

Tishk International University
Faculty of Applied Science
Nutrition and Dietetics Department
Maternal and Child Nutrition – 2nd Grade



An Introduction about: Maternal and Child Nutrition Course



Course Objectives:

By the end of this course, students will be able to:

- Understand key physiological and nutritional changes during pregnancy and lactation.
- Examine the impact of maternal nutrition on fetal and child development.
- Analyze infant and young child feeding practices and their health implications.
- Identify common maternal and child nutrition problems across contexts.
- Evaluate interventions and programs improving maternal and child nutrition.
- Apply dietary assessment and counseling skills in health settings.
- Design nutrition education and communication strategies for families and communities.

Introduction

- **Human body** changes and behaves differently in different ‘periods’ of its lifecycle



- At different stages of lifecycle with reference to **changing age** and continuously changing **physiological status**, the requirement of nutrients is based on **activity, BMR, growth rate**, etc.



Introduction to Maternal and Child Nutrition

Maternal and child nutrition refers to the study and practice of ensuring adequate dietary intake and nutritional status for women before conception, during pregnancy and lactation, and for their infants and young children.

It encompasses nutrient requirements across different life stages, focusing on the health and development of both mother and child. Adequate nutrition during these periods supports fetal development, infant growth, and long-term health outcomes

Developmental Origin of Health and Disease - Barker's Hypothesis -

What happens here



Can influence health here





Maternal and Child Nutrition

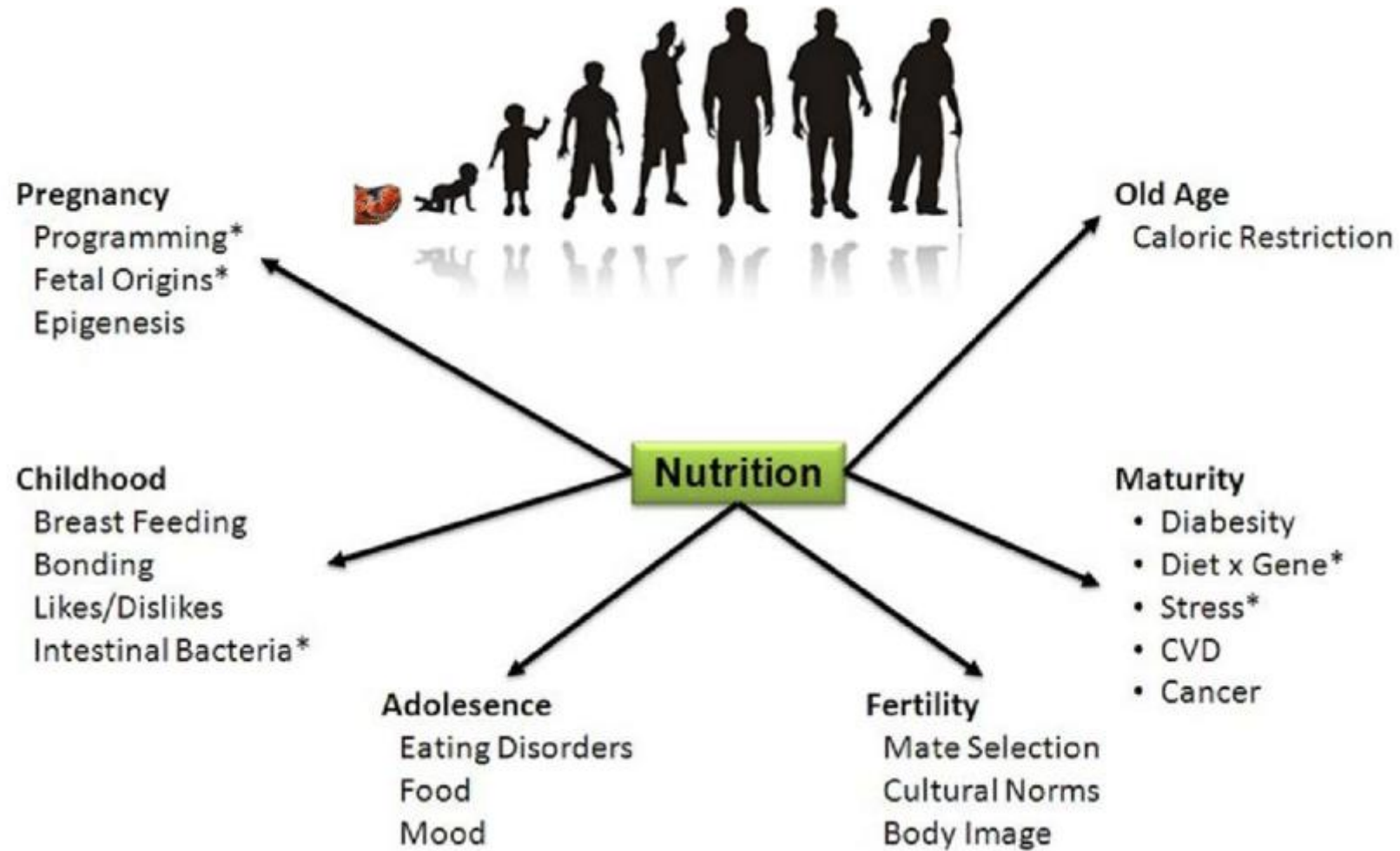
Nutrition during the critical periods of **preconception, pregnancy, lactation, infancy, and early childhood** directly impacts immediate and **lifelong health**.

Proper maternal nutrition reduces risks of pregnancy complications and promotes optimal fetal growth, while early childhood nutrition affects physical and cognitive development



Impact on Maternal Health, Fetal Development, and Child Survival

- Maternal nutrition influences fertility, pregnancy outcomes (e.g., preterm delivery, low birth weight), and maternal morbidity.
- Nutrient deficiencies or excesses can lead to complications such as preeclampsia, gestational diabetes, and poor fetal growth (e.g., intrauterine growth restriction).
- Postnatal nutrition via breastfeeding supports infant immune function and development, reducing morbidity and mortality risks.





Determinants of Maternal and Child Nutrition

Biological, Socioeconomic, and Environmental Factors

Biological: Age, parity, health status, and metabolic demands affect nutritional needs and outcomes.

Socioeconomic: Income influences access to nutritious food, healthcare services, and education. Poverty correlates strongly with higher rates of malnutrition.

Environmental: Food security, sanitation, cultural feeding practices, and exposure to infectious diseases also determine nutritional status



Basics of Nutrition:

- **Nutrition** is a vital component to overall wellness and health. Diet affects energy, well being and many disease states.
- There is a connection between lifetime nutritional habits and the risks of many chronic diseases such as cardio vascular diseases, diabetes, cancer.
- A well balanced diet can prevent such conditions and improve energy levels and over all health and wellness.
- The basis of nutrition is FOOD



Factors influencing food selection

Why do people choose the foods they do?

