

# Macro and micro nutrients

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Editing File

# Objectives



Understand the nutritional importance of dietary macro and micronutrients.



Identify major dietary sources and RDAs of macro and micronutrients.



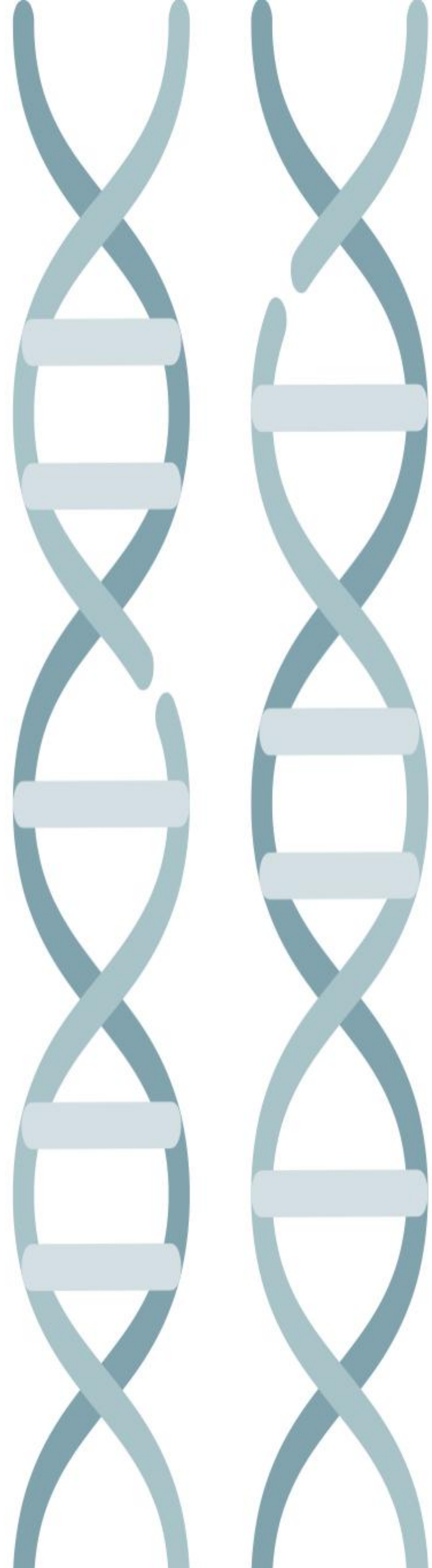
Evaluate the nutritional quality of proteins, the types of dietary carbohydrates, fibers and fats and their benefits.



Discuss the role of macronutrients in causing diseases or conditions such as nitrogen imbalance, diabetes, obesity, atherosclerosis and heart disease



Understand the functions of micronutrients and the diseases due to their deficiencies.



# Macronutrients and Micronutrients

## Macronutrients

- Nutrients needed by the body in large amounts (proteins, carbohydrates, fats). **In gram quantities**
- They provide energy and building blocks for proteins, carbohydrates and fats.

## Micronutrients

- Nutrients needed by the body in small amounts (vitamins, minerals, trace elements). **In mg or microgram**
- Required for maintaining normal health and preventing various diseases.
- They do not provide energy.

# Energy Content of food

- Body obtains energy as ATP.
- ATP is used for all body functions.
- The energy content of food is measured in calories (Kilocalories) or J.
- **Definition of calorie:** One calorie is the heat required to raise the temperature of 1 gm of water by 1°C.
  - Proteins = 4 kcal/gm.
  - Carbohydrates = 4 kcal/gm.
  - Fat = 9 kcal/gm.

## Acceptable Macronutrient Distribution Range (AMDR)

- Adequate intake of macronutrients to prevent the risk of disease
- AMDR for adults:
  - CHO: 45-65%
  - Proteins: 10-35%
  - Fats: 20-35%

