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SEARCH

SPORT EDUCATION FOR ACTIVE AND RESPONSIBLE CITIZENSHIP THROUGH HEALTH CARING

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MODULE 2

ENCOURAGING SPORTS PRACTICE FOR ONE'S OWN PSYCHO-PHYSICAL WELLBEING AND TO CONTROL NATIONAL SOCIAL AND HEALTH COSTS

SEGMENT 6

Metabolism

Nutrition

Nutrients: substances used by body to produce energy, provide building blocks or function in other chemical reactions.

Classes:

- Carbohydrates, proteins, lipids, water: required in large amounts.
- Vitamins, minerals: required in small amounts.

Essential nutrients: must be ingested, cannot be synthesized. Certain amino acids, certain fatty acids, most vitamins, minerals, water, and a minimum number of carbohydrates.

Kilocalorie: measure of energy supplied by food and released through metabolism.

Carbohydrates

Most come from plants (exception: lactose from milk).

Monosaccharides: include glucose, fructose, galactose.

Disaccharides: include sucrose, maltose, lactose.

Polysaccharides (complex): include starch, glycogen, cellulose. Cellulose is indigestible.

Disaccharides and polysaccharides converted to glucose (used for energy or stored as glycogen or fats).

Uses of Carbohydrates In the Body

- Digestion breaks polysaccharides and disaccharides into monosaccharides before absorption.
- Liver converts monosaccharides into glucose which is then used as an energy source to produce ATP.
- Excess glucose converted to glycogen and stored in muscles and liver cells.
- Excess beyond storage is converted to fat.
- Sugars also become part of DNA, RNA, ATP, glycoproteins, glycolipids.

Lipids

Triglycerides (95%): used for energy to produce ATP or stored in adipose tissue, liver:

- Saturated fats and oils: single covalent bonds between carbons; found in meat fats, whole milk, cheese, eggs.
- Unsaturated fats and oils: one or more double bonds between carbons.
  - Monounsaturated fats have one double bond; found in olive and peanut oil.
  - Polyunsaturated fats have two ore more double bonds; found in fish and sunflower oil.

Cholesterol: steroid found in liver, egg yolks but not found in plants.

Phospholipids: for example, lecithin; major components of plasma membranes, found in egg yolks.

Uses of Lipids In the Body

- **Triglycerides**: used to produce ATP.
  Excess stored in adipose tissue or liver.
- **Cholesterol**: can be eaten or manufactured in the body. Component of plasma membranes, can be modified to form bile salts and steroids.
- **Eicosanoids:** derived from fatty acids. Involved in inflammation, blood clotting, tissue repair, smooth muscle contraction.
- **Phospholipids**: part of plasma membrane and used to construct the myelin sheath. Part of bile.

Proteins

Proteins are chains of amino acids

Types:

- Essential: must be obtained in diet.
- Non essential: body can synthesize.
- Complete proteins: contain all necessary amino acids (such as meat, fish, poultry, milk, cheese, eggs), whereas incomplete proteins (such as rice or beans) do not.

Functions:

- Protection (antibodies), regulation (enzymes, hormones), structure (collagen), muscle contraction (actin, myosin), transportation (hemoglobin, ion channels).

Vitamins 1

Vitamins: organic molecules that exist in minute quantities in food.

- Essential vitamins must be obtained by diet.
- Pro-vitamins: substance that can be assembled by the body into a functioning vitamin. Examples include beta carotene, 7-dehydrocholesterol, and tryptophan.

Many function as coenzymes or parts of coenzymes (combined with enzymes make the enzyme functional).

Vitamins 2

Classifications:

- **Fat-soluble**: A, D, E, K. Can be stored in fatty tissues to the point of toxicity. Too much A causes bone and muscle pain; skin disorders, hair loss, increased liver size. Too much D causes deposition of Ca in kidneys, heart, blood vessels.

- **Water-soluble**: B, C, and all others remain short time then are excreted. Too much C causes stomach inflammation; diarrhea.

Minerals

Minerals: inorganic nutrients necessary for normal metabolic functions.

Daily requirements for:

- Major minerals = 100 mg or more daily.
- Trace minerals = less than 100 mg daily.

Functions: they establish resting membrane potentials, generate action potentials, add strength to bones and teeth, buffers, involved in osmotic balance; they are components of coenzymes, vitamins, hemoglobin.

