Horecker)** so that's called **HMP pathway,**

And the PPP are further divided into two category.

1. **Oxidative phase:-** mainly occurs in liver, adipose tissues, testes, ovary, RBC's and lactating mammary glands.

2. ***Non oxidative phase:-*** mainly occurs in all tissues, as in this phase pentose sugar is formed which is used in DNA and RNA synthesis.

➢***ENZYME USEED AND PPP PATHWAY,***

- Glucose-6-phosphate dehydrogenase
- 6-Phosphogluconolactone hydrolase Gluconolactonase
- 6- Phosphogluconate dehydrogenase
- Trans ketolase
- Trans aldolase
- Epimerise enzyme
- Isomerise

Q5. What is the function of carnitine shuttle system? Write down the stages and steps involved in Beta oxidation of Lipids.

ANS:-*Function:-* The carnitine shuttle is responsible for transferring long-chain fatty acids across the barrier of the inner mitochondrial membrane to gain access to the enzymes of beta-oxidation.

- The oxidation of fatty acids is an important source of energy for ATP production in mitochondria through the entry of acetyl-CoA into the Krebs cycle.
- Fatty acids are oxidized inside the mitochondrial matrix but the fatty acids to be oxidized come from the cytosol. Fatty acids are activated in the cytosol by esterification with Coenzyme A (CoA)to form acyl-CoA (RCO-CoA, where R is the fatty acid acyl group).
- Activated medium-chain fatty acids (C8 and C10) freely diffuse into mitochondria to be oxidized but long chain fatty acids do not diffuse into mitochondria so they must be transported in.

The stages and steps involved in Beta oxidation of Lipids:-

"Beta oxidation take place and four steps,

'de hydrogenation

-hydration

_oxidation

_tholos’s

Each step is catalyzed by a distinct enzyme.

Briefly, each cycle of this process begin with acetyle CoA, one FADH2 one NADH, AND Water and the Acyl-CoA chain become two carbon shorter,