**This is called a balanced diet.**

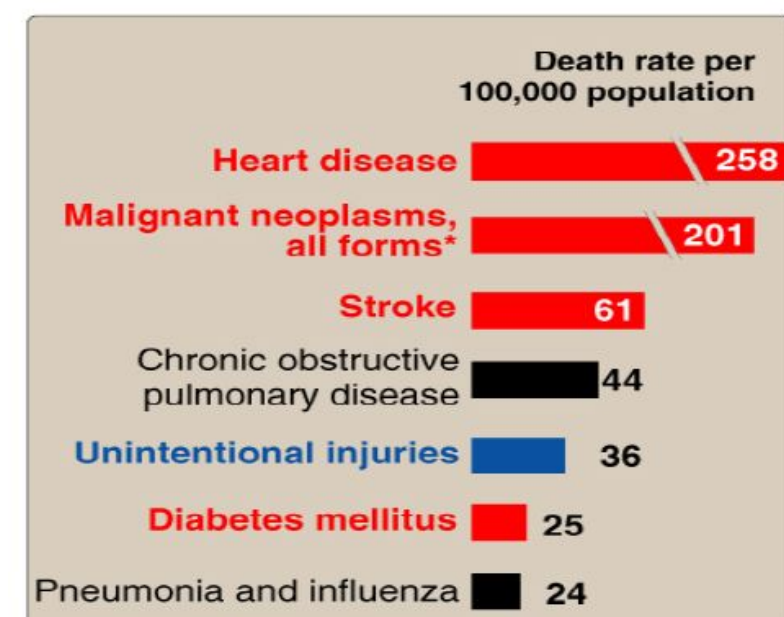


Figure 27.8

Influence of nutrition on some common causes of death in the United States in the year 2000. Red indicates causes of death in which the diet plays a significant role. Blue indicates causes of death in which excessive alcohol consumption plays a part. (\*Diet plays a role in only some forms of cancer.)

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In diseases marked with red, nutrition is playing a significant role.

# Macronutrients

1. Proteins

2. Carbohydrates

3. Dietary Fiber

4. Fats in the Diet



# Proteins

## Nutritional Importance of protein

- Proteins supply amino acids and amino nitrogen for the body.
- Essential amino acids :
  - Body can't synthesize, must be supplied in the diet.
  - PVT TIM HALL:  
Phenylalanine, Valine, Tryptophan, Threonine, Isoleucine, Methionine, Histidine, Arginine, Lysine, Leucine. *Arginine is conditionally essential (not always essential)*
- Non-essential: body can synthesize.
- *Under normal conditions carbs are the main source of energy, proteins are source of energy in case of carb depletion.*

## Nutritional Quality of Proteins

*What are the factors that determine the quality of a protein?*

- 1-A measure of a protein's ability to provide the essential amino acids required for tissue maintenance.
- 2-Measured in PDCAAS units (Digestibility-Corrected Amino Acid Scoring):
- High value indicates more digestibility and high quality (maximum score 1.0)
- Proteins from animal sources: 0.82-1.0
- Proteins from plant sources: 0.4
- *Proteins of animal sources have higher score and this makes sense because the proteins of animal sources are similar to those our body needs.*

## Sources

- Meat, poultry, fish, milk, wheat, corn, beans, nuts.



## RDA (gms/kg body weight)

- Normal adults: 0.8
- Athletes: 1.0
- Pregnancy / lactation: upto **additional 30 g/day**
- Children: 2.0

## Protein-Energy Malnutrition

**Malnutrition:** A condition or disease caused by not eating enough food or not eating a balanced diet.

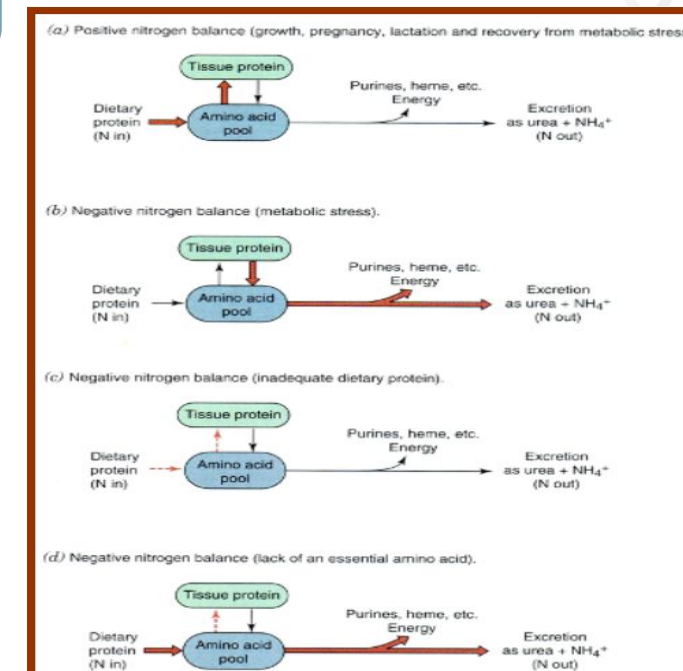
- Malnutrition due to inadequate intake of proteins or energy.
- **Two conditions:**
  - Marasmus.
  - Kwashiorkor.