This is a very complex question, and many factors influence what you eat, as you can see from this list:

- Flavor
- Other aspects of food (such as cost, convenience, nutrition)
- Demographics
- Culture and religion
- Health
- Social and emotional influences
- Food industry and the media
- Environmental concerns

FIGURE 1-3 FACTORS INFLUENCING WHAT YOU EAT

Flavor

- Taste
- Smell
- Appearance
- Texture

Other Aspects of Food

- Cost
- Convenience
- Availability
- Familiarity
- Nutrition

Demographics

- Age
- Gender
- Educational level
- Income

Culture and Religion

- Traditional foods and food habits
- Attitudes and beliefs
- Special events and celebrations
- Religious foods and food practices

Health

- Health status and desire to improve health
- Desire to improve appearance
- Nutrition knowledge and attitudes

Social and Emotional Influences


- Social status
- Peer pressure
- Emotional status
- Food associations

Food Industry and the Media

- Food industry
- Food advertising
- Food portrayal in media
- Reporting of nutrition/health studies

Environmental Concerns

- Use of synthetic fertilizers and pesticides
- Wastefulness of fattening up livestock/poultry



A **Food** is any substance utilized by a living thing for energy, growth and repair.

- There are both plant and animal sources for foods.
 - **For example**, you can eat grains in the form of bread, and you can eat the meat of an animal that ate such grains.





- **Nutrition** can be defined as the science of the action of food, beverages, and their components in biological systems (within the body).



Nutrients

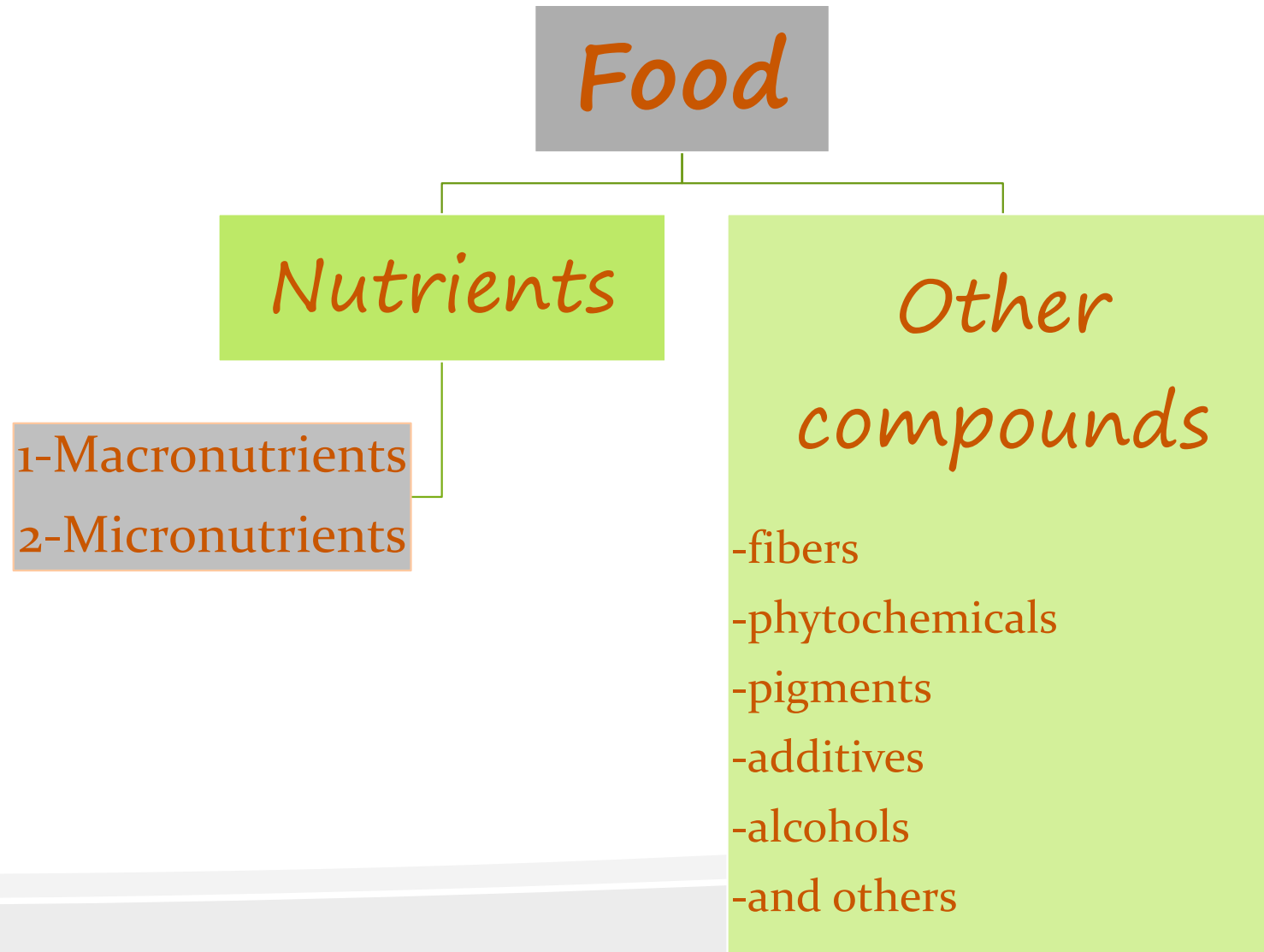
A **nutrients** is a compound that provides a needed function in the body.

There are six different kinds of nutrients in foods.

1. Proteins (Meat, Beans, Fish)
2. Carbohydrates (Wheat, Grains)
3. Fats
4. Vitamins
5. Minerals
6. water



Food Composition





Nutrients can be further classified into groups based on the amount needed in the body.

