

# FOOD 2001 Midterm

## Chapter 1: Nutrition and Health Promotion

### Learning Outcomes:

After completing this chapter, the student should be able to:

1. Discuss the importance of nutrition and its effect on health
2. List several personal life choices that affect health
3. List energy-yielding nutrients and helper nutrients
4. Define the 5 characteristics of a healthy diet
5. Describe the Canadian Food Guidelines
6. Describe the research process

### Questions:

1. Malnutrition includes deficiencies, imbalances, and excesses of nutrients, any of which can be detrimental over time.  
a. False                      **b. True**
  - *It has to be fixed over time or else it will impact greatly in the long run.*
2. Enriched and fortified foods are not necessarily more nutritious than whole basic foods.  
a. False                      b. True
  - *Fortified: extra nutrients are added*
  - *Enrichment: Its already there but extra amount has been added.*
3. Cultural traditions regarding food are static and inflexible.  
**a. False**                      b. True
  - *It's not true, because it's based on the environment and what is there.*

Common ground Nutrition, Food Science and Consumer

### **Consumer Need**

- Most people agree but that is knowledge, cause its not based on what we want.

### **Consumer Food Preferences**

- Based on what we want, not what we need. Sometimes we want things that we don't need
- Scientist created trans-fat cause it increased the shelf life, the texture was nicer, but they didn't consider the consequences

### **Nutrition (definition)**

- Nutrition is the science that interprets the relationship of foods to the functioning of living organisms

### **The study of**

- nutrients in foods,
- how nutrients are used in the body,
- and human behaviours related to food and lifestyle

### **Food**

- Food: Any substance the body can take in and assimilate (used to enable the body to stay alive and grow)
- Food Science: study of nature of foods, causes of deterioration, principles of food processing, improvement of foods
- Food Technology: application of food science to product development (Sensory qualities, Nutritional enhancement, Food safety)
- *Anything that can be digest and the body can take*

### **Diet**

Diet: foods and beverages a person usually eats and drinks

Dietetics: application of nutritional science to provide dietary advice and intervention to address individual and public health

### **Why is Nutrition Important?**

- One of several factor contributing to health
- Can prevent some diseases and reduce your risk for others
- Nutrition contributes to wellness

### **Nutrition can prevent disease**

- Diseases caused by nutrient deficiency:  
e.g.
- Diseases influenced by nutrition: chronic diseases such as heart disease
- Diseases in which nutrition plays a role: osteoarthritis, osteoporosis
- Diseases caused by nutrient deficiency: scurvy, goiter, rickets.

### **Leading causes of death**

- Cancer (reduce by more antioxidant)

- Cardiovascular diseases
- Cerebrovascular diseases
- Chronic respiratory diseases
- Accidents

### History of Nutrition

- 400 B.C. - Squeezing the juice of liver into the eye
- 1747 – Dr. James Lind, a physician in the British Navy, performed the first scientific experiment in nutrition
  - *The problem they were having here was scurvy, but Vitamin C wasn't discovered*
- Early 1800's – foods are composed primarily of four elements
- Vitamin A is important for our eyes, and it is stored in our liver.
- Vitamin A eye disease
- Scurvy (Lind): 3 groups Sea water, vinegar, limes ((Vitamin C discovered in 1930): Bleeding from the mucous, skin spot
- Four elements: C, N, H, O
- 1897- Beriberi: (heart problems, paralysis. Christian Eijkman, a Dutchman working with natives in Java (Indonesia) : Vitamin B1 (thiamine)
- 1912- Vitamin A discovered (first Vitamin)
- 1914- Pellagra Joseph Goldberger (B3 Niacin discovered in 1938): affects Skin and mucous (Areas of the skin may become prone to bacterial infection)

### Food choices

- Availability, cost, convenience
- Emotional, social, cultural factors
- Personal preference and genetics
- Advertising
- Nutritional value
- Positive associations
- Values or beliefs

### Health Definition

- The state of a human when it functions optimally without evidence of disease or abnormality.