	Marasmus	Kwashiorkor
cause	Inadequate intake of energy with adequate protein intake	Inadequate intake of proteins with adequate energy intake
Age	1-3 year	After weaning (at about 1 year)
food intake	Mother's milk is supplemented with food (cereals) deficient in calories	Diet mainly contains CHOs
symptoms	<ul style="list-style-type: none"> <li>• Arrested growth.</li> <li>• Extreme muscle wasting.</li> <li>• Weakness.</li> <li>• Weight loss.</li> <li>• No edema or changes in plasma proteins.</li> </ul> 	<ul style="list-style-type: none"> <li>• <b>Edema.</b></li> <li>• Distended abdomen.</li> <li>• Diarrhea.</li> <li>• Dermatitis / thin hair.</li> <li>• Enlarged fatty liver.</li> <li>• Low plasma albumin.</li> </ul> 

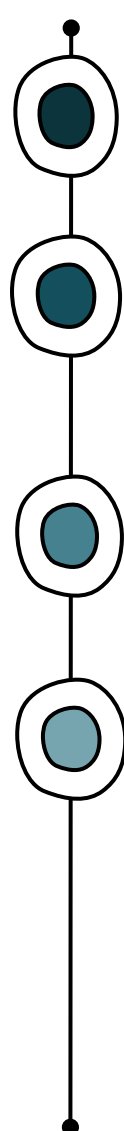
# Nitrogen Balance

- **Normal Nitrogen Balance:**
  - In a healthy person, the nitrogen intake is equal to nitrogen loss.
- **Negative nitrogen balance:**
  - When nitrogen loss is more than intake.
  - Occurs in burns, trauma, illness, metabolic stress.
- **Positive nitrogen balance:**
  - When nitrogen intake is more than loss.
  - Occurs in growth, pregnancy, lactation, recovery from illness.

Dr. said: These are some scenarios and I want you to go over it by yourself.



# Carbohydrates



Their major role in diet is energy production.

## Types in the diet:

- Simple CHOs: sucrose, fructose, lactose, corn syrup.
- Complex CHOs: whole grains, pasta, wheat, starch. *Are better to be included in diet because breaking them down requires energy (chance of gaining weight when taking simple carbs)*

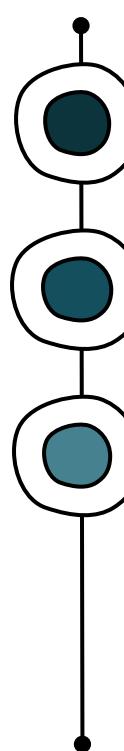
## RDA:

- 130 grams/day for adults and children.
- CHO intake above RDA causes weight gain or obesity due to increased fat storage in adipose tissue.

## Protein-Sparing Effect:

- Dietary protein requirement and CHO diet are related to each other.
- CHO have protein-sparing effect:
  - They inhibit gluconeogenesis from amino acids.
  - That way amino acids are used for repair and maintenance of tissue protein and not for gluconeogenesis. *So, you will lose your muscle mass*
- If CHO intake is less than the RDA (130 g/day):
  - more proteins will be metabolized.
  - more gluconeogenesis will take place.

# Dietary Fiber



The component of food that cannot be broken down by human digestive enzymes.

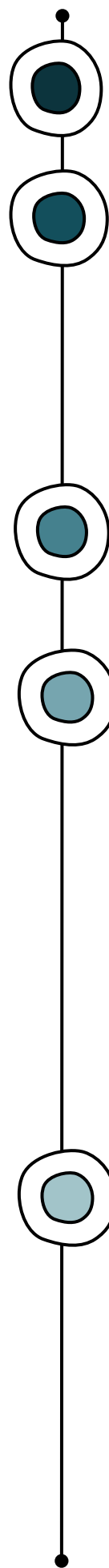
## RDA (gm/day):

- Men: 38, Women: 25.

## Benefits:

- Lowers serum LDL levels.
- Reduces constipation.
- Promotes feeling of fullness.
- Slows gastric emptying (long-term glucose control in patients with diabetes mellitus).
- Reduces exposure of gut to carcinogens. *It bonds to harmful agent and then get excreted with it.*

# Fats in the Diet



A concentrated source of energy (9 kcals/gram).

