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The History of the Discovery of Cytochrome Group Enzymes

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Annotation: Cytochromes are hemoproteins containing an iron-porphyrin complex that play a key role in electron transfer and redox reactions in cells. They participate in the respiratory and photosynthetic chains, providing the synthesis of adenosine triphosphate (ATP) and other vital processes. The classification of cytochromes is based on their genetic structure and includes more than 57 families, in particular cytochromes P450, which are important for drug metabolism and detoxification. The functions of cytochromes vary depending on their type and localization, including involvement in immune responses and regulation of metabolism. Cytochromes are widely used in biochemistry, pharmacology, and medicine, being the object of study in the development of new drugs and the assessment of their metabolic activity.

Keywords: cytochromes, hemoproteins, electron transport, redox

reactions, metabolism, biotransformation, cytochrome P450, energy metabolism, mitochondria, enzymes, biochemistry, pharmacology, detoxification.

Cytochromes are protein molecules that perform key functions of xenobiotic oxidants and electron transporters in various biochemical processes of the cell. They contain a heme group and can be in different states of oxidation and reduction.

The history of the discovery of cytochromes covers a long period of scientific research. Back in 1884, the German scientist Emil von Behring first mentioned cytochrome in his works on blood chromophores (pigments). He also noted that the color of cytochrome changes during oxidation. However, at that time, the structure and functions of these molecules remained poorly understood.

At the beginning of the 20th century, the American biochemist George Jensen, studying herbivores, discovered a specific enzyme involved in oxidation processes. He called it the "yellow enzyme" and suggested its connection with cytochromes.

Later, in 1911, the German biochemist Otto Warburg confirmed the presence of cytochromes in mitochondria and established their important role in cellular respiration. He also proved that cytochromes are involved in the transfer of electrons along the chain of reactions, which contributes to the transport of oxygen and nutrients inside the cell.

Additional studies conducted in the 1940s and 1950s made it possible to identify different types of cytochromes with differences in structure and functionality. For example, cytochrome P450 was discovered in 1962 and got its name due to its characteristic absorption maximum at a wavelength of 450 nm.

In the following decades, detailed studies of cytochromes were carried out using X-ray diffraction analysis and electron microscopy. These methods have allowed scientists to gain a deeper understanding of the molecular organization and mechanism of action of cytochromes, which has significantly expanded scientific understanding of them.

The following scientists have contributed to the discovery of cytochromes:

George Jensen (early 20th century) - The first studies on herbivores have shown the presence of an enzyme involved in oxidation, called the "yellow enzyme".

Otto Warburg (1911) - Confirmed the presence of cytochromes in mitochondria, their role in respiration and the ability to carry electrons. In the 1940s and 1950s, various types of cytochromes were identified, each with its own structure and function.

Cytochrome P450 (1962) - Discovered and named in accordance with the spectral characteristic at a wavelength of 450 nm.

Further research: X-ray diffraction analysis and electron microscopy allowed for a better understanding of the molecular structure and mechanism of action of cytochromes.

The functions of cytochromes are very diverse. They are involved in many biological processes, including respiration, photosynthesis, amino acid oxidation, and the metabolism of drugs and poisons.

The main functions of cytochromes

Electron transport: One of the main functions of cytochromes is the transfer of electrons in the respiratory and photosynthetic chains between various enzymes and proteins involved in these

processes. In mitochondria, cytochromes play an important role in the formation of adenosine triphosphate (ATP), which is the main energy source of the cell.

Participation in redox reactions: Due to the ability of the heme group to change its oxidative state, cytochromes are key participants in redox processes. They provide the transfer of electrons, which facilitates the transfer of energy inside the cell. This is extremely important for many cellular functions, including the synthesis of ATP and the formation of various substances.

Regulation of metabolism: Cytochromes are able to influence metabolic processes by participating in redox reactions and changing their activity depending on the physiological conditions of the body and the time of day. Role in the immune system: Some cytochromes are involved in the work of the immune system, especially in protecting against pathogenic microorganisms such as bacteria and viruses. They promote the activation of immune cells and the development of inflammatory processes. It should be noted that the functions of cytochromes can vary depending on their type and localization in the body. For example, cytochromes P450 are key enzymes involved in the metabolism of drugs and toxins. Cytochromes play an important role in photosynthesis in plants, as well as in respiration in animals and microorganisms. They take part in some biochemical reactions and the synthesis of metabolites. The main function of cytochromes is to transfer electrons between the components of an electronic transport chain. At the same time, they are able to change their redox state: in the oxidized form, cytochrome gives up electrons, causing oxidation of other components of the chain, and in the reduced form, it accepts electrons, restoring other molecules. Cytochromes are enzymes, the main part of which is protein. They are localized in the membranes of the endoplasmic reticulum of liver cells, where they participate in the processes of oxidation and synthesis of biologically active substances. Cytochromes are hemoproteins containing an iron-porphyrin complex. The form of heme may vary: These can be types of Heme A or C, as well as more complex structures such as Heme B or Heme C. Cytochromes usually contain one or more hemes, which play a key role in the electron transfer process. The classification of cytochromes is based on their genetic structure and the analysis of amino acid sequences. To date, more than 57 families of cytochromes P450 are known in various organisms, including humans. Cytochromes are classified according to their genetic similarity and functional characteristics. A universal nomenclature is used to classify them, within which an alphanumeric code is assigned to each family. Cytochrome families are designated by the abbreviation CYP, followed by a number — for example, CYP1, CYP2, CYP3, and so on. Within each family, there are subfamilies designated by Latin letters (for example, CYP2A, CYP2B, etc.). If necessary, the subfamilies are supplemented with numbers to clarify the various genetic variants of cytochromes. For example, CYP2D6 is one of the most well—known subfamilies, which includes many genetic variants that determine individual drug metabolism in humans. The main function of cytochromes is to provide oxidative reactions, during which molecules are activated by the incorporation of oxygen into their structure. This process, known as oxygen-coupled oxidation (OSC), allows cytochromes to participate in the phase I biotransformation of a variety of drugs, as well as other substances such as steroids, fatty acids, vitamins, and toxic compounds. Classification of cytochromes is an important tool for understanding their functions and role in metabolism. It also helps predict possible drug interactions associated with various cytochromes, which is taken into account when developing new drugs and evaluating their metabolic activity in humans. In general, cytochromes are key participants in energy metabolism in the cell and perform the most important functions that support the vital functions of the body. Today, cytochromes are widely used in biochemistry, pharmacology, and medicine. They play a significant role in metabolic processes, detoxification, and reactions to oxidative stress. In addition, cytochromes serve as targets for many drugs that exert their effects by influencing electronic transport in mitochondria.

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