- **Macronutrients**

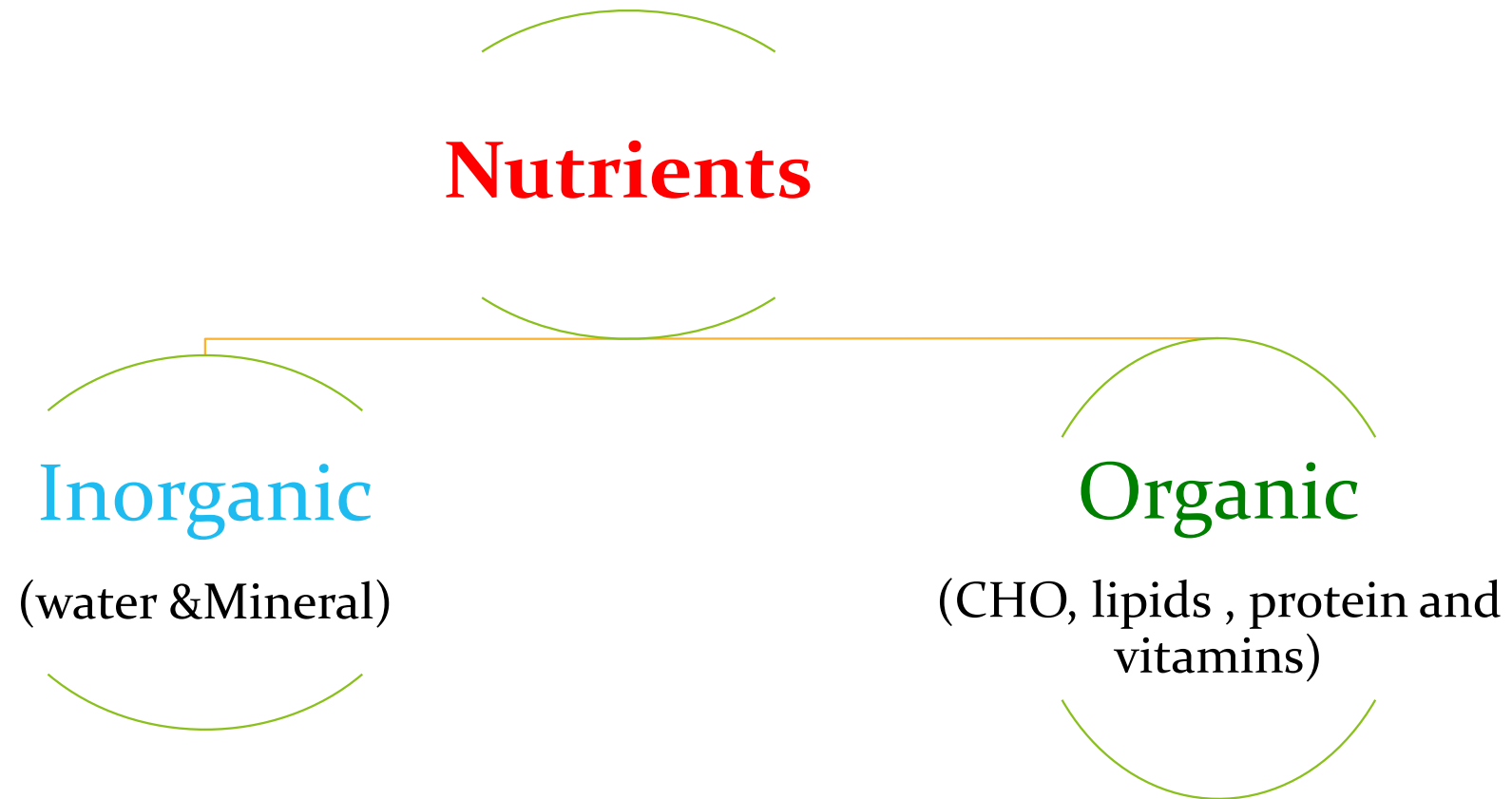
are various types of nutrients needed in larger amounts for the body. The types of nutrients that are found in this group include **carbohydrates, proteins, lipids** and **water**.

- **Micronutrients**

are types of nutrients needed in smaller amounts for the body. These nutrients are just as important. The types of nutrients that are found in this group include **vitamins** and **minerals**
















Chemical composition of the nutrients



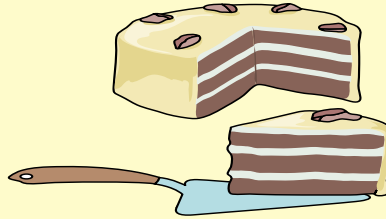
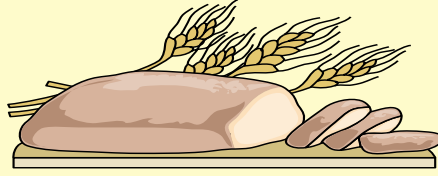
→ **Organic nutrients:** substance that **contain carbon atom.**

→ **Inorganic:** substances that **do not contain carbon atoms.**

Nutrients and Their Functions

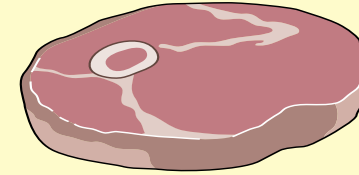
	Energy	Growth, maintenance, support, or structure	Regulate body processes
Carbohydrates			
Protein			
Fats			
Vitamins			
Minerals			
Water			

Carbohydrates – A large class of nutrients including sugar, starches, and fibers that are the body's primary source of energy.



Lipids (fats) – A group of fatty substances including triglycerides and cholesterol that are not soluble in water and that provide a rich source of energy and structure to the body's cells.

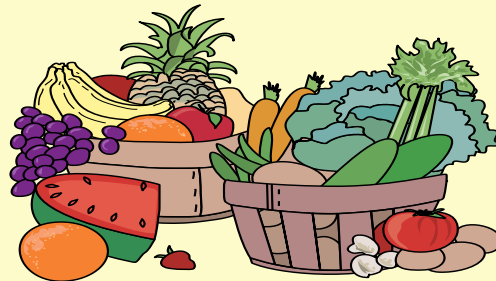
Proteins – Major structural part of body's cells composed of nitrogen-containing amino acids, particularly rich in animal foods.



Vitamins – 13 noncaloric nutrients found in a wide variety of foods (especially fruits and vegetables)

Both vitamins and minerals are essential in small amounts to maintain the body, regulate body processes, and for growth and reproduction.


Minerals – Noncaloric, inorganic chemical substances found in a wide variety of foods



Water – Inorganic nutrient that plays a vital role in all bodily processes and makes up just over half of the body's weight.

Nutrients (Function and Sources)

1. Proteins:

Function	Source
<ul style="list-style-type: none">-Provides amino acids (building blocks) that we can't make ourselves.-Needed for growth, development and repair of the body.-Also provides energy	<p>Meat, fish, eggs, dairy foods, cereal products such as bread, soya products, nuts</p> 

2. Carbohydrates



Function	Source
<ul style="list-style-type: none">- Starches and sugars are carbohydrates, the main source of the body's energy.- Sugars are not essential foods. They provide energy (calories) but no nutrients. For that reason sugar is called an "empty calorie" food	<p>Carbohydrates</p> <ul style="list-style-type: none">- Rice, wheat, corn, and potatoes,-fruit and starchy vegetables, milk and milk products, <p>Sugar,</p> <ul style="list-style-type: none">- preserves and confectionery.