## RDA (gm/day):

Total fats: 65, Saturated: 20.

- **Excessive fat intake can cause:**
  - Atherosclerosis/heart disease.
  - Obesity.

- Supply essential fatty acids such as linoleic and linolenic acids.
- Provide phospholipids for membrane function.
- Source of fat-soluble vitamins (A, D, E, K) and help in their absorption.

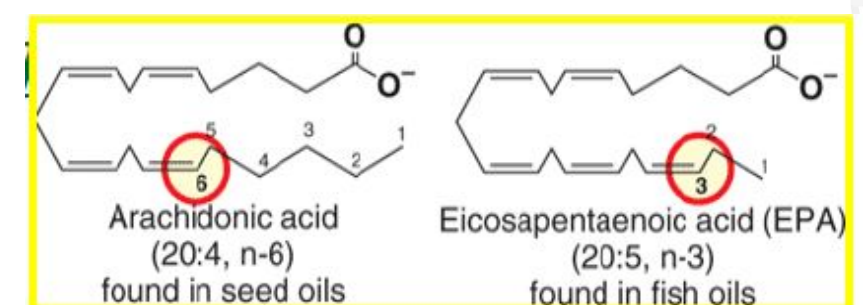
## Essential Fatty Acids:

- **Two essential fatty acids:**
  - $\alpha$ -linolenic acid ( $\omega$ -3 fatty acid).
  - linoleic acid ( $\omega$ -6 fatty acid).
- Used for eicosanoids synthesis which appear to have cardioprotective effects.
  - decrease blood clotting.
  - decrease blood pressure.
- **Deficiency causes:** scaly skin, dermatitis, reduced growth (most common in infants).

## Trans fatty acids:

Unsaturated fatty acids, behaving more like saturated fatty acids in the body

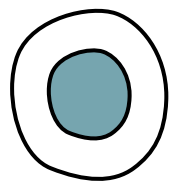
- increase serum LDL (but not HDL).
- risk of CVD.
- Not found in plants (animals only).
- Formed during hydrogenation of liquid vegetable oils.
- Found in baked food: cookies, cakes, deep-fried foods.



The reason behind nomenclature:

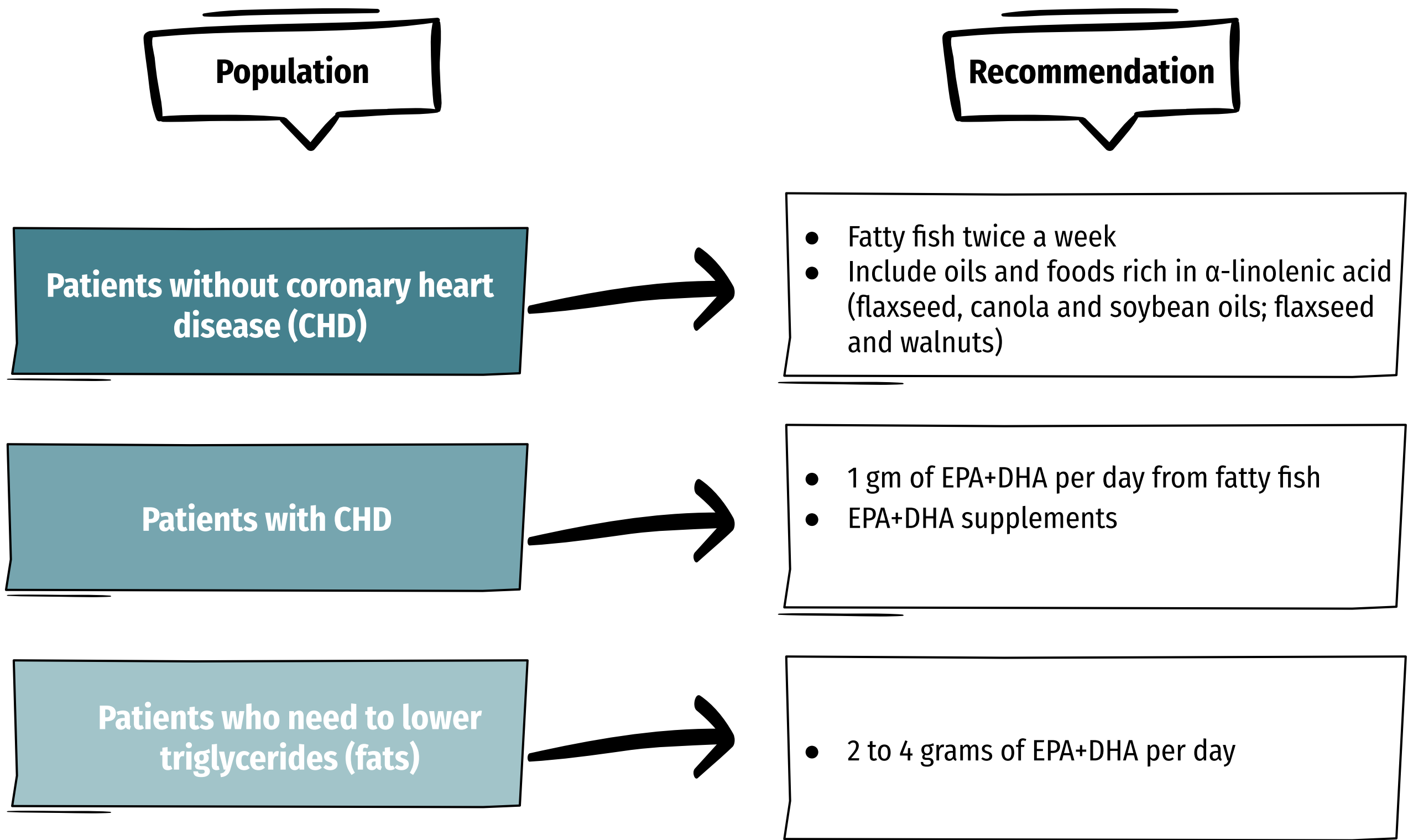
- $\alpha$ -linolenic acid ( $\omega$ -3 fatty acid). the first double bond is at carbon No.3
- linoleic acid ( $\omega$ -6 fatty acid). the first double bond at carbon No. 6

