**Course Title: Medical Biochemistry II**

**RAD 2nd, Sec A**

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**Max Marks: 50**

**Note: There are FIVE questions, each carry 10 marks with grand total of 50 marks.**

**ATTEMPT all questions.**

**Avoid copy paste material, as it may deduct your marks.**

Q1. Explain the process of “ATP synthesis coupled with electron flow”.

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

* + 1. Acyl CoA dehydrogenase
    2. Adenosine deaminase
    3. Nucleotidase
    4. Gluconolactonase
    5. Enoyl-CoA hydratase

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

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

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

**ANSWER #3:**

**NUCLEOTIDE:**

Nucleotides are the basic building blocks of the nucleic acid (both DNA and RNA).

**COMPONENTS:**

Structurally nucleotides have three components;

* A nitrogenous (nitrogen containing) base
* A pentose sugar
* A phosphate group

**TYPES OF NITROGENOUS BASES:**

There are two types of nitrogenous bases;

* Purines
* Pyrimidines

**PURINES:**

They are larger molecules, double ring nitrogenous base.

**Examples:**

* Adenine
* Guanine

**PYRIMIDINES:**

They are smaller molecules, single ring nitrogenous base.

**Examples:**

* Cytosine
* Thymine
* Uracil

**NUCLEOCIDE:**

The molecule without the phosphate group is called nucleoside.

**OR**

It is a nitrogenous base with sugar.

**EXAMPLES:**

* Adenine**+**sugar =adenosine
* Guanine + sugar = guanosine
* Thymine + sugar = thymidine
* Cytosine + sugar = cytidine
* Uracil + sugar = uridine

**DIFFERENTIATE BETWEEN DNA AND RNA:**

|  |  |
| --- | --- |
| **DNA** | **RNA** |
| DNA stands for deoxyribonucleic acid | RNA stands for ribonucleic acid |
| Chiefly found inside the nucleus | Found in cytoplasm |
| Double stranded | Single stranded |
| The sugar is deoxyribose | The sugar is ribose |
| Four nitrogenous bases A, G, T, C | Four nitrogenous bases A, G, C, U |

**ANSWER #4:**

**HMP PATHWAY:**

The pentose pentose phosphate pathway (also called the hexose monophosphate pathway) is a metabolic pathway parallel to glycolysis.

**OR**

This is an alternative pathway to glycolysis and TCA cycle for the oxidation of glucose.

**DICKENS AND HORECKER'S PATHWAY:**

The HMP pathway was proposed by two scientists named as (Dickens and Horecker) and it is an alternate route for metabolism of glucose and contains hexose monophosphate so that it is called HMP pathway.

**PHASES OF HMP PATHWAY:**

There are two distinct phases of HMP pathway.

* **Oxidative phase:**

Oxidative phase is irreversible and it mainly occur in liver, adipose tissues, testes, ovary, RBCs and lactating mammary glands. In this phase NADH is generated.

* **Non oxidative phase:**

Non oxidative phase is reversible and it mainly occurs in all tissues as in this phase pentose sugar is formed which is used in DNA and RNA synthesis.

**ENZYMES INVOLVED IN OXIDATIVE PHASE:**

* Glucose 6 phosphate dehydrogenase
* 6 phosphogluconolactone hydrolase **/**Gluconolactonase
* 6 phosphogluconate

**ENZYMES INVOLVED IN NON OXIDATIVE PHASE:**

* Isomerase or epimerase
* Transketolase TPP
* Transaldolase

**ANSWER #5:**

**CARNITINE SHUTTLE:**

The carnitine shuttle represents a mechanism by which long chain fatty-acids, which are impermeable to the mitochondrial membranes, and transported into the mitochondrial matrix for the purpose beta oxidation and energy production.

**Function:**

* It is responsible for transferring of long chain fatty acids across the barrier of the inner mitochondrial membrane to gain access to the enzyme of beta oxidation.
* In living cells carnitine is required for the transport of fatty acids from the cytosol into the mitochondria during the breakdown of lipids (fats) for the generation of metabolic energy.
* It is widely available is a nutritional supplement.

**BETA OXIDATION OF LIPIDS:**

**DEFINITION:**

Beta oxidation is the catabolic process by which fatty acid molecules are broken down to generate acetyl Co-A.

**Use of NADH and FADH2:**

Acetyl Co-A enters the citric acid cycle while NADH and FADH2 produced in beta oxidation process is used in electron transport chain.

**OCCURRENCE:**

Beta oxidation of fatty acid occur in mitochondria.

**SUBSTRATES:**

Free fatty acids, H2O.

**PRODUCTS:**

One acetyl CoA, one NADH, and one FADH2 for every removal of a two-carbon group from the fatty acid chain.

