



L6:

Macro & Micro Nutrients

GNT Block



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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.



Important remark: Dr. Usman said we will not ask you about sources and RDAs in the exam. Functions, deficiencies, diseases are important.

Lecture presented by :

Dr. Sumbul Fatma

Dr. Usman Ghani

Macronutrients & 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**) e.g. Vit E, Na+, Iron
- Required for maintaining normal health and preventing various diseases.
- They do not provide energy. **Not source of energy, but required for other functions (as co-enzymes/co-factors) for our normal physiology.**

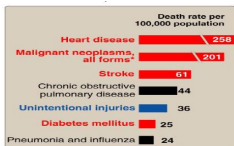
Energy Content of Food & AMDR

- ◆ Body obtains energy as ATP. ATP is used for all body functions
- ◆ The energy content of food is measured in calories (Kilocalories). Or J
- ◆ One calorie is the heat required to raise the temperature of 1 gm of water by 1 C°.

◆ Proteins → 4kcal/g ◆ Carbohydrates → 4kcal/g ◆ Fat → 9kcal/g

AMDR

Stands for Acceptable Macronutrient Distribution Range.
Adequate intake of macronutrients to prevent the risk of disease.



AMDR for adults:

*CHOs: 45-65% *Proteins: 10-35% *Fats: 20-35%

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

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.)

Macronutrients

1-Proteins

Nutritional Importance of Proteins

- 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 ?
- A measure of a protein's ability to provide the essential amino acids required for tissue maintenance
- Measured in PDCAAS units (Protein 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 e.g. meat
- Proteins from plant sources: 0.4 e.g. beans
- 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 (g/kg body weight)

- Normal adult: 0.8
- Athletes: 1.0
- Pregnancy/Lactation: up to additional 30 g/day
- Children: 2.0

Female Dr: RDA is Important

Macronutrients

Nitrogen Balance

Normal nitrogen balance

In a healthy person, the nitrogen intake is equal to nitrogen loss.

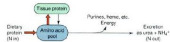
Negative nitrogen balance

- When nitrogen loss is more than intake.
- Occurs in **burns, trauma, illness, metabolic stress.**

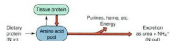
Positive nitrogen balance

- When nitrogen intake is more than loss.
- Occurs in **growth, pregnancy, Lactation, Recovery from illness.**

(a) Positive nitrogen balance (growth, pregnancy, lactation and recovery from metabolic stress)



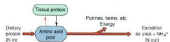
(b) Negative nitrogen balance (metabolic stress)



(c) Negative nitrogen balance (inadequate dietary protein)



(d) Negative nitrogen balance (lack of an essential amino acid)



Proteins

Amino acids

Nitrogen


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

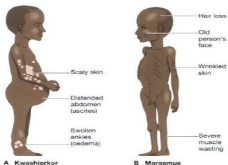
بالنسبة لهذي الصورة صار فيه اختلاف بين الدكتوراة, دكتوراة البنات قالت انه قد جابوا الصورة من قبل و سألوا عن النوع + أمثلة , أفضل انكم تعرفونهم من باب الاحتياط

Macronutrients

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

 Important	Kwashiorkor	Marasmus
Cause	Inadequate intake of proteins with adequate energy intake	Inadequate intake of energy with adequate protein intake
Age	After weaning (at about 1 year)	1-3 Years
Food intake	Diet mainly contains CHO's	Mother's milk is supplemented with food (cereals) deficient in calories
Symptoms	Edema , distended abdomen, diarrhea, dermatitis/thin hair, enlarged fatty liver , low plasma albumin	Arrested growth, extreme muscle wasting, weakness, weight loss, No edema or changes in plasma proteins



Macronutrients

2- Carbohydrates

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
- Complex CHOs better to be included in diet because breaking them down requires energy (chance of gaining weight when taking simple carbs)

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

RDA **Female Dr: RDA is Important**

- 130 grams/day for adults and children.
- CHO intake above RDA causes weight gain or obesity due to increased fat storage in adipose tissue.
- If CHO intake is less than the RDA (130 g/day):
 - more proteins will be metabolized.
 - more gluconeogenesis will take place.
- Taking enough CHO inhibits gluconeogenesis, no degradation of proteins in the muscles

Macronutrients

3- Dietary fibers

Dietary fibers

- The component of food that cannot be broken down by human digestive enzymes.
- Because of B(1,4) found in cellulose, it is indigestible

RDA (gm/day)