	Omega -3 Fatty acids	Omega-6 Fatty acids
Sources	<ul style="list-style-type: none"> <li>● Mainly found in cold-water ocean fish such as: albacore, mackerel, salmon, sardines, tuna, whitefish.</li> <li>● Plants such as spanish.</li> <li>● Fish oil containing docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA).</li> </ul>	<ul style="list-style-type: none"> <li>● Nuts.</li> <li>● Avocados.</li> <li>● Olives.</li> <li>● Soybeans.</li> <li>● Oils (sesame, cottonseed, corn oil).</li> </ul>
Effects	<p><b>Play an important role as:</b></p> <ul style="list-style-type: none"> <li>● Structural membrane lipids.</li> <li>● Modulator of <math>\omega</math>-6 fatty acid metabolism.</li> <li>● Suppress cardiac arrhythmias.</li> <li>● ↓ Serum triacylglycerols.</li> <li>● ↓ Tendency to thrombosis.</li> <li>● Lower blood pressure.</li> <li>● ↓ Risk of cardiovascular mortality.</li> <li>● Little effect on LDL or HDL levels.</li> </ul>	<ul style="list-style-type: none"> <li>● ↓ Plasma cholesterol.</li> <li>● ↓ LDL.</li> <li>● ↓ HDL.</li> </ul>



# Recommendations for Omega-3 Fatty Acid Intake

## American Heart Association Guidelines



### Micronutrients

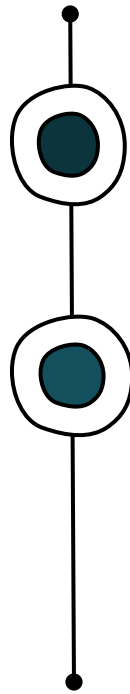
1. Vitamins

2. Minerals and Trace Elements





# Vitamins



Organic compounds present in small quantities in different types of food.

- Help in various biochemical processes in cell.
- Important for growth and good health.
- Essential.
- Noncaloric.
- Required in very small amounts.