3. Fats and oil


Function	Sources
<ul style="list-style-type: none">- Concentrated source of energy- Make certain vitamins available for use in the body,- Cushion vital organs- Make up part of all body cells,- Help to maintain body temperature.	<p>Saturated (mono) Fats: usually are solid in form and of animal origin ex. Beef, pork, chicken, cakes, fried food</p> <p>Unsaturated (poly)Fats: Usually liquid at room temperature, but not always ex-olive oil, avocado, nuts, fish</p>

4. Vitamins

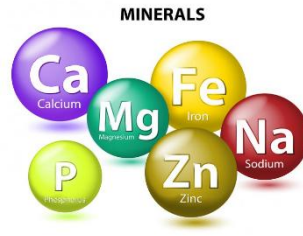
- Fat-soluble vitamins. They are digested and absorbed with the help of fats in the gut.

Vitamin	Function	Source
Vitamin A	- for strong bones, good vision, and healthy skin and immune system	- dark green and yellow fruits and vegetables
Vitamin D  	- helps calcium and phosphorus to form straight, strong bones and teeth.	With direct sunlight on the skin, the body can make its own. - Oily fish, eggs, - Added to milk 
Vitamin E	- Acts as an antioxidant and protects the cells in our bodies against damage	Vegetable oils, nuts and seeds.
Vitamin K 	- Needed for the normal clotting of blood and is required for normal bone structure.	- Made by bacteria that live in the intestinal tract. - green leaves of spinach, kale, cabbage, and cauliflower and also in pork liver.

Water soluble vitamins- cannot be stored in our bodies and are readily excreted.

Vitamin	Function	Source
Vitamin B (1, 2, 3, 6, 12) and folic acid	<ul style="list-style-type: none">- Maintain healthy skin and a well-functioning nervous system.- Converts carbohydrates into energy.- Healthy fetal development	<ul style="list-style-type: none">- Whole grains, nuts, meat (especially pork), fruit and green vegetables and fortified breakfast cereals.- Milk, eggs, rice, liver, legumes, mushrooms- Poultry, white fish, soya beans, peanuts
Vitamin C 	<ul style="list-style-type: none">- Builds the connective tissue that holds body cells together.- Healthy teeth, gums, and blood vessels.- Helps the body to absorb iron.	<ul style="list-style-type: none">- Citrus fruits and berries; green vegetables, peppers, tomatoes and potatoes





• **5. Minerals:** Minerals do not broken down during digestion destroyed by heat or light.

- **Trace Minerals** – minerals that are required in our diet at amounts less than 100 mg/day.
- **Major Minerals** - minerals that are required in our diet at amounts greater than 100 mg/day.

Trace Minerals

Mineral	Symbol	Function	Deficiency	Food Sources
Iron	Fe	Red Blood Cell structure	Iron def. anemia	Dark green leafy vegetables, liver, legumes
Iodine	I	Thyroid hormone development Energy metabolism	Goiter	Sea foods, iodized sale
Zinc	Zn	Fetal development, wound healing		Whole grain, meat, egg
Fluoride	Fl	Teeth maintenance	Dental carries	Fortified water, tea, fish bones



Major Minerals

Major Minerals

Mineral	Symbol	Function	Deficiency	Food Sources
Calcium	Ca	Maintenance of bones and teeth	Osteoporosis, convulsion, muscle spasm	Dairy products, green leafy veg, fish with bones
Phosphorus	Ph	Bone growth		Milk, cereal, all foods
Magnesium	Mg	Muscle contraction, Bone & tooth structure		Green veg, sea foods, legumes
Sodium	Na	Body fluid & acid-base balance	Hypertension, edema	Salt, processed foods
Potassium	K	Body fluid balance		All whole foods
Chloride	Cl	Body Fluid Balance		Salt, processed food



Goiter
Iodine deficiency



Angular stomatitis
Vit. C deficiency



Rickets
Vit. D deficiency


6. Roughage

	Function	Source
Fibre	<ul style="list-style-type: none">- Not a nutrient, but improves the movement of the gut contents and helps prevent constipation.- Some types of fibre also help lower blood cholesterol and glucose levels.	Cereals, beans, pulses, lentils, fruit and vegetables.

7. Water

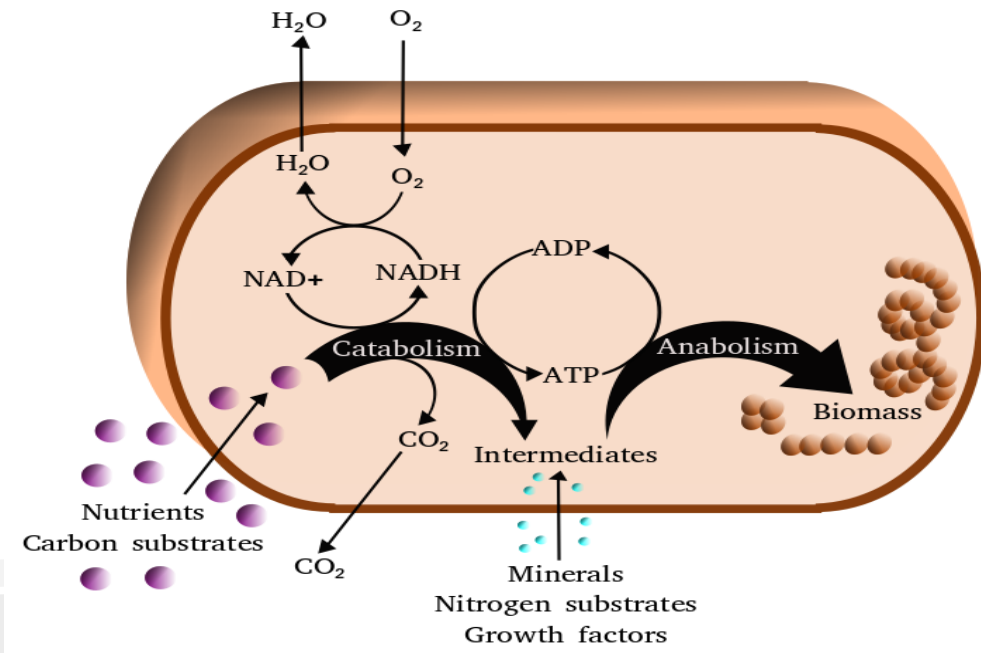
Function	Source
<ul style="list-style-type: none">- Takes an active part in many chemical reactions and is needed to carry other nutrients- Regulates body temperature- Eliminate wastes.- Makes up about 60-70 % of an adult's body weight.	<p>Requirements for water are met in many ways.</p> <ul style="list-style-type: none">- Minimum 8 glasses of water a day- Most fruits are more than 90 percent water.



