HUMAN ANATOMY & PHYSIOLOGY-II- BP201T

UNIT: 2 (DIGESTIVE SYSTEM)

CLASS: 06

TOPIC: Energetics

ENERGETICS: the branch of science which deals with the properties of energy and the way in which it is redistributed in physical, chemical, or biological processes

Adenosine Triphosphate (ATP)

Definition: Adenosine triphosphate, also known as ATP, is a molecule that carries energy within cells. It is the main energy currency of the cell, and it is an end product of the processes of photophosphorylation (adding a phosphate group to a molecule using energy from light), cellular respiration, and fermentation. All living things use ATP. In addition to being used as an energy source, it is also used in signal transduction pathways for cell communication and is incorporated into deoxyribonucleic acid (DNA) during DNA synthesis.

It is the creation of ATP from ADP using energy from sunlight, and occurs during photosynthesis. ATP is also formed from the process of cellular respiration in the mitochondria of a cell. This can be through aerobic respiration, which requires oxygen, or anaerobic respiration, which does not. ATP (adenosine triphosphate) is formed through several cellular processes, primarily oxidative phosphorylation (in mitochondria during respiration) and photophosphorylation (in chloroplasts during photosynthesis). Additionally, substrate-level phosphorylation can produce ATP in various cellular reactions.

1. Oxidative Phosphorylation: This process occurs in the mitochondria of eukaryotic cells and is the main way ATP is generated during cellular respiration.

It involves the electron transport chain, where electrons are passed along a series of protein complexes, releasing energy that is used to pump protons (H+) across the inner mitochondrial membrane.

This creates an electrochemical gradient, and as protons flow back down their concentration gradient through ATP synthase, the enzyme uses the released energy to synthesize ATP from ADP and inorganic phosphate (Pi).

2. Photophosphorylation: This process takes place in chloroplasts of plant cells during photosynthesis.

Light energy is captured by chlorophyll and used to energize electrons.

These energized electrons are passed along an electron transport chain, creating a proton gradient across the thylakoid membrane.

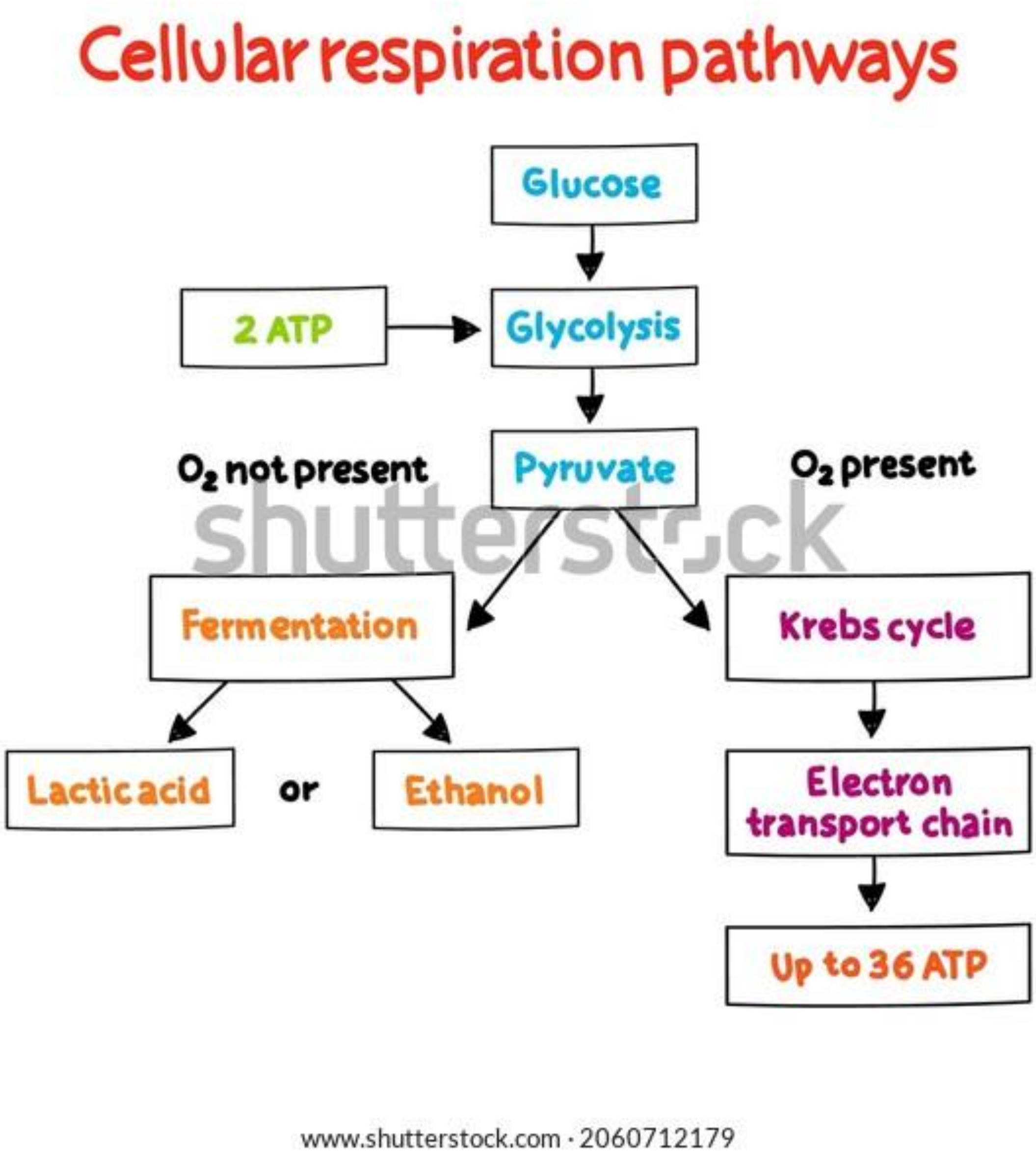
Similar to oxidative phosphorylation, ATP synthase uses the proton gradient to synthesize ATP.