Obtained from animal and plant sources. Minerals attached to plant fibers are difficult to absorb.

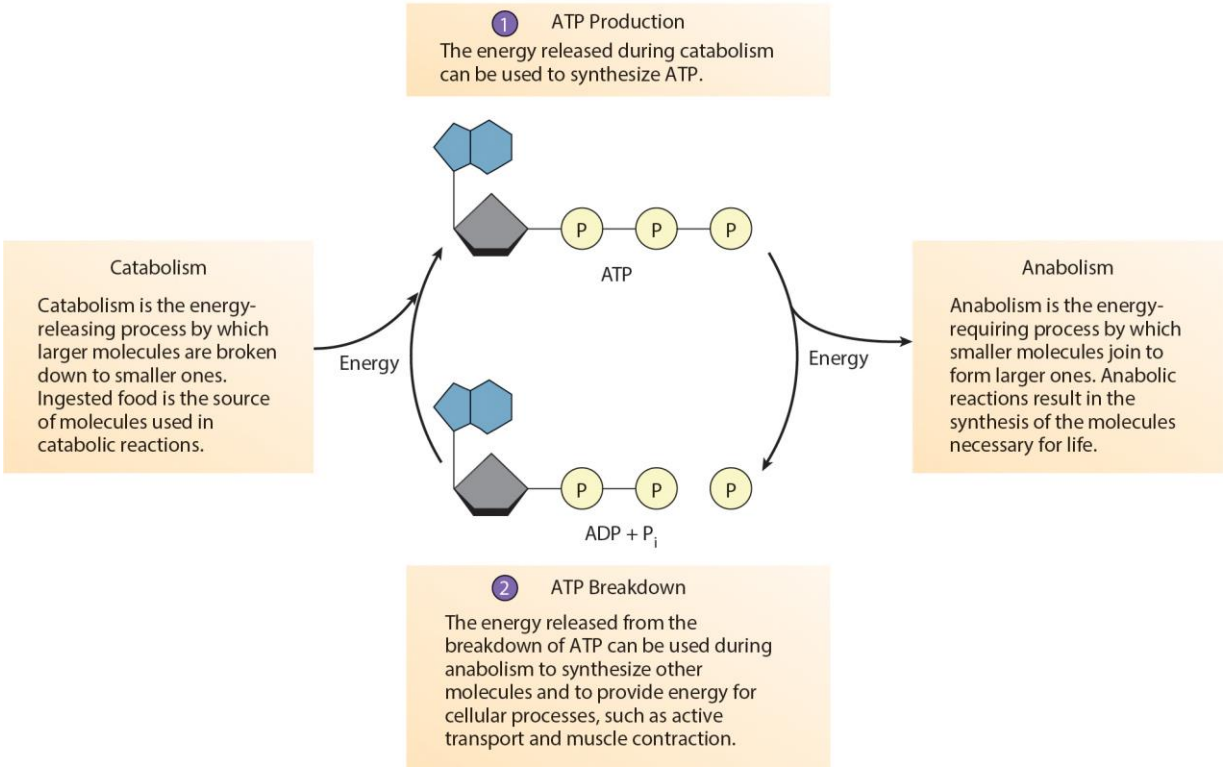
Metabolism

Metabolism: total of all chemical changes that occur in body; consists of:

- **Catabolism:** energy-releasing process where large molecules broken down to smaller.
- **Anabolism:** energy-requiring process where small molecules joined to form larger molecules.

Energy from nutrient catabolism used to produce ATP, which can then be used to drive anabolic reactions.