### Nutrients

- Components in food that are indispensable (or essential) to the functioning of the body.

### Nutrients provide:

- energy
- building material
- help maintain or repair body parts and support growth

### The Nutrients

#### Energy Providing:

- carbohydrate
- fat
- protein

#### Other nutrients:

- water
- vitamins
- minerals

### Energy-yielding nutrients

### Energy

Food energy measured in calories

Table in book:

<b>Carbohydrate</b>	<b>4 Cal/g (=kcal/g)</b>
<b>Fat (lipid)</b>	<b>9 Cal/g</b>
<b>Protein</b>	<b>4 Cal/g</b>
<b>Alcohol</b>	<b>7 Cal/g</b>

### Food quantity measured in grams

- *Alcohol has very little benefit! If you have excess, it will be considered toxic and shift the metabolism in order to resolve the excess alcohol in the system prevent the other nutrients to be absorbed.*

### Essential Nutrients

- The nutrients that the body cannot make for itself from other raw materials

- Or "conditionally essential": the body cannot make enough to meet the requirements for health. E.g. the amino acid histidine to support protein synthesis during growth
- 9 essential amino acids (TV TILL PM)
  - Threonine
  - Valine
  - Tryptophan
  - Isoleucine
  - Leucine
  - Lysine
  - Phenylalanine
  - Methionine
- 2 groups essential fatty acids
- Vitamins
- Minerals

#### Nutrient in Food

- Dietary supplements
  - Pills, liquids, or powders that contain purified nutrients or other ingredients
  - Cannot be used in place of food
  - Food offers more than just the six basic nutrients
- *You need a diversity in the food you eat. Thus these cannot replace the food, but can be a part of our diet*

#### Healthy Diets (Nutritious)

- **Adequate:** in essential nutrients, fiber and energy.
- **Balance:** in nutrients and food types
- **Calorie control:** foods provide amount of energy to maintain healthy body weight
- **Moderation** in fat, salt, sugar, cholesterol
- **Variety:** choose different foods each day
  - *To avoid monotony, you need to change it up everyday*

#### Nutrient Density

- Getting the most nutrients for your calories.

#### Discretionary Calories

#### Calculating % Calories from fat

- **Potato Chips (small bag)**
- **2 g protein, 15 g fat, 24 g CHO, and 239 Calories for 43 grams (~22 chips)**
- **% Calories from fat?**

$$\text{Cal (fat)} = 15g \times 9 \frac{\text{cal}}{g} = \frac{135}{239} \times 100$$

$$= \text{---}\%$$

- **% Calories from CHO?**

$$\text{Cal (CHO)} = 24g \times 4 \text{ cal/g}$$

$$(24 \times 4 / 239) \times 100 = 40.1674$$

#### Calculating calories

- CHO = 225 x 4 cal/g = 1020 Cal
- Fat = 50g x 9 cal/g = 450
- Protein = 70g x 4 cal/g = 280
- Alcohol = 8x 7 cal/g = 56 cal
- Total = 1806 cal

#### Energy contribution from fat, CHO, Protein

- Let's say you have completed a personal diet analysis and you consume 2500 cal/per day (300g CHO, 90g fat, 123g protein)
- %CHO = ((300x4)/2500)x100% = 0.48
- %fat = ((70x9)/2500)x100%=0.252
- %Protein

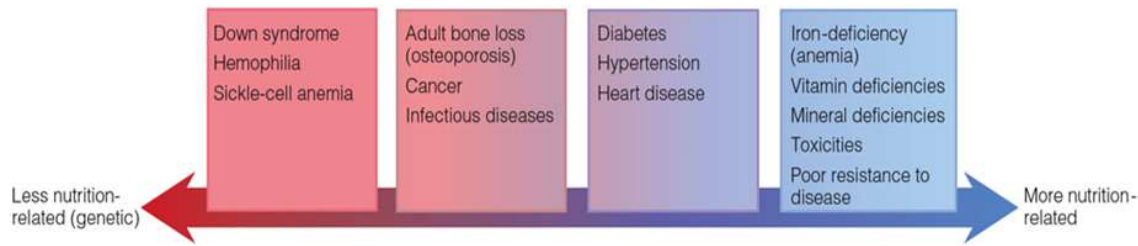
#### Canada's Guideline for Healthy Eating

- Variety of food

- Emphasize cereals, breads, other grains, veggies and fruits
- ... rest on slide

### Genetics and Individuality

- Some genetic based diseases are related to nutrition and other aren't.