- 
- There is a lot of interest in non-nutritive compounds and ingredients found in foods that are believed to provide health benefits beyond the traditional nutrients. These include:
 - **Phytochemicals:** Compounds found in plants
 - **Zoochemicals:** Compounds found in animals. Zoochemicals are the animal equivalent of phytochemicals in plants. An example of this are the yellow carotenoids, lutein and zeaxanthin. Kale, spinach, and corn (phytochemicals) are good sources of lutein and zeaxanthin. However, egg yolks are also a good source of these carotenoids (zoochemicals).
 - **Functional foods:** Food or food ingredients that generally contain phytochemicals, zoochemicals or both

Metabolism

- ❖ Metabolism The sum of all chemical reactions that take place in the body which it maintains itself produces energy for its functioning.





Metabolism

Metabolism – process by which living systems acquire and use free energy to carry out vital processes

Catabolism (degradation)

- Nutrients and cell constituents are broken down for salvage and/or generation of energy
- Exergonic oxidation

Anabolism (biosynthesis)

- Endergonic synthesis of biological molecules from simpler precursors
- Coupled to exergonic processes through “high-energy” compounds

Calories and Food Energy

Food Energy

- Your body requires food energy to grow, move, think, create blood cells, etc.
- The nutrients carbohydrates, protein, and lipids provide energy but water, vitamins and minerals do not.
- **Nutritionists recommend you get energy from a variety of foods:**
 - 55% from carbohydrates
 - 15% from proteins
 - 30% or less from lipids/fats



Food energy is measured in kilocalories (kcal), commonly referred to as **calories**. This terminology is technically incorrect, but is used so commonly that we refer to them as **Calories**.

- calories cannot be seen because it is not a thing. You burn energy, not calories, as calories are just a measurement tool.

Amount / Teneur	% Daily Value
Calories / Calories	
Fat / Lipides 4.5 g*	
Saturates / saturés 2.5 g + Trans / trans 0.2 g	
Cholesterol / Cholestérol 15 mg	
Sodium / Sodium 870 mg	
Carbohydrate / Glucides 55 g	
Fibre / Fibres 3 g	
Sugars / Sucres	

International unit of energy

It is measured in **kilojoules (kJ)** or **megajoules (MJ)**.

When using imperial measurements, **kilocalories (kcal)** are used.

$$1 \text{ kJ} = 1000 \text{ J}$$

$$1 \text{ MJ} = 1000 \text{ kJ}$$

$$1 \text{ kcal} = 1000 \text{ cal}$$

$$1 \text{ kcal} = 4.18 \text{ kJ}$$



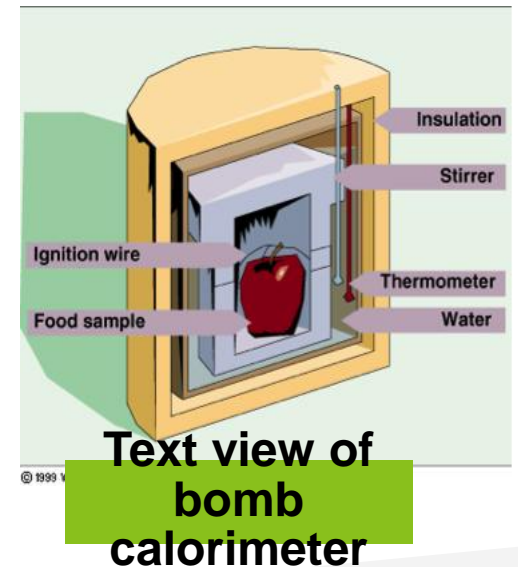
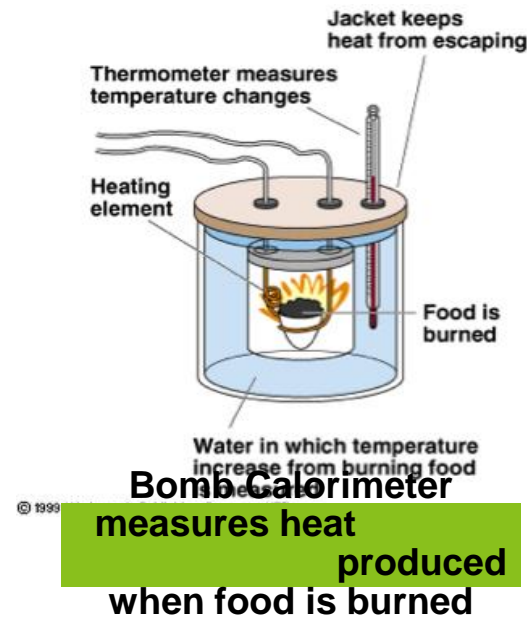


- A **kilocalorie** can be defined as the amount of energy needed to raise 1 kilogram of water 1 degree Celsius.
- A **calorie** is the amount of heat necessary to raise temperature of 1 gm of water by 1 C.
- 1000-calorie metric units are known as [kilocalories \(kcal\)](#).
- A food's kilocalories are determined by putting the food into a bomb calorimeter and determining the energy output (Energy = Measurement of Heat Produced).
- The image shown is a **bomb calorimeter**.

Bomb calorimetry

To measure the number of calories in a particular food substance, a certain amount of food is burned in a device called a **calorimeter**.

- As the food burns, heat is created. The heat dissipates to the surrounding water while a thermometer detects the change in temperature of the water.
- The energy value of a food indicates its value to the body as a fuel. This energy value may be less than the heat value obtained experimentally by 'burning' the food outside the body in a 'bomb calorimeter'





Calorie value:

By using 'Atwater factors' it is easy to calculate the energy in any food,

Example:

TABLE 1-2 kCalorie Values
of Energy Nutrients

Energy Nutrients	kCalories ^a (per gram)
Carbohydrate	4 kcal/g
Fat	9 kcal/g
Protein	4 kcal/g

NOTE: Alcohol contributes 7 kcalories per gram that can be used for energy, but it is not considered a nutrient because it interferes with the body's growth, maintenance, and repair.

^aFor those using kilojoules: 1 g carbohydrate = 17 kJ; 1 g protein = 17 kJ; 1 g fat = 37 kJ; and 1 g alcohol = 29 kJ.

Empty-kcalorie foods

a popular term used to denote foods contribute energy (from sugars, fat or both) but lack in protein, vitamins and minerals.

- Example: (potato chips and candies).



Energy density A measure of the nutrients provided in a food per kilocalorie of that food.




LOWER ENERGY DENSITY

This 450-gram breakfast delivers 500 kcalories, for an energy density of 1.1 (500 kcal ÷ 450 g = 1.1 kcal/g).



HIGHER ENERGY DENSITY

This 144-gram breakfast also delivers 500 kcalories, for an energy density of 3.5 (500 kcal ÷ 144 g = 3.5 kcal/g).

- 
- **Nutritional Status** – is the condition of the body resulting from the utilization of essential nutrients.
 - **Nutritional Assessment** is an in-depth evaluation of both objective and subjective data related to an individual's food and **nutrient** intake, lifestyle, and medical history.
 - Aims of Nutritional Assessment
 - To identify certain specific nutritional problem.
 - To map out magnitude and geographical distribution of malnutrition
 - To determine ecological factors responsible for malnutrition.
 - **Malnutrition** – It is the condition of the body resulting from a lack of one or more essential nutrients or due to excessive nutrient supply.