ATP Derived from Catabolic Reactions Drives Anabolic Reactions



Aerobic Respiration 1

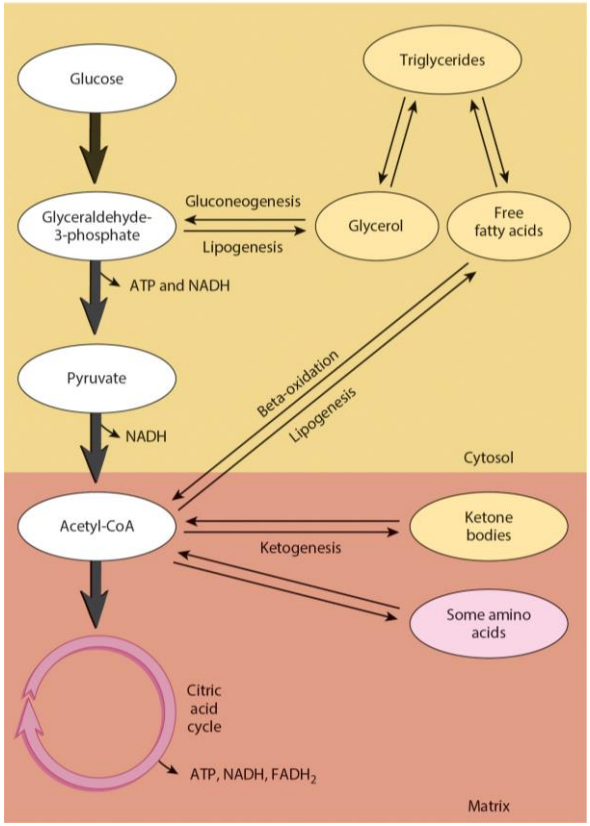
Aerobic respiration: breakdown of glucose in presence of oxygen to produce carbon dioxide, water, 36 ATP molecules.

- Most of ATP molecules that sustain life are produced this way.

Phases:

1. Glycolysis.
2. Acetyl-CoA formation.
3. Citric acid cycle.
4. Electron-transport chain.

Lipid Metabolism



Triglycerides are broken down and released as free fatty acids.

Free fatty acids are taken up by cells and broken down by beta-oxidation into acetyl-CoA which:

- Can enter citric acid cycle.
- Can be converted to ketone bodies (ketogenesis) in liver. Ketones travel to skeletal muscle and are used in citric acid cycle to produce ATP.

Protein Metabolism

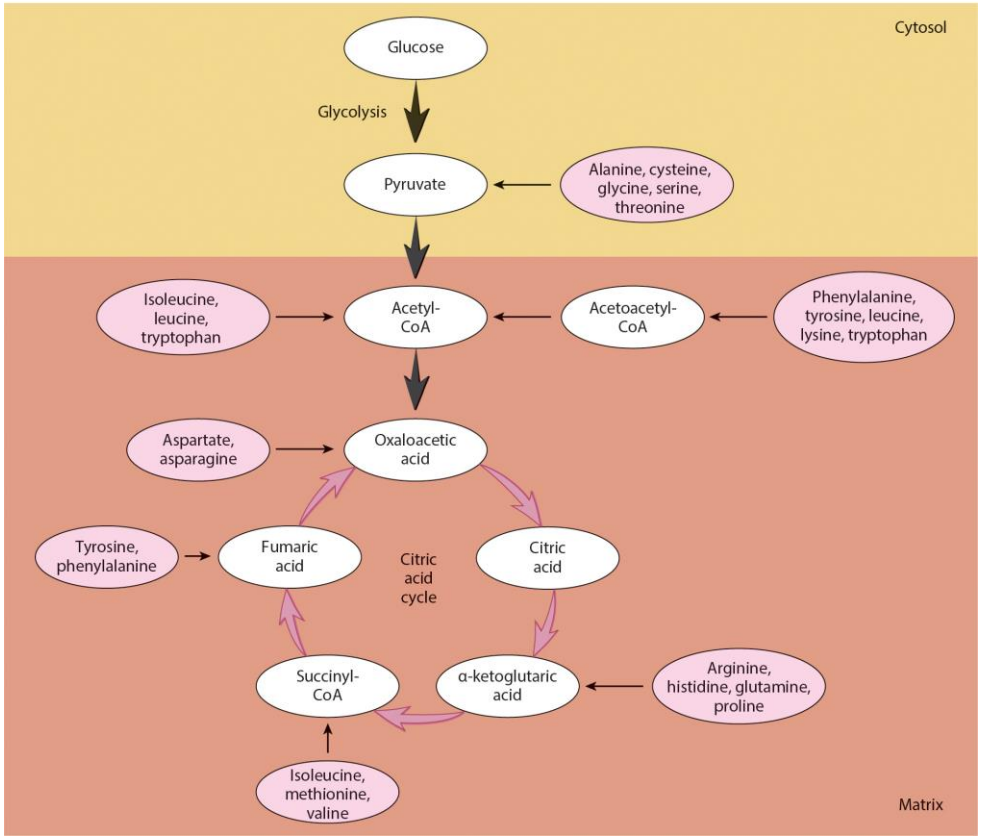
Non-essential amino acids can be formed by transamination, transfer of an amine group to ketoacid. Can also be ingested.