**STAGES INVOLVED IN BETA OXIDATION:**

Three stages are involved in beta oxidation of fatty acid;

* Activation of fatty acid occurring in the cytoplasm
* Transport of fatty acid into mitochondria
* Beta oxidation in the mitochondrial matrix

**ANSWER #1:**

**ATP SYNTHESIS:**

ATP synthesis move H+ ions that were pumped out of the matrix by electron transport chain back into the matrix. The energy from the influx of proton into the matrix is used to generate ATP by the phosphorylation (addition of phosphate) of ADP. The movement of ion across the selectively permeable mitochondrial membrane and down there electrochemical gradient is called chemiosmosis.

**IMPORTANT:**

NADH generates more ATP and FADH2 for every NADH molecule that is oxidized 10 H+ ions are pumped into the intermembrane phase. The yield about 3 ATP molecule. Because FADH2 enter the chain at larger stage (complex 11) Only six H+ ions are transferred to the intermembrane space.

This account for about two ATP molecule.

**ELECTRON TRANSPORT CHAIN:**

* It is also called oxidative phosphorylation or respiratory chain.
* It is a series of electrons FAD, AND, FMN coenzymes Q and cytochrome (b, c1, c, a+a3) collectively known as electron transport chain ETC.
* Electron transport chain passes on electron from NADH2 OR FADH2 to molecular oxygen Forming of molecule of water and generating energy, which is capture in the form of ATP,s.
* The metabolic intermediates of glucose and fatty acids donates electron to coenzyme i.e NAD and FAD and reduce them to NADH2 and FADH2 .
* These reduced coenzyme then donates a pair of electron to specialized Set of electron carriers collectively called electron transport chain and become oxidized thus reducing the next member of electron transport chain .
* ETC is therefore the best example of redox phenomena because the oxidation and reduction is taking place side by side.
* As electron passed down the ETC , they lose much of their free energy.
* Part of this energy is captured and store in the form of ATP and the rest is released as heat.
* ATP is produced by the phosphorylation of ADP with Pi. This phosphorylation is coupled with the oxidation and reduction member of the electron transport chain therefore this whole process known is oxidative phosphorylation.
* Each carriers of ETC can receive electron from electron donor and can subsequently donate electron to the next carrier of the chain ultimately to combine ½ molecule O2 and to form water.
* This requirement of oxygen make the electron transport chain , respiratory chain which account for greatest portion of the body's utilization oxygen.

 Electron transport chain is present in the inner mitochondrial membrane

 It is the common final pathway by which electron derived From different fuels of the body flow to oxygen

 ETC and ATP Synthesis by oxidative phosphorylation proceed continuously in all cells of the body that contain mitochondria .

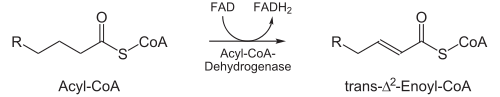
**Chemiosmosis:-**

Energy released in electron transport chain reaction captured by ATP synthase which is then used to make ATP a process called chemiosmosis.

Chemiosmosis is a movement of ion across a semipermeable membrane, down there electrochemical gradient.

**ANSWER #2:**

**REACTION THAT IS CATALYZED BY ACYL CO.A DEHYDROGENASE:**

[](https://en.m.wikipedia.org/wiki/File:Beta-Oxidation1.svg)

**REACTION THAT IS CATALYZED BY ADENOSINE DEAMINASE:**

H2O NH3

Adenosine deaminase ----------------》inosine

HOH2 CNH2

**REACTION THAT IS CATALYZED BY NUCLEOTIDASE:**

The 5’ nucleotidase enzyme catalyzes the following reaction;

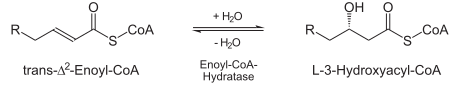
a 5'-nucleotide + H2O ⇌ a nucleoside + phosphate

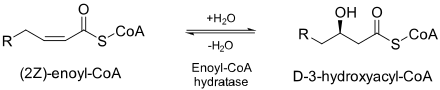
Ribose5-phosphte + H2O ⇌ ribose + phosphate

**REACTION THAT IS CATALYZE BY GLUCONOLACTONASE:**

D-glucono-1,5-lactone + H2O = D-gluconat

**REACTION OF ENOYL-COA HYDRATASE:**

[](https://en.m.wikipedia.org/wiki/File:Beta-Oxidation2.svg)

[](https://en.m.wikipedia.org/wiki/File:Enoyl-CoA_hydratase_reaction_cis.svg)

**“THE END"**