## classifications

Fat-soluble vitamins	Water-soluble vitamins
<ul style="list-style-type: none"> <li>• A, D, E, and K (stored in the body).</li> </ul>	<ul style="list-style-type: none"> <li>• Ascorbic acid (vitamin C).</li> <li>• Thiamin (vitamin B<sub>1</sub>).</li> <li>• Riboflavin (vitamin B<sub>2</sub>).</li> <li>• Niacin (vitamin B<sub>3</sub>).</li> <li>• Pyridoxine (vitamin B<sub>6</sub>).</li> <li>• Biotin.</li> <li>• Pantothenic acid.</li> <li>• Folate.</li> <li>• Cobalamin (vitamin B<sub>12</sub>).</li> </ul>

## Vitamin E

<b>Function</b>	<ul style="list-style-type: none"> <li>• Antioxidant: prevents oxidation of cell components by molecular oxygen and free radicals</li> <li>• May have a role in fertility and anti-aging effect</li> </ul>
<b>Active form</b>	<ul style="list-style-type: none"> <li>• α - tocopherol is the most active form in the body</li> </ul>
<b>Sources and RDA</b>	<ul style="list-style-type: none"> <li>• Vegetable Oil, nuts, seeds, vegetables</li> <li>• Adults: 15, Children: 7</li> </ul>
<b>Deficiency</b>	<p>(mostly observed in premature infants)</p> <ul style="list-style-type: none"> <li>• Defective lipid absorption</li> <li>• Anemia due to oxidative damage to RBCs</li> <li>• Neurological problems</li> <li>• Male infertility</li> </ul>



## Vitamin B1 (Thiamine)

<b>Function</b>	<ul style="list-style-type: none"><li>• Coenzyme for transketolase and oxidative decarboxylation reactions</li><li>• In thiamin deficiency, the activity of these two dehydrogenases is decreased</li><li>• Causing: Low ATP production and defective cellular function</li></ul>
<b>Active form</b>	<ul style="list-style-type: none"><li>• Thiamin pyrophosphate (TPP)</li></ul>
<b>Sources and RDA</b>	<ul style="list-style-type: none"><li>• Plants, cereals, meat</li><li>• Adults: 1.2, Children: 0.6</li></ul>
<b>Deficiency</b>	<p><b>Beriberi</b></p> <ul style="list-style-type: none"><li>• A type of chronic peripheral neuritis due to severe thiamine deficiency causes weakness, neuropathy, disorderly thinking, paralysis</li><li>• Thiamin has a role in nerve conduction</li><li>• Neuropathy affects glial cells (astrocytes) of the brain and spinal cord causing neuron death</li></ul> <p><b>Wernicke-Korsakoff syndrome</b></p> <ul style="list-style-type: none"><li>• Common in alcoholics due to defective intestinal <b>absorption</b> of thiamin or dietary insufficiency</li><li>• Causes apathy, loss of memory</li></ul>

## Vitamin C

<b>Function</b>	<ul style="list-style-type: none"><li>• Powerful antioxidant (prevents some cancers) <i>They give it to people who work in dye industry</i></li><li>• Helps in dentine, intercellular matrix and collagen formation</li><li>• Increases iron absorption</li><li>• Helps in the maturation of RBCs</li><li>• Promotes wound healing</li><li>• Stimulates phagocytic action of leukocytes</li><li>• Reduces risk of cataract formation</li></ul>
<b>Sources and RDA</b>	<ul style="list-style-type: none"><li>• Citrus fruits, tomatoes, melon, peppers</li><li>• Men: 90, Women: 75, Children: 15-25 <i>in mg</i></li></ul>
<b>Deficiency</b>	<p><b>Scurvy</b></p> <ul style="list-style-type: none"><li>• Abnormal collagen production</li><li>• Gums become painful, swollen and spongy</li><li>• The pulp is separated and the teeth are lost</li></ul>

# Minerals and Trace Elements

## Macrominerals

(>100 mg/day)

- Calcium.
- Phosphorous.
- Sodium.
- Potassium.
- Chloride.
- Magnesium.

## Microminerals

(<100 mg/day)

- **Iron.**
- Iodine.
- Copper.
- Manganese.
- Zinc.
- Cobalt.
- Molybdenum.
- Selenium.
- Fluoride.
- Chromium.
- Silicon.