Characteristics of a nutritious diet

A nutritious diet has four characteristics. It is:

1. Adequate
2. Balanced
3. Moderate
4. Varied

Adequate diet - A diet that provides enough kcalories, essential nutrients, and fiber to keep a person healthy.

Moderate diet - A diet that avoids excessive amounts of kcalories or any particular food or nutrient.

Balanced diet - A diet in which foods are chosen to provide kcalories, essential nutrients, and fiber in the right proportions.

Varied diet - A diet in which you eat a wide selection of foods to get necessary nutrients.

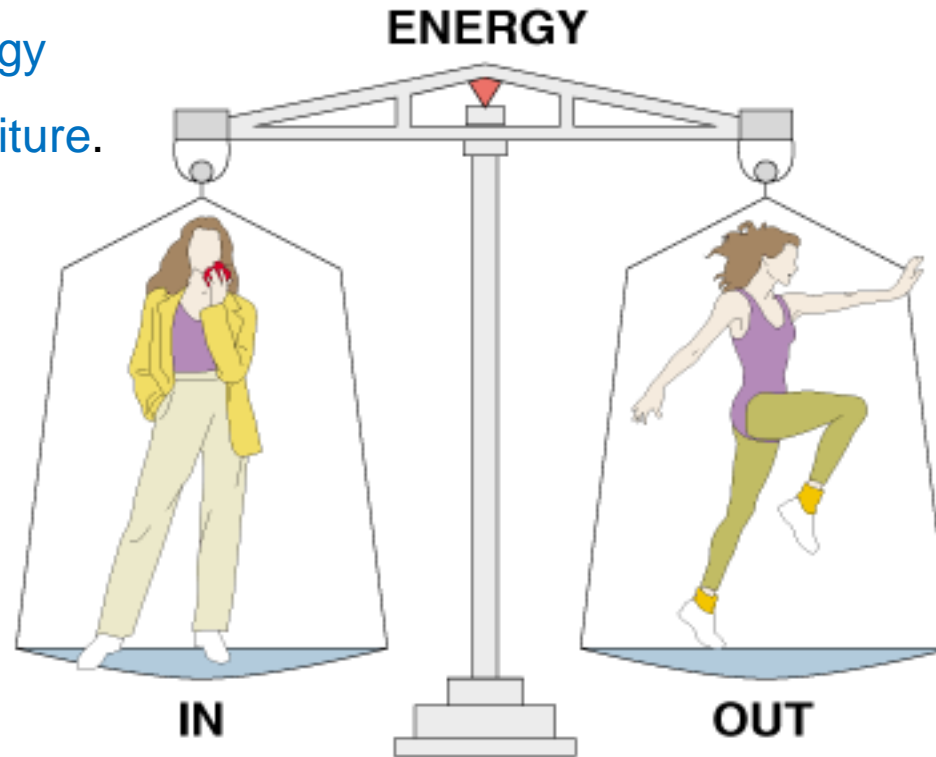


Energy Balance



Energy Balance: Input vs Output

- **Energy balance** is the relationship between **energy intake** and **energy expenditure**.





Energy Balance

Energy In = Energy Out

- Weight Maintenance

Energy In > Energy Out

- Weight Gain

Energy In < Energy Out

- Weight Loss














Energy balance

To maintain body weight it is necessary to balance the energy derived from food with that expended in activity.

Energy balance is achieved when energy intake equals energy expenditure.

It is important to maintain a healthy weight or avoid becoming overweight or underweight



Intake	Output	Weight Change	Energy Balance
 <p>3000 kcal</p>	 <p>3000 kcal</p>	 <p>No change</p>	<p>Energy balance (equilibrium)</p> <p>Calories in = Calories out</p> 
 <p>4000 kcal</p>	 <p>2000 kcal</p>	 <p>Increase</p>	<p>Positive energy balance</p> <p>Calories in > Calories out</p> 
 <p>2000 kcal</p>	 <p>3000 kcal</p>	 <p>Decrease</p>	<p>Negative energy balance</p> <p>Calories in < Calories out</p> 



Positive energy balance

If energy intake exceeds energy expended, the result is a **positive energy balance**.

The excess energy consumed is stored, resulting in weight gain. There are some situations in which positive energy balance is desired, such as during the growth stages of the life cycle (pregnancy, infancy, childhood, adolescence) and to restore body weight to healthy levels after losses caused by starvation, disease, or injury.



Overweight and obese

- However, during other times, such as adulthood, positive energy balance over time can cause body weight to climb to unhealthy levels. The process of aging itself does not cause weight gain; rather, weight gain stems from a pattern of excess food intake coupled with limited physical activity and slower metabolism
- Excess energy is stored in adipose tissue and can build up if energy intake continues to be too high, or activity levels remain too low.
- **Being overweight or obese is associated with an increased risk of developing**
 - certain cancers
 - cardiovascular disease
 - and type 2 diabetes.



Negative energy balance

- **Negative energy balance** results when energy intake is less than energy expenditure.
- **Weight loss** occurs because energy stored in the body—fat and muscle—is used to make up for the shortfall in energy intake.
- Negative energy balance is desired in adults when body fatness exceeds healthy levels.
- Negative energy balance during growth stages of the life cycle generally is not recommended because it can impair normal growth.

People who achieve a negative energy balance over an extended period of time, are likely to become underweight.



Underweight

When too little energy is consumed over a period of time, the body derives energy from fat stores leading to weight loss.

When too much fat is lost, the person becomes underweight.

Being underweight is associated with health problems, such as osteoporosis, infertility and heart failure.