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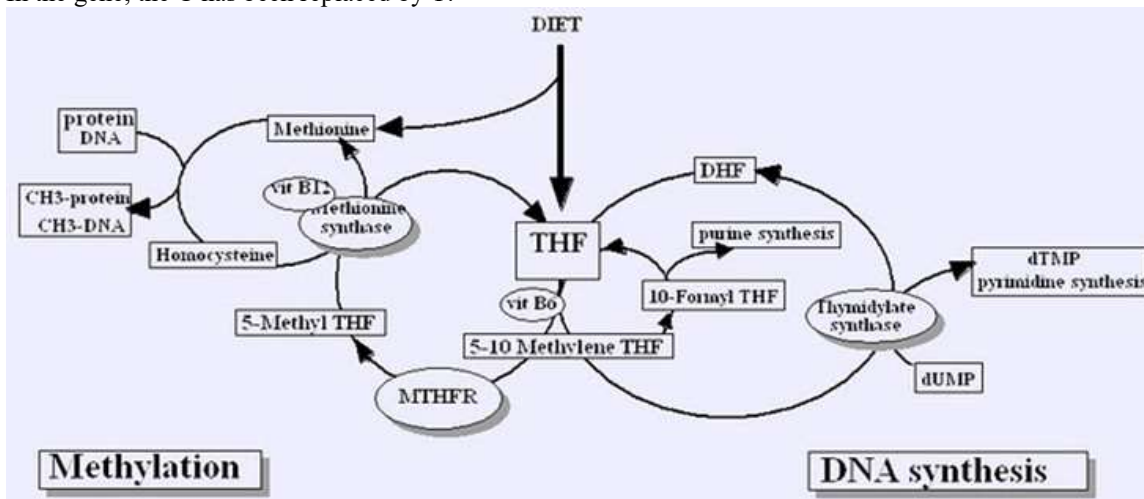
- Some people metabolize different types of protein and carbs based on genetic make up.
- Example: There are specific genes where people crave more sugar than others. It's a metabolic problem..

### Nutritional Genomics

- How nutrients affect gene activities
- Might explain the difference in individual response to dietary factors that have led to major controversies in nutrition.
- Gene: MTHFR - 5,10-Methylenetetrahydrofolate reductase
- Normal role provide instructions or code for making the enzyme to metabolize homocysteine.
- This reaction is involved in converting homocysteine to methionine



- Homocysteine--> Methionine: If this reaction doesn't occur, you have high concentration in blood system
- In the gene, the C has been replaced by T.



- If the MTHFR is missing due to genetic disorder, the 5-Methyl THF can be given as external source (diet instead of folic acid) in order for the system to function.

### Nutrition Research

- Scientists uncover nutrition facts by experimenting
- Research designs:
  - case studies
  - epidemiological study
  - intervention study
    - Group treatment
    - Any changes that happen here are from treatments
  - laboratory study
    - Any changes you see from a controlled group

### Neural Tube Defects

- Caused by nutrients deficiency (folic acid) during one's pregnancy
- Impacts brain, spinal cord and/or their protective covering

Who can I trust?

- Labels
- News media
- Even if it's in a scientific journal, it hasn't been verified so you shouldn't completely trust it

Reading Nutrition news with an educated eye

- Published in a peer-reviewed journal
- Purpose of the study and describe the research methods
- Limitations
- Previous research

Who can you trust?