Female Dr: RDA is Important

- Men: 38, Women: 25

● Benefits

- Lowers serum LDL levels
- How? bile salts contains cholesterol, Fibers bind to LDL (bile salts) blocks the reabsorption, Fibers are two type : 1- soluble: helps the removal of bile salts. 2- insoluble: more contributing to bulk.
- Reduces constipation
- Promotes feeling of fullness
- Slows gastric emptying (long-term glucose control in patients with diabetes mellitus)
- It bonds to harmful agent and then get excreted with it

4- Fats in the diet

Fats

Female Dr: RDA is Important

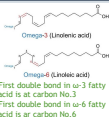
- A concentrated source of energy (9 kcals/gram)
- RDA (gm/day): Total fats: 65, Saturated: 20
- Excessive fat intake can cause:
 - Atherosclerosis/heart disease.
 - Obesity.
- Supply essential fatty acids such as **linoleic** and **linolenic** acids
- Provide phospholipids for membrane function
- Source of fat-soluble vitamins (A, D, E, K) and help in their absorption.

Macronutrients

4- Fats in the diet

Essential Fatty Acids

- Two essential fatty acids: **Unsaturated**
 - α -linolenic acid (ω -3 fatty acid).
 - linoleic acid (ω -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 in small amount)
- Formed during hydrogenation of liquid vegetable oils
- Found in baked food: cookies, cakes, deep-fried foods

Essential Fatty acids	Omega-3 fatty acids	Omega-6 fatty acids
Source	<ul style="list-style-type: none"> - Mainly found in cold-water ocean fish such as: albacore, mackerel, salmon, sardines, tuna, whitefish. - Plants such as spanish - Fish oil containing docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) 	<ul style="list-style-type: none"> - Nuts - Avocados - Olives - Soybeans - Oils (sesame, cottonseed, corn oil)
Effects	<ul style="list-style-type: none"> - Structural membrane lipids - Modulator of ω-6 fatty acids metabolism. - Little effect on LDL or HDL levels - Suppress cardiac arrhythmias - \downarrow Serum triacylglycerols - \downarrow Tendency to thrombosis - \downarrow blood pressure - \downarrow Risk of cardiovascular mortality 	<ul style="list-style-type: none"> - *Omega 3 lowers triglycerides* whereas omega 6 raises triglycerides in bloodstream - \downarrow Plasma cholesterol - \downarrow LDL - \downarrow HDL

Recommendations for Omega-3 Fatty Acid Intake

American Heart association Guidelines

Population	→	Recommendation
Patients without coronary heart disease (CHD)		<ul style="list-style-type: none"> - Fatty fish twice a week - Include oils and foods rich in α-linolenic acid (flaxseed, canola and soybean oils; flaxseed and walnuts)
Patient with CHD		<ul style="list-style-type: none"> - 1 gm of EPA+DHA per day from fatty fish - EPA+DHA supplements
Patients who need to lower triglycerides (fats)		- 2 to 4 grams of EPA+DHA per day

Micronutrients

Vitamins

Minerals and trace elements

- 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, Required in very small amounts
- Noncaloric

- Vitamins are Not required for energy but important for growth

Vitamins - classified based on solubility

Fat-soluble vitamins	Water-soluble vitamins
<p>A, D, E, and K (stored in the body)</p> <p>AKED</p>	<ul style="list-style-type: none"> - Ascorbic acid (vitamin C) - Thiamin (vitamin B1) - Riboflavin (vitamin B2) - Niacin (vitamin B3) - Pantothenic acid (vitamin B5) - Pyridoxine (vitamin B6) - B6on (B7) - Folate (B9) - Cobalamin (vitamin B12)

Vitamins

Vitamin E

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

Vitamin B1

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

Vitamins

Vitamin C

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



Female Dr: You should know 2 examples of Macro & Micro Minerals

Vitamins

Minerals and trace elements

Macrominerals (>100 mg/day)	Microminerals (<100 mg/day)
<ul style="list-style-type: none">- Calcium- Phosphorus- Sodium- Potassium- Chloride- Magnesium	<ul style="list-style-type: none">- Iron- Copper- Zinc- Molybdenum- Fluoride- Iodine- Manganese- Cobalt- Selenium- Chromium- Silicon