Energy Balance

Sources of fuel for energy

- Input from diet: carbs, fat, proteins, alcohol
- Stored energy: glycogen, fat, muscle

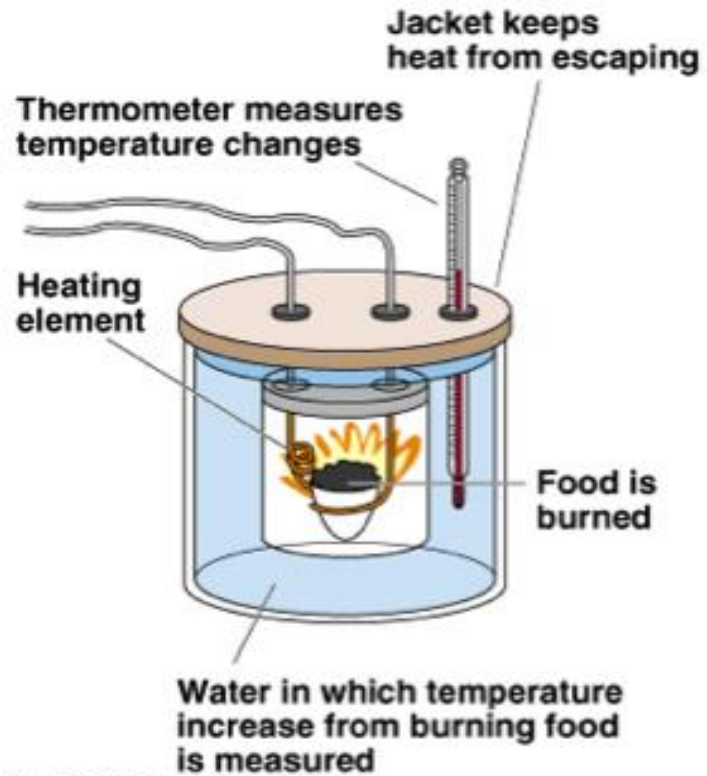
Energy outgo from:

- Basal metabolism
- Physical activity
- “Dietary thermogenesis”



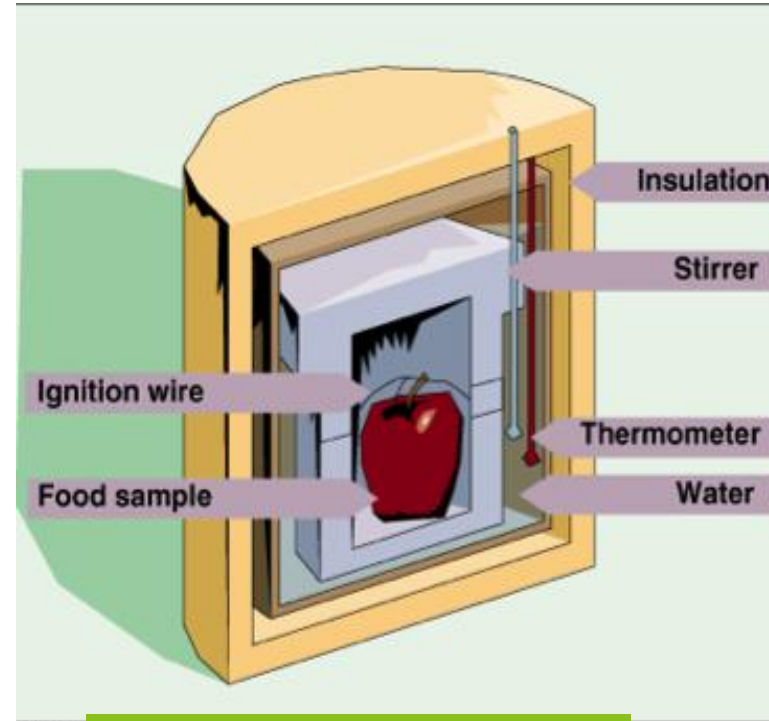
Energy Intake

- The amount of energy in a food or beverage can be estimated using nutrient databases or nutrient analysis software.
 - Calorie values in these tables and programs can be derived by directly measuring calorie content using a device called a **bomb calorimeter**.
- Calorie content is most commonly calculated by determining the grams of carbohydrate, protein, and fat (and possibly alcohol) in a food and multiplying these compounds by their physiological fuel values.
- physiological fuel values are 4 kcal/g for carbohydrates and proteins, 9 kcal/g for fat, and 7 kcal/g for alcohol.)



© 1999

Bomb Calorimeter measures heat produced when food is burned



© 1999

Text view of bomb calorimeter



Energy Expenditure

- The body uses energy for 3 main purposes:
 - basal metabolism
 - physical activity
 - and the digestion, absorption, and processing of ingested nutrients.
 - An additional, minor form of energy output, known as thermogenesis, is the energy expended during fidgeting or shivering in response to cold.



Energy output

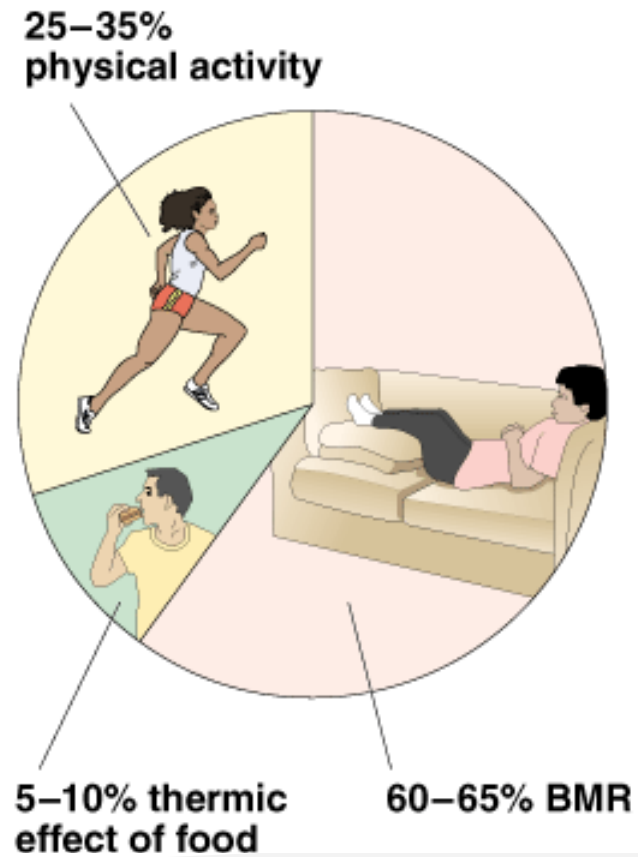
We need energy for:

Basal metabolism

thermogenesis

Physical activity

BMR > Activity > Dietary Thermogenesis





Basal Metabolism

- **Basal metabolism** (expressed as **basal metabolic rate [BMR]**) represents the minimum amount of energy expended in a fasting state (12 hours or more) to keep a resting, awake body alive in a warm, quiet environment.
 - For a sedentary person, basal metabolism accounts for about 60 to 70% of total energy expenditure. Some of the processes involved include the beating of the heart, respiration by the lungs, and the activity of other organs, such as the liver, brain, and kidneys.
 - It does not include energy expended for physical activity or the digestion, absorption, and processing of nutrients recently consumed.
- If the person is not fasting or completely rested, the term **resting metabolism** is used (expressed as **resting metabolic rate [RMR]**). RMR is typically 6% higher than BMR.



Both BMR and RMR are expressed as the number of calories burned per unit of time. A rough estimate of basal metabolic rate for women is 0.9 kcal/kg per hour and 1.0 kcal/kg per hour for men.