- Separating the imposters from the real nutrition experts
  - Identifying valid nutrition info
  - Who are the experts
  - Nutrition on the net

Nutrition advice

- Trustworthy experts and educated and credentialed
- Government sources of info are trustworthy
- Professional organizations provide reliable nutrition info

Evaluation of nutrition claim

- **Greens+ whole body nutrition**
  - Summarize the basic idea
  - Can you find a scientific paper that supports the claim(s)?
  - Identify the statements in the claim that you believed and those you do not believe
- <http://www.acaicanada.com/>
- Product that improves the digestive system
- Can you find any scientific info on this product?

## Chapter 2: Evaluating the diet

### **Learning Outcomes**

After completing this chapter, you should be able to:

- Describe the methods used in diet analysis
- Explain the purpose of the Dietary Reference Intakes
- Interpret the Nutrition Fact Table on food label
- Discuss how foods are grouped in the Canada's Food Guide
- Describe the Canada's Food Guide and how it can be used to plan a nutritious diet
- Discuss the importance of serving sizes in nutrition

### **Diet assessment**

It's a method of measuring dietary intake

Dietary intake

- Is what people eat or consume on a daily basis

Include

- Breakfast
- Lunch
- Dinner
- Snacks or in-betweens

Methods for Food Intake Analysis

- Diet recall, usually 24 hours
  - Advantage:
  - Disadvantage:
- Diet record, usually 3-5 days
  - Advantage:
  - Disadvantage:
- Food frequency questionnaire
  - targeted at different nutrients

### **Interpretation of Food Intake: How to do this?**

Compare the average daily intake to:

- Canada Food Guide for Healthy Eating
- Dietary Reference Intakes
- Canadian Nutrient File

**Eat Well with Canada's Food Guide**

Health Canada [www.hc-sc.gc.ca](http://www.hc-sc.gc.ca)

- Translation of nutrient requirements (DRI) into food intake
- Prior focus on, under-nutrition, preventing deficiencies
- Current focus (2007) on optimal intakes, diet approach

### Canadian Food Guide

- Rainbow of food groups indicates variety and proportions in diet
- Defines serving sizes for foods
- Range of servings/day to plan diets for different people with different needs
  - age, body size, physical activity
  - male or female (pregnant or breastfeeding)

### Food Groups

Food groups:

- Vegetables and Fruit
- Grain Products
- Milk and Alternatives
- Meat and Alternatives

### Food Guide Servings for nine age/sex groups:

- Children: 2-3 y, 4-8 y, 9-13 y
- Teens: 14-18 y (males, females)
- Adults: 19-50 y (males, females)  
51+ y (males, females)

### Nutrients in the Food Groups

Grain Products (3-8 servings/day)

- protein, CHO, fibre, thiamin, riboflavin, niacin, folate and iron
- choose whole grain and enriched products (nutrients added back that were lost in product processing e.g. wheat flour) more often



Vegetables and Fruit (4-10 servings/d)

- CHO, fibre, thiamin, folate, Vit. C, Vit. A and iron
- choose dark green and orange vegetables (more concentrated in folate and Vit. A), and orange fruit (Vit. C) more often



Milk and milk products (2-4 servings/d)

- protein, fat (\*may be non-fat choices), calcium, riboflavin, niacin, folate, Vitamins B12, A, D
- Vitamins A and D are added to milk
- choose lower-fat milk products more often



Meat and Alternatives (1-3 servings/d)

- protein, fat, thiamin, riboflavin, niacin, folate, Vitamins B12, A and iron
- choose leaner meats, poultry and fish as well as dried peas, beans and lentils more often.

Serving/Portion



- *In general, Canadians eat*
  - *too few servings of Vegetables and Fruit*
  - *too many foods that are rich in fat*
- *It is recommended that Canadians choose more:*

- *Vegetables*
  - *Especially dark green vegetables, orange vegetables, and legumes*
- *Fruits*

**Canada Food Guide**

- Combination foods: e.g. pizza could be 2 Grain, 0.5 Meat, 1 Milk, 1.5 F&V
- Cheese can be counted as either milk or meat group
- Adapting the food guide to ethnic foods and cultural backgrounds

