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HUMAN ANATOMY AND PHYSIOLOGY – II

UNIT 2

TOPIC :

- **Energetics**

  Formation and role of ATP, Creatinine Phosphate and BMR.

Energetics

➢ Energetics is the study of how the body produces, stores, and uses energy to perform various biological functions such as muscle contraction, active transport, biosynthesis, and cell signaling.

ATP (Adenosine Triphosphate)

→ ATP (Adenosine Triphosphate) is the primary energy carrier in all living organisms.

→ It stores and transports chemical energy within cells and is essential for life processes like muscle contraction, active transport, biosynthesis, and cell division.

Formation of ATP

ATP is synthesized in cells through:

a) *Cellular Respiration* ***(Main Pathway):***

Occurs in mitochondria and includes:

- Glycolysis (in cytoplasm) → produces 2 ATP
- Krebs cycle (TCA cycle) → produces 2 ATP (GTP)
- Electron Transport Chain (ETC) → produces ~32 ATP

Total ATP from 1 glucose molecule = ~36–38 ATP

b) *Oxidative Phosphorylation:*

- Most ATP is formed here.
- Electrons from NADH and $FADH_2$ are used to pump H^+ across the inner mitochondrial membrane.
- ATP is formed by ATP synthase.

c) Substrate-Level Phosphorylation:

- Occurs in glycolysis and the TCA cycle
- Direct formation of ATP by transfer of a phosphate group to ADP.

Role of ATP

Function	Description
Energy currency	Provides energy for metabolic reactions
Muscle contraction	Required for actin-myosin interaction
Active transport	Powers transport proteins (e.g., Na^+/K^+ pump)
Biosynthesis	Supplies energy for synthesis of proteins, DNA, RNA, lipids, etc.
Signal transduction	Involved in phosphorylation of enzymes and receptors
Nerve impulse conduction	Maintains ion gradients essential for nerve signals

Creatine Phosphate (Phosphocreatine)

→ Creatine phosphate (phosphocreatine) is a high-energy compound found primarily in muscle cells.

→ It serves as a rapid source of energy for the resynthesis of ATP (adenosine triphosphate), especially during the initial seconds of high-intensity, short-duration activities like sprinting or weightlifting.

Formation

- Synthesized in **liver, kidneys, and pancreas**
- Stored mainly in **muscle cells**
- Formed from:
  - **Creatine + ATP → Creatine phosphate (CP)** + ADP
    (via enzyme creatine kinase)

Role of Creatine Phosphate

Function	Description
Rapid energy source	Acts as a **quick reserve** of high-energy phosphate to regenerate ATP
Muscle contraction	Used during first 10–15 seconds of intense activity (e.g., sprinting)
ATP buffer	Helps maintain ATP levels during early stages of activity

BASAL METABOLIC RATE

→ Basal Metabolic Rate (BMR) is the minimum amount of energy required by the body to perform vital functions at complete physical and mental rest, in a thermoneutral environment, and in a fasting state (usually 12 hours post-meal).

→ BMR is the energy your body needs to maintain basic life functions such as:

- Breathing
- Blood circulation
- Body temperature regulation
- Cell production
- Brain and nerve function

Units of BMR

- BMR is commonly expressed as:
  - **Kcal/day** or
  - **Kcal/m²/hour**

Example

➢ A typical adult male may have a BMR of 1600–1800 kcal/day, and a female around 1400–1600 kcal/day.

How BMR is Measured

Method	Description
Direct Calorimetry	Measures heat produced by the body in a calorimeter chamber.
Indirect Calorimetry	Measures O_2 consumption and CO_2 production to estimate energy usage.
Predictive Equations	Common formula: Harris-Benedict Equation based on weight, height, age, and gender.

Factors Affecting BMR

Factor	Effect on BMR
Age	BMR decreases with age
Gender	Males usually have higher BMR (more muscle mass)
Body Composition	More muscle = higher BMR
Hormones (e.g., Thyroxine)	Increased thyroxine = higher BMR
Body Temperature	Fever increases BMR
Pregnancy	Increases BMR
Fasting/Starvation	Decreases BMR to conserve energy
Genetics	Some people naturally have higher BMR

Significance of BMR

- Helps in **planning calorie requirements** for
  - Diet plans
  - Weight loss or gain
  - Managing metabolic disorders
- Useful in **diagnosing thyroid dysfunction**
- Guides **nutritional support** in critically ill patients