3. Substrate-Level Phosphorylation: This involves the direct transfer of a phosphate group from a high-energy substrate molecule to ADP, forming ATP.

This method produces fewer ATP molecules compared to oxidative and photophosphorylation but is still important in various cellular reactions.

Examples include glycolysis and the citric acid cycle.

ATP is synthesized through various pathways, with oxidative phosphorylation and photophosphorylation being the major contributors. Substrate-level phosphorylation also plays a role in specific cellular reactions.



THE ROLE OFATP Adenosine triphosphate (ATP) is a small molecule that acts as a coenzyme within a cell. The main role of ATP is to provide energy. Below are the ways it provides energy which

1. A source of energy. • An ATP molecule releases approximately 30kj (mol^-1) of energy • Energy from an ATP molecule is released in small quantities to prevent damage to the cell

• Energy released is used for metabolism in the cell.

2. Muscle contraction • ATP is critical for the contraction of muscles; it binds to myosin to provide energy and facilitate its binding to actin to form a cross-bridge • ADP and phosphate are then released and a new ATP molecule binds to myosin.
3. Structural Maintenance • ATP plays a very important role in preserving the structure of the cell by helping the assembly of the cytoskeletal elements.

4. Cell Signaling • ATP has key functions both in intracellular and extracellular signaling.

5. Active Transport • ATP plays a critical role in the transport of macromolecules such as proteins and lipids into and out of the cell.

6. Synthesis of DNA and RNA • During DNA synthesis, ribonucleotide reductase (RNR) reduces the sugar residue from ribonucleoside diphosphates to form deoxyribonucleoside diphosphates such as ADP

CREATININE PHOSPHATE The muscles of the body function through the use of ATP, or adenosine triphosphate, to power contractions. When one molecule of ATP is used in the contraction process, it is hydrolyzed to ADP(adenosine diphosphate), and an inorganic phosphate. The muscles' limited ATP supply is used very quickly in muscle activity, so the need to regenerate ATP is essential. One of the ways that this ATP supply is regenerated is through the molecule creatine phosphate (or phosphocreatine). The high energy phosphate bond in phosphocreatine has more energy than the bond in ATP, 10,300calories per mole in comparison with ATP- 7300.

In the process of regeneration of ATP, creatine phosphate transfers a high-energy phosphate to ADP. The products of this reaction are ATP and creatine. Creatine phosphate can be obtained from two sources: ingestion of meat and internal production by the liver and kidneys. Creatinine (fromed from the metabolism of creatine) waste is removed from the body through the kidneys and urinary system.

BASAL METABOLIC RATE •Basal metabolism or basal metabolic rate (BMR) is defined as the minimum amount of energy required by the body to maintain life at complete physical and mental rest in the postabsorptive state (i.e. 12 hours after the last meal). • It may also called resting metabolic rate (RMR).

MEASUREMENT OF BMR Preparation of the subject: For the measurement of BMR the subject should be awake, at complete physical and mental rest, in a post-absorptive state and in a comfortable surrounding (at 25°C).

The BMR is determined either by the apparatus of Benedict and Roth (closed circuit device) or by the Douglas bag method (open circuit device). Units of BMR : • BMR is expressed as Calories per square meter of body surface area per hour i.e. Cal/sq.m/hr.

Normal values of BMR : • For an adult man 35–38 Cal/sq. m/hr • For an adult woman 32-35 Cal/sq.m/hr. • A BMR value between –15% and+20% is considered as normal. Some authors continue to represent BMR as Cal/day. • For an adult man BMR is around 1,600 Cal/day • For an adult woman around 1,400 Cal/day. • This is particularly important for easily calculating energy requirements per day.

FACTORS AFFECTING BMR 1.Surface area : The BMR is directly proportional to the surface area. Surface area is related to weight and height. 2. Sex : Men have marginally higher (about 5%) BMR than women. This is due to the higher proportion of lean muscle mass in men. 3. Age : In infants and growing children, with lean muscle mass, the BMR is higher. In adults, BMR decreases at the rate of about 2% per decade of life.

4.Physical activity: BMR is increased in persons (notably athletes) with regular exercise. This is mostly due to increase in body surface area.

5. Hormones : Thyroid hormones (T) have a stimulatory effect on the metabolism of the body and, therefore, BMR. Thus, BMR is raised in hyperthyroidism and reduced in hypothyroidism. In fact, the measurement of BMR was earlier used to assess thyroid function.