**Other Foods in Moderation**

- Mostly fat: butter, margarine, oil
- Mostly sugar: jam, honey, syrup, candy
- Condiments: pickles, mustard, ketchup
- High fat and/or high salt: chips, pretzels
- Beverages: tea, coffee, alcohol and soft drinks

**Advice for different ages and stages**

- Children
  - Serve small nutritious meals and snacks each day
  - Do not restrict nutritious foods because of their fat content
- Women of childbearing age
  - Take a multivitamin containing folic acid every day
- Men and women over 50
  - Take daily vitamin D supplement of 10 µg (400 IU)

**Health Canada: Nutrition Recommendations**

- No more than 10% of energy as saturated fat (11 g/1,000 calories)
- 55% of energy as carbohydrate (138 g/1,000 calories) from a variety of sources
- Sodium content should be reduced
- No more than 5% of total energy as alcohol or 2 drinks daily, whichever is less (not during pregnancy)
- No more caffeine than the equivalent of 4 regular cups of coffee/day
- Community water supply fluoridated to 1 mg/litre

**Dietary Reference Intakes (DRI)**

- DRIs are a set of nutrient reference values
  - For vitamins, minerals, macronutrients and energy
- Used modelling to develop the eating pattern
  - Examined different combinations of amounts and types of food to find an eating pattern that would meet nutrient needs
  - Used DRI nutrient reference values and assessment methods to determine if the eating pattern was satisfactory

**DRIs**

goals:

- Setting intake values for individuals
  - assess intakes, plan diets
- Facilitating nutrition policy and research
  - e.g. fortification [iodine (salt), Vitamin C (evaporated milk)]
- Establishing safety guidelines
- Preventing chronic disease

**Association between foods and chronic diseases**

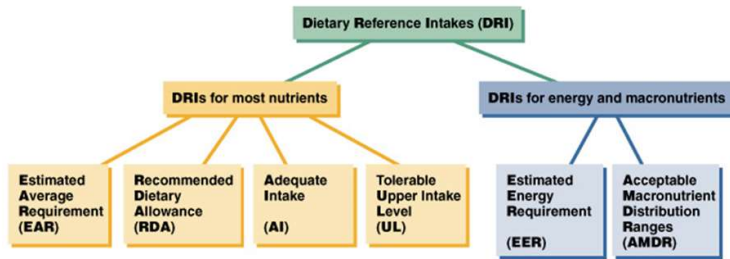
- Convincing evidence
  - Increase in vegetables and fruits: Decrease CVD and Decrease cancer
  - Increase in grains: Decrease CVD, Increase in fish: decrease CVD
- Food intake pattern reviewed for consistency
  - Consistent with vegetables, fruit and whole grains
  - Added statement "Eat at least two Food Guide Servings of fish each week".

**DRI of major nutrients**

- Set healthy ranges of intake for carbohydrate, fat, and protein
  - Acceptable Macronutrient Distribution Ranges (AMDR)

Age group	Percent calories from		
	Carbohydrates	Protein	Fat
1-3 yrs	45-65 %	5-20%	30-40%
4-18 yrs	45-65 %	10-30%	25-35%
19 yrs +	45-65 %	10-35%	20-35%

## DRI terms



- RDA (Recommended Dietary Allowances): intake goals for individuals
- EAR (Estimated Average Requirements): intake goals for individuals when no RDA
- AI (Adequate Intakes): when insufficient scientific data for setting EAR
- UL (tolerable Upper Limits): danger from toxicity
- Estimated Energy Requirements (EER)
- The Daily Values (DV)

### DRI Recommendation 2007

- It is recommended that Canadians choose more:
  - Vegetables
    - Especially dark green vegetables, orange vegetables, and legumes
  - Fruits
- It is recommended that Canadians choose less:
  - Refined grains
  - Total fats
    - Especially saturated fat, trans fat, and cholesterol
  - Added sugars

### DRI: Factors considered

- Target population > 2 years of age
- Body size makes more difference than sex, except for iron and calcium
- Age: to account for physiological changes of lifecycle
- Adaptation: e.g. protein & calcium intakes
- Time: not based on 1 day of food intake