Amino acids are used to synthesize proteins.

If used for energy, amino acids undergo oxidative deamination. Ketoacids are produced as by-products of oxidative deamination. Ammonia is converted to urea and excreted.

Amino acids not stored in the body.

Amino Acid Metabolism



Metabolic Rate

Metabolic rate: total amount of energy produced and used by body per unit of time.

- Estimated by amount of oxygen used per minute.

Metabolic energy used in three ways:

1. For basal metabolism: energy used at rest, 60% of basal metabolic rate (BMR).
2. For thermic effect of food: energy used to digest and absorb food, 10%.
3. For muscular activity: energy used for muscle contraction, 30%.

Body Temperature Regulation

Free energy: total amount of energy liberated by the complete catabolism of food.

- 43% used to produce ATP.
- Rest lost as heat.

Balance maintained between heat gain and loss.

- Heat is produced through metabolism.
- Heat is exchanged through radiation (loss of heat as infrared radiation), conduction (exchange of heat between objects in direct contact with each other), convection (transfer of heat between the body and the air), evaporation (conversion of water from a liquid to a gaseous form).

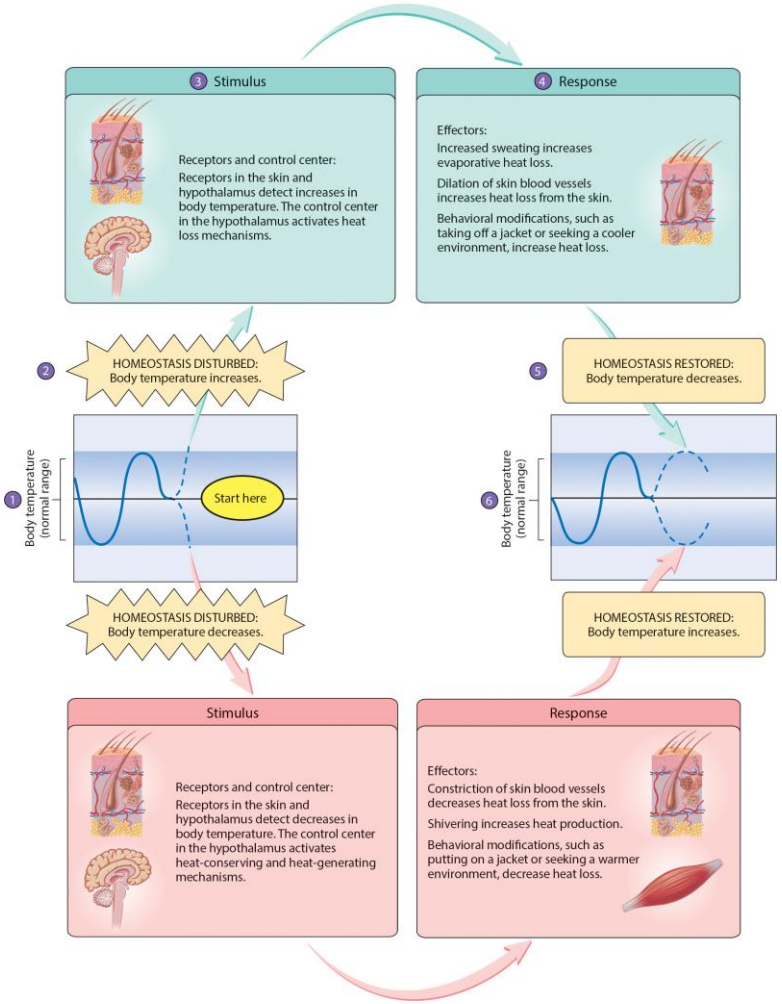
The greater is the temperature difference between body and environment, the greater is the rate of heat exchange.

Regulated by a “set point” in hypothalamus. Negative feedback mechanism.

Set point can change; for example, during a fever.

