####  Co-enzymes

#### Meaning of Coenzymes:

Many reactions of substrates are catalyzed by en­zymes only in the presence of a specific non-protein organic molecule called the coenzyme. Coenzymes combine with the apoenzyme (the pro­tein part) to form holoenzyme. The coenzymes are also regarded as co-substrates.

Coenzymes are heat-stable, dialyzable non­-protein organic molecules and the prosthetic groups of enzymes.

#### Classification of Coenzymes:

**I. Based on chemical characteristics:**

**A. Containing an aromatic hetero ring**.

1. ATP & its relatives.

2. NAD, NADP.

3. FMN, TPP, B6-PO4.

**B. Containing a non-aromatic hetero ring. Biotin, lipoic acid.**

**C. No hetero ring.** Sugar phosphate, coenzyme Q.

***II. Based on functional characteristics:***

**A. Group transferring coenzymes:**

1. ATP and its relatives.

2. Sugar phosphates.

3. Thiamine pyrophosphate (TPP)

4. CoA.

5. Pyridoxal phosphate (B6-P04).

6. Biotin.

**B. Hydrogen transferring coenzymes:**

ADVERTISEMENTS:

1. Nicotinamide adenine dinucleotide (NAD) and Nicotinamide adenine di­nucleotide phosphate (NADP).

2. Flavin adenine dinucleotide (FAD) and flavin mono-nucleotide (FMN).

3. Coenzyme Q.

***III. Based on nutritional characteristics:***

**(a) Containing B vitamins:**

1. CoA.

2. TPP.

3. NAD & NADP.

4. B6-PO4.

5. FMN, FAD.

6. Folic acid coenzyme.

7. B12 coenzyme.

8. Biotin.

**Function:**

1. Their function is usually to accept atoms or groups from a substrate and to transfer them to other molecules.

2. They are less specific than are enzymes and the same coenzyme can act as such in a number of different reactions.

3. The coenzymes are also attached to the protein at a different but adjacent site so as to be in a position to accept the atoms or groups which art removed from the substrate.

4. NAD and NADP coenzymes function as hydrogen acceptors in dehydrogenation reactions.

5. The chief function of CoA is to carry acyl groups and they are used in the oxidative decarboxylation of pyruvic acid and syn­thesis of fatty acids and acetylation.

6. The function of TPP (co-carboxylase) is to carry ‘active aldehyde’ (R. CH(OH) ) group.

7. The chief function of pyridoxal phosphate (B6-PO4) is involved in transamination re­actions.

8. The chief function of tetrahydrofolic acid is expressed as a carrier of formate and it is used in the synthesis of purines and pyrimidines.

#### Coenzyme A (CoA):

**Chemistry:**

1. It is composed of adenosine triphosphate (ATP), pantothenic acid and β-mercaptoethalamine. So it is the coenzyme form of pantothenic acid, a vitamin.

2. It is a group transferring coenzyme.

3. The reaction group is the sulfhydryl (-SH) group.

4. The acyl group is accepted by the sulfhydril group to form acetyl coenzyme A (CH3CoS.CoA). The acyl coenzyme de­rivatives are the high energy compounds.

**Function:**

1. Carrier of acyl groups, e.g., acetyl, sccinyl, benzoyl.

2. Some of the pantothenic acid is bound to protein in the form of “acyl carrier pro­tein”. This can be regarded as coenzyme A in which the adenine dinucleotide is replaced by protein. ‘”Acyl carrier protein” chiefly functions in the synthetic proc­esses, e.g., of fatty acids and cholesterol.

It is required in the oxidative decarboxy­lation of pyruvic acid and α-ketoglutaric acid, in the breakdown and synthesis of fatty acids and in the synthesis of choles­terol which is involved in bile acids, bilp salts, steroid hormones and vitamin D for­mation.

4. It is used for conjugation with amino com­pounds to form N-acetyl compounds and in the formation of hippuric acid (Ben­zoyl glycine).

5. It is involved in the formation of ketone bodies.

6. It is used in the formation of acetyl choline.

7. It is finally oxidized to CO2, H2O and ATP via citric acid cycle.

**Coenzyme A (CoA):**

Coenzyme A has a complex structure consisting of an adenosine triphosphate, a pantothenic acid which is a B-vitamin and cysteamine. The coenzyme is involved in transfer of acyl-groups. The sulfhydryl (-SH) group of cysteamine moiety of this coenzyme forms a thioester with the carboxyl (-COOH) group of the acyl-compound, such as acetic acid to produce acetyl-CoA which is one of the most important CoA derivatives. The thioester bond is energy-rich and can easily transfer the acetyl- group to an acceptor.

**The structure of coenzyme A, formation of a thioester and a reaction involving****coenzyme A are shown in Fig. 8.33:**

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