Iron	
Function	<ul style="list-style-type: none"> <li>• Oxygen transport and metabolism</li> <li>• Part of hemoglobin, myoglobin, cytochromes</li> <li>• Body stores iron as ferritin, hemosiderin and transferrin</li> <li>• Adult women have much lower iron storage than men. <i>Because of menstrual cycle</i></li> </ul>
Sources and RDA	<ul style="list-style-type: none"> <li>• <b>Heme iron:</b> Animal products (meat, liver), 25% absorption <i>So, absorption is faster.</i></li> <li>• <b>Nonheme iron:</b> Plants (spinach, beans), 5% absorption <i>So, absorption is slower.</i></li> <li>• Men: 8, Women: 18, Children: 7-15</li> </ul>
Deficiency	<ul style="list-style-type: none"> <li>• <b>Iron deficiency anemia is most common in</b> <ul style="list-style-type: none"> <li>○ Growing children, pregnant, lactating and menstruating women need more iron</li> </ul> </li> <li>• <b>Hemosiderosis (iron overload disorder)</b> <ul style="list-style-type: none"> <li>○ Due to iron excess (toxicity) <i>excessive storage of iron.</i></li> <li>○ Hemosiderin (Iron stored in complex with ferritin protein in liver and spleen)</li> <li>○ Occurs in persons receiving repeated blood transfusions</li> </ul> </li> </ul>

## Take Home Messages



Macro and micronutrients are essential for energy and maintaining good health.



Various diseases are associated either with malnutrition or excessive intake of these nutrients





# Summary

Macronutrients	Protein	<p><b>Function:</b> Proteins supply amino acids and amino nitrogen for the body.</p> <p><b>Sources:</b> Meat, poultry, fish, milk, wheat, corn, beans, nuts.</p> <p><b>RDA:</b></p> <ul style="list-style-type: none"> <li>- Normal adults: 0.8.</li> <li>- Athletes: 1.0.</li> <li>- Pregnancy / lactation: upto 30.</li> <li>- Children: 2.</li> </ul>	
	Carbohydrates	<p><b>Function:</b> energy production.</p> <p><b>Types:</b></p> <ul style="list-style-type: none"> <li>- <b>Simple</b> CHOs: sucrose, fructose, lactose, corn syrup.</li> <li>- <b>Complex</b> CHOs: whole grains, pasta, wheat, starch.</li> </ul> <p><b>RDA:</b> 130 grams/day for adults and children.</p>	
	Dietary Fibers	<p><b>RDA (gm/day):</b> Men: 38, Women: 25.</p> <p><b>Benefits:</b></p> <ul style="list-style-type: none"> <li>- Lowers serum LDL levels.</li> <li>- Reduces constipation.</li> <li>- Promotes feeling of fullness.</li> <li>- Slows gastric emptying (long-term glucose control in patients with diabetes mellitus).</li> <li>- Reduces exposure of gut to carcinogens.</li> </ul>	
	Fats	<p><b>Function:</b></p> <ul style="list-style-type: none"> <li>- A concentrated <b>source of energy</b> (9 kcals/gram).</li> <li>- <b>Supply essential fatty acids</b> such as linoleic and linolenic acids.</li> <li>- Provide phospholipids for <b>membrane function</b>.</li> <li>- Source of <b>fat-soluble vitamins</b> (A, D, E, K) and help in their absorption.</li> </ul> <p><b>RDA (gm/day):</b> Total fats: 65, Saturated: 20.</p>	
Micronutrients	Vitamins	<b>E</b>	<p><b>Function:</b></p> <ul style="list-style-type: none"> <li>- Antioxidant.</li> <li>- May have a role in fertility and anti-aging effect.</li> </ul> <p><b>Sources:</b> Vegetable Oil, nuts, seeds, vegetables.</p> <p><b>RDA (mg/day):</b> Adults: 15, Children: 7.</p> <p><b>Deficiency:</b> (mostly observed in premature infants)</p> <ul style="list-style-type: none"> <li>- Defective lipid absorption.</li> <li>- Anemia due to oxidative damage to RBCs.</li> <li>- Neurological problems.</li> <li>- Male infertility.</li> </ul>
		<b>B<sub>1</sub></b>	<p><b>Function:</b> Coenzyme for transketolase and oxidative decarboxylation reactions.</p> <p><b>Sources:</b> Plants, cereals, meat.</p> <p><b>RDA (mg/day):</b> Adults: 1.2, Children: 0.6.</p> <p><b>Deficiency:</b></p> <ul style="list-style-type: none"> <li>- Beriberi.</li> <li>- Wernicke-Korsakoff syndrome.</li> </ul>
		<b>C</b>	<p><b>Function:</b></p> <ul style="list-style-type: none"> <li>- Powerful antioxidant (prevents some cancers).</li> <li>- Helps in dentine, intercellular matrix and collagen formation.</li> <li>- Increases iron absorption.</li> <li>- Helps in the maturation of RBCs.</li> <li>- Promotes wound healing.</li> <li>- Stimulates phagocytic action of leukocytes.</li> <li>- Reduces risk of cataract formation.</li> </ul> <p><b>Sources:</b> Citrus fruits, tomatoes, melon, peppers.</p> <p><b>RDA (mg/day):</b> Men: 90, Women: 75, Children: 15-25.</p> <p><b>Deficiency:</b> Scurvy.</p>
		<b>Iron</b>	<p><b>Functions:</b></p> <ul style="list-style-type: none"> <li>- Oxygen transport and metabolism.</li> <li>- Part of hemoglobin, myoglobin, cytochromes.</li> <li>- Body stores iron as ferritin, hemosiderin and transferrin.</li> </ul> <p><b>Sources:</b></p> <ul style="list-style-type: none"> <li>- Heme iron: Animal products (meat, liver), 25% absorption.</li> <li>- Nonheme iron: Plants (spinach, beans), 5% absorption.</li> </ul> <p><b>RDA (mg/day):</b> Men: 8, Women: 18, Children: 7-15.</p> <p><b>Deficiency:</b></p> <ul style="list-style-type: none"> <li>- Iron deficiency anemia.</li> <li>- Hemosiderosis (iron overload disorder).</li> </ul>
Minerals and Trace Elements			

