Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science Hons. (First Year)

Subject: Zoology

Paper Code: ZOC 101

Paper Title: Diversity of Non- Chordates and Cell Biology

Unit: Cell Organelles

Module Name: Microbodies (Peroxisomes & Glyoxisomes)

Module No: 42

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Notes

Microbody

A microbody (or cytosome) is a type of organelle that is found in the cells of plants, protozoa, and animals. Organelles in the microbody family include peroxisomes, glyoxysomes, glycosomes and hydrogenosomes. In vertebrates, microbodies are especially prevalent in the liver and kidney. A microbody is usually a vesicle with a spherical shape, ranging from 0.2-1.5 micrometers in diameter. Microbodies contain enzymes that participate in the preparatory or intermediate stages of biochemical reactions within the cell. This facilitates the breakdown of fats, alcohols and amino acids.

PEROXISOMES

These are the membrane bound organelles isolated by Beaufay and Berther in 1963. They are called peroxisomes as they are specifically involved in the formation and decomposition of hydrogen peroxide. Lazarow in 1981 also identified another important function of peroxisomes which is the beta oxidation of fatty acids. They are ovoid granules enclosed by single membrane and contain a fine granular substance that may condense in the center forming an opaque and homogenous core.

In animal cells, the long fatty acids are converted to medium chain fatty acids, which are subsequently shuttled to mitochondria where they eventually are broken down to carbon dioxide and water. In yeast and plant cells, this process is carried out exclusively in peroxisomes.

Peroxisomes contain oxidative enzymes, such as D-amino acid oxidase and uric acid oxidase. enzymes within the peroxisome, by using molecular oxygen, remove hydrogen atoms from specific organic substrates (labeled as R), in an oxidative reaction, producing hydrogen peroxide (H_2O_2).

$$\mathrm{RH_2 + O_2 \rightarrow R + H_2O_2}$$

Catalase, another peroxisomal enzyme, uses this H2O2 to oxidize other substrates, including phenols, formic acid, formaldehyde, and alcohol, by means of the peroxidation reaction: thus eliminating the poisonous hydrogen peroxide in the process.

$$\mathrm{H_2O_2 + R'H_2 \rightarrow R' + 2H_2O,}$$

This reaction is important in liver and kidney cells, where the peroxisomes detoxify various toxic substances that enter the blood. About 25% of the ethanol that humans consume by drinking alcoholic beverages is oxidized to acetaldehyde in this way. In addition, when excess H2O2 accumulates in the cell, catalase converts it to H2O through this reaction:

$$\mathrm{2H_2O_2 \rightarrow 2H_2O + O_2}$$

In Plants, peroxisomes are involved in numerous processes, including primary and secondary metabolism, development, and responses to abiotic and biotic stresses. The plant peroxysomes or Leaf peroxisomes are unique as compared to microbodies of heterotrophic organisms because they play an important role in a photosynthesis-related pathway, referred to as photorespiration. Photorespiration is a light-dependent process reminiscent of mitochondrial respiration regarding its gas exchange, because O2 is taken up and CO2 released. Photorespiration also provides protection against abiotic stress conditions caused by high light intensity, drought, and salinity

Glyoxysomes

Glyoxysomes are specialized microbodies found in plants (particularly in the fat storage tissues of germinating seeds) and also in filamentous fungi. Seeds that contain fats and oils include corn, soybean, sunflower, peanut and pumpkin. Glyoxysomes contain enzymes that initiate the breakdown of fatty acids and additionally possess the enzymes to produce intermediate products for the synthesis of sugars by gluconeogenesis. The seedling uses these sugars synthesized from fats until it is mature enough to produce them by photosynthesis.