Micronutrients

Iron

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

Take home message

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

Amazing summary from 439

Macronutrients	Proteins	<p>Function: Proteins supply amino acids and amino nitrogen for the body.</p> <p>Sources: Meat, poultry, fish, milk, wheat, corn, beans, nuts.</p> <p>RDA: - Normal adults: 0.8. - Athletes: 1.0. - Pregnancy / lactation: upto 30. - Children: 2.</p>	
	Carbohydrates	<p>Function: energy production.</p> <p>Types:</p> <ul style="list-style-type: none"> - Simple CHOs: sucrose, fructose, lactose, corn syrup. - Complex CHOs: whole grains, pasta, wheat, starch. <p>RDA: 130 grams/day for adults and children.</p>	
	Dietary fibers	<p>RDA (gm/day): Men: 38, Women: 25.</p> <p>Benefits:</p> <ul style="list-style-type: none"> - 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 	
	Fats	<p>Function: A concentrated source of energy (9 kcals/gram).</p> <ul style="list-style-type: none"> - 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. <p>RDA (gm/day): Total fats: 65, Saturated: 20.</p>	
Micronutrients	Vitamins	E	<p>Function: - Antioxidant - May have a role in fertility and anti-aging effect.</p> <p>Source: Vegetable Oil, nuts, seeds, vegetables.</p> <p>RDA: Adults: 15, Children: 7.</p> <p>Deficiency: (mostly observed in premature infants)</p> <ul style="list-style-type: none"> - Defective lipid absorption. - Anemia due to oxidative damage to RBCs. - Neurological problems. - Male infertility.
		B1	<p>Function: - Coenzyme for transketolase and oxidative decarboxylation reactions.</p> <p>Source: Plants, cereals, meat.</p> <p>RDA: Adults: 1.2, Children: 0.6.</p> <p>Deficiency: - Beriberi - Wernicke-Korsakoff syndrome</p>
		C	<p>Function: - Powerful antioxidant (prevents some cancers). - Helps in dentine, intercellular matrix and collagen formation. - Increases iron absorption. - Helps in the maturation of RBCs. - Promotes wound healing. - Stimulates phagocytic action of leukocytes. - Reduces risk of cataract formation.</p> <p>Source: Citrus fruits, tomatoes, melon, peppers.</p> <p>RDA: Men: 90, Women: 75, Children: 15-25.</p> <p>Deficiency: - Scurvy.</p>
	Mineral & Trace elements	IRON	<p>Function: - Oxygen transport and metabolism. - Part of hemoglobin, myoglobin, cytochromes. - Body stores iron as ferritin, hemosiderin and transferrin..</p> <p>Source:</p> <ul style="list-style-type: none"> - Heme iron: Animal products (meat, liver), 25% absorption. - Nonheme iron: Plants (spinach, beans), 5% absorption. <p>RDA: Men: 8, Women: 18, Children: 7-15.</p> <p>Deficiency: - Iron deficiency anemia. - Hemosiderosis (iron overload disorder).</p>

Quiz

MCQs

Q1: Which one of the following diseases that associated with high death rate is strongly correlated with diet that is deviated from ADMR?

- A- Stroke
- B- Heart Disease
- C- Malignancy
- D- Pneumonia

Q3: Which of the following represents a negative nitrogen balance?

- A- Growth
- B- Pregnancy
- C- Lactation
- D- Burns

Q5: Which one of the following macronutrients makes you feel full for long time and controls long-term glucose in diabetic patients?

- A- Proteins
- B- Carbohydrates
- C- Fats
- D- Dietary fibers

Q2: A 2 year old child came to the clinic complaining of arrested growth, extreme muscle wasting and weight loss. After history taking, his parents informed the physician that his diet is normal with adequate protein intake. What is the diagnosis ?

- A- Kwashiorkor
- B- Marasmus
- C- Scurvy
- D- Beriberi

Q4: Scurvy is caused due to the deficiency of?

- A- Vitamin A
- B- Vitamin C
- C- Vitamin D
- D- Vitamin K

Q6: Transketolase has the coenzyme?

- A- Vitamin C
- B- Vitamin E
- C- Thiamine
- D- Pyridoxal phosphate

Answers: 1-B, 2-B, 3-D, 4-B, 5-D, 6-C

SAQ

Q: Write one function, source, effect of deficiency for each vitamin? A- Slide 11-12

	Function	source	Deficiency Effect
Vitamin E			
Vitamin B1			
Vitamin C			

Members board

Team Leaders



Remas Aljeaidi



Raghad Alhamid



Mohammed Alqutub

Team Members



Leen Alduaij



Zeyad Alotaibi



Sultan Almishrafi



Wafa Alakeel



Mohammed Alarfaj



Juwan Al Musma



Madawi Alhussain



Nazmi A Alqutub



Wasan Alanazi



Leen K Althunayan



Faisal Alshowier



Aishah boureggah



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Osama Almashjari



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Nazmi M Alqutub



Salma Alsaadoun



Layan Al-Ruwaili



Fahad Mobeirek



Sarah Alajaji



Abdulrahman
Alosleb



Areej Alquraini



Waad alqahtani

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Biochemistry.med443@gmail.com