Heat Exchange

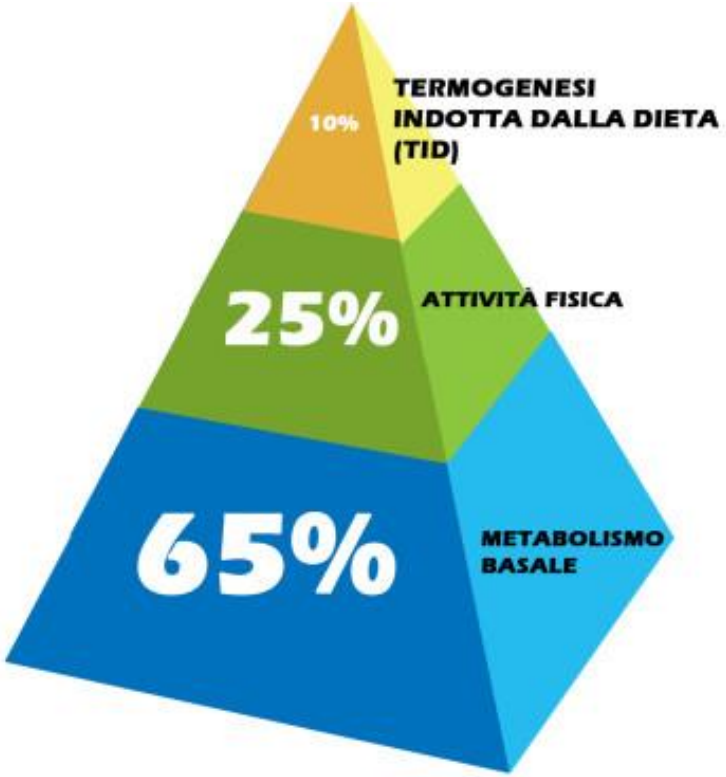
Summary of Temperature Regulation



A rather small proportion (10%) of our metabolism is influenced by a third factor which is **diet-induced thermogenesis**.

This is the *amount of energy we use for digesting introduced substances,* defined as *food-specific dynamic action*.

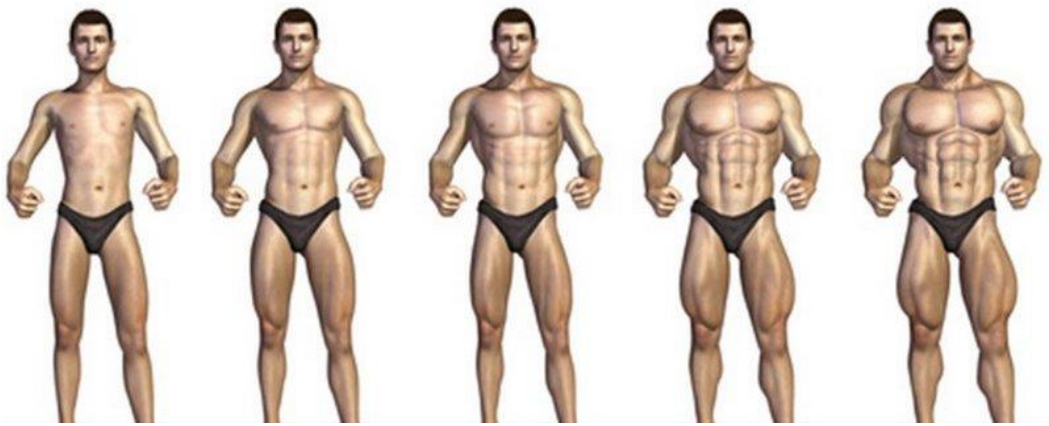
In absolute terms, digesting proteins requires more energy than fats while significantly less for sugars. At rest, *liver and brain are the organs which consume the most*.



There are several factors which can affect basal metabolic rate, other than the aforementioned gender factors.

Fasting tends to reduce the basal metabolic rate, whereas an *increase in the outside temperature over 30° or intense cold tends to raise it*.

A higher percentage of **muscle mass** (i.e. body composition) increases the BM by about 1.5% for every kilo of extra muscle, as well as the body surface area (*everything being equal, a taller person consumes indeed more*).



Hormones deserve a separate mention, as they are responsible for the gender differences in BM.

Thyroid **hormones** are very important and their increased production is accompanied by weight loss.

The same applies to **adrenalin** produced by the adrenal gland, as well as the hormones essential for growth and muscular development, **growth hormone** and **testosterone**, both of which are responsible for the significant increase in BM in subjects of developing age.

Keywords

Basal Metabolic

Rate

Vital Functions

Hormonal Activity

Catabolic

Anabolic

Sugars

Saturated Fats

Muscle Mass

Thyroid Hormones

Growth Hormones

Testosterone