 **MCQs**

**1- Which of the following is a micronutrient:**

A-Proteins	B-Carbohydrates	C-Fats	D-Vitamins
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**2- Which of the following is an essential amino acid:**

A-Tyrosine	B-Tryptophan	C-Cysteine	D-Alanine
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**3-In which of the following does a negative nitrogen balance occur:**

A-Lactation	B-Recovery from illness	C-Illness	D-Growth
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**4- Which is not an effect of Omega-6 Fatty acid:**

A- Lower plasma cholesterol	B- Raise LDL	C- Lower LDL	D- Lower HDL
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**5- What is the active form of vitamin B1:**

A- Pyridoxal phosphate (PLP)	B- Thiamin pyrophosphate (TPP)	C- $\alpha$ - tocopherol	D- Methylcobalamin
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**6- Iron deficiency anemia is not commonly found in:**

A- Growing children	B- Pregnancy	C- Old age	D- Lactating women
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Answers key

1- D      2- B      3- C      4- B      5- B      6- C

## SAQs

### 1- Give two conditions of malnutrition and mention their cause and 3 of their symptoms.

1-Marasmus:

- Inadequate intake of energy with adequate protein intake.
- No edema or change in plasma proteins, extreme muscle wasting, weight loss, weakness, arrested growth.

2-Kwashiorkor:

- Inadequate intake of proteins with adequate energy intake.
- Edema, low plasma albumin, enlarged liver, distended abdomen, diarrhea, dermatitis\ thin hair.

### 2- Describe what happens in these 2 scenarios:

**a-CHO intake is less than RDA:**

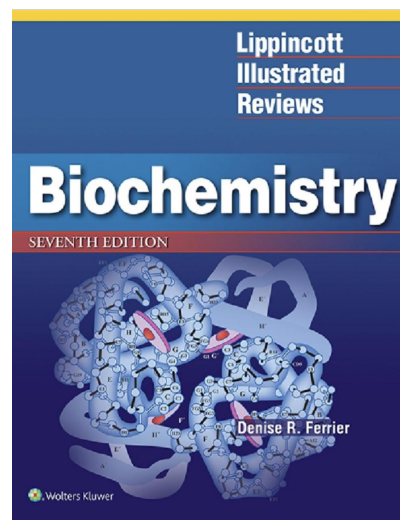
**b-CHO intake is more than RDA:**

- a- More proteins will be metabolized, more gluconeogenesis will take place.
- b-Weight gain due to increased fat storage in adipose tissue.

### 3- List 4 functions of Vitamins:

- 1- help in various biochemical processes in cell
- 2- Important for growth and good health
- 3- Noncaloric
- 4- Required in very small amounts

## Resources Click on the book to download the resource







## Leaders



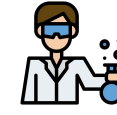
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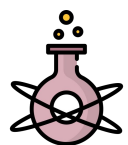
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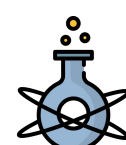
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Special thanks to Fahad AlAjmi for designing our team's logo.