To see how basal metabolism contributes to energy needs, consider a **59 kg women**. Using rough estimation of basal metabolic rate rate of 0.9 kcal per hour for women, calculate her basal metabolic rate

$$59 \times 0.9 = 53 \text{ kcal/hour}$$

Finally, use the hourly basal metabolic rate to find her basal metabolic rate for an entire day;

$$53 \times 24 = 1272 \text{ kcal}$$




Factors Affect Basal Metabolic Rate


The BMR of a subject is influenced by many factors such as body size, body composition, age, sex, nutritional, and physiological state.

Factors that increase basal metabolism include:

- Greater lean body mass
- Large body surface area
- Male gender (typically more lean body mass compared to females)
- Body temperature (fever or cold environmental condition)
- Thyroid hormones
- Aspects of nervous system activity (release of norepinephrine)
- Pregnancy
- Caffeine and tobacco use (still, using smoking to control body weight is not recommended because too many health risks are increased).

Of these factors, the amount of muscle mass a person has is the most important

- 
- These factors decrease basal metabolism:
 - Lower than normal secretions of thyroid hormones (hypothyroidism)
 - Restricted calorie intake
 - Less body surface area and muscle mass
 - Aging after age 30 years

- 
- Basal metabolism decreases by about 10 to 20% (about 150 to 300 kcal/day) when calorie intake declines and the body shifts into a conservation mode.
 - This shift helps us survive during periods of famine and starvation, but it also is a barrier to sustained weight loss during dieting that involves extremely low calorie intake.
 - Basal metabolism drops 1 to 2% for each decade past the age of 30 years as a result of the lean body mass loss that typically occurs with advancing age. However, physical activity helps maintain lean body mass and helps preserve BMR throughout adulthood.



Physical Activity (PA)

Physical Activity affected by:

- Intensity -- how vigorous
- Time spent
- Body weight
- Variable: 20-40%
- Working muscles require energy
 - Heart/lung extra energy



Energy for Physical Activity

- Physical activity increases energy expenditure above and beyond basal energy needs by as much as 25 to 40%.
- In choosing to be active or inactive, we determine much of our total energy expenditure for a day. Climbing stairs rather than riding the elevator, walking rather than driving to the store, and standing in a bus rather than sitting increase physical activity and hence energy expenditure.




Thermic Effect of Food (TEF)

- The **thermic effect of food (TEF)** is the energy the body uses to digest, absorb, transport, store, and metabolize the nutrients consumed in the diet.
- The TEF accounts for about 5 to 10% of the energy consumed each day.
 - If daily energy intake were 3000 calories, TEF would account for 150 to 300 calories.
- As with other components of energy output, the total amount varies somewhat among individuals.



Thermic effect of food (TEF)

- Affected by:
 - Meal size/frequency: large meals result in higher TEF values than the same amount of food eaten over many hours
 - Composition: Protein > Carbs/fat: The TEF value for a protein rich meal (20 to 30% of the energy consumed) is higher than that for a carbohydrate rich (5 to 10%) or fat rich (0 to 3%) meal because it takes more energy to metabolize amino acids into fat than to convert glucose into glycogen or transfer absorbed fat into adipose stores.
 - Genetics

- 
- **Thermogenesis**, the process of heat production by humans and other organisms, makes a fairly small contribution to overall energy expenditure. Thermogenesis goes by other names, such as thermoregulation and non-exercise activity thermogenesis (NEAT).
 - **Adaptive thermogenesis heat** is produced when the body expends energy for non voluntary physical activity triggered by extreme cold conditions, overfeeding, trauma, or starvation.
 - Examples of non voluntary activities include fidgeting, shivering when cold, maintaining muscle tone, and holding the body up when not lying down. This non voluntary production of heat increases energy expenditure, resulting in less storage of energy. In some cases this could be a considerable amount of energy lost as heat.




Measurement of energy expenditure

The amount of energy a body uses can be measured by both direct and indirect calorimetry or can be estimated based on height, weight, degree of physical activity, and age.




Direct calorimetry

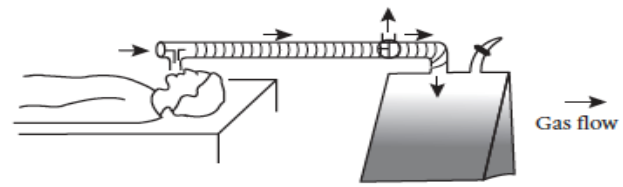
- **Direct calorimetry** estimates energy expenditure by measuring the amount of heat released by the body.
- Direct calorimetry works because approximately 60% of the energy the body uses eventually leaves as heat.
- Heat release is measured by placing a person in an insulated chamber, often the size of a small bedroom, that is surrounded by a layer of water.
- The change in water temperature before and after the body releases heat is used to determine the amount of energy the person has expended.
- Recall that a calorie is related to the amount of heat required to raise the temperature of water.
- Direct calorimetry is expensive and complex to use.



Indirect calorimetry: a method to measure energy use by body by measuring oxygen uptake. Formula are then used to convert this gas exchange value into energy use.

- Utilisation of oxygen
- Oxygen consumption is proportional to ATP synthesis
- Use oxygen consumption to determine heat production

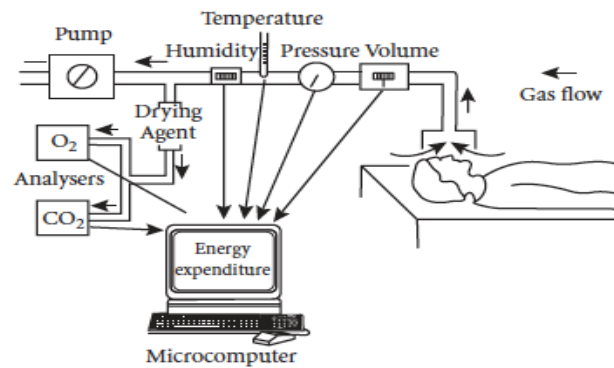
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- **Indirect calorimetry**, the most commonly used method to determine energy use by the body, involves collecting expired air from an individual during a specified amount of time .
 - This method works because a predictable relationship exists between the body's use of energy and the amount of oxygen consumed and carbon dioxide produced.
 - The procedure to collect the air can be done in a laboratory or with a handheld device that allows the individual to be mobile and not restricted to the lab.
 - Data tables showing energy costs of different exercises are based on information from indirect calorimetry studies.



The Douglas bag



The Kofrani-Michaelis respirometer



A ventilated hood indirect calorimeter

Fig. 5.1 Most commonly used devices for indirect calorimetry.

Source: Garrow J.S. and James W.P.T. (eds). (1993) *Human nutrition and dietetics* (9th edition). Churchill Livingstone, Edinburgh.



Figure 10-5 Indirect calorimetry measures oxygen intake and carbon dioxide output to determine energy expended during daily activities. Handheld indirect calorimeters also are available.



Thank
You