### DRI: Factors not considered

- Activity: elite athletes vs. inactive
- Diet: vegans vs. omnivores
- Geographic area: southern vs. northern Canada for Vitamin D from sunlight
- Lifestyle: smoking increases Vitamin C requirement
- Illness, malnutrition

### Proper Use of DRI

Energy: average requirement based on average height and weight

- For 19-24 years
  - Males: 42 cal/kg body weight
    - 3,000 calories/day for 71 kg male
  - Females: 36 cal/kg
    - 2,100 calories/day for 58 kg female
- Most nutrients (except energy): mean  $\pm$  2 standard deviations (SD).
- The DRI meets the nutritional needs of 97.5 % of the population
- Thus, the DRI exceeds the requirement of most individuals in the population (all except 2.5%)

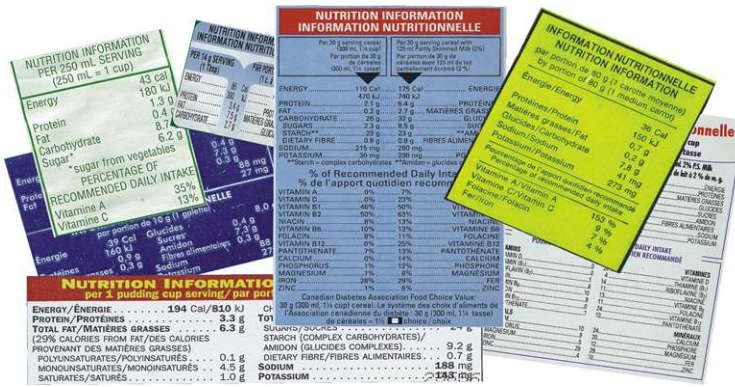
If a person has less than the DRI for one nutrient, this does not mean that they have a deficiency of that particular nutrient, only an increased risk of developing one

- Consuming less than 2/3 of the DRI (based on the 3 day average) indicates risk

### Counting Food Guide Servings

- An example is provided illustrating how to estimate the number of Food Guide Servings in a mean





## Required informations

- Nutrition Fact

## What food products have Nutrition Facts?

**Almost all** prepackaged foods have Nutrition Facts.

Some exceptions are:

- fresh fruit and vegetables;
- raw meat, poultry, fish and seafood;
- foods prepared or processed at the store:  
*bakery items, sausage, salads;*
- foods that contain very few nutrients:  
*coffee beans, tea leaves, spices;*
- alcoholic beverages.

## Foods Labeling

Beef burger		Chicken burger	
<b>Nutrition Facts</b>		<b>Nutrition Facts</b>	
Per 1 burger (130 g)		Per 1 burger (130 g)	
Amount	% Daily Value	Amount	% Daily Value
Calories 340		Calories 200	
Fat 27 g	42 %	Fat 9 g	14 %
Saturated Fat 12 g + Trans Fat 2 g	70 %	Saturated Fat 2 g + Trans Fat 1 g	15 %
Cholesterol 70 mg		Cholesterol 70 mg	
Sodium 330 mg	14 %	Sodium 800 mg	33 %
Carbohydrate 3 g	1 %	Carbohydrate 4 g	1 %
Fibre 0 g	0 %	Fibre 0 g	0 %
Sugars 3 g		Sugars 0 g	
Protein 24 g		Protein 25 g	
Vitamin A 0 % Vitamin C 0 %		Vitamin A 0 % Vitamin C 0 %	
Calcium 2 % Iron 30 %		Calcium 4 % Iron 2 %	

## Use the % DV to make informed food choices

- Increase a specific nutrient...

calcium, iron, fibre	≥15% DV	HIGH
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- Decrease a specific nutrient...

combined saturated and trans fats	≤ 10% DV	LOW
fat, sodium	≤ 5% DV	LOW

## List of ingredients

- *Example of a granola-type snack bar:*  
“flour, sugar, whole oats, water, hydrogenated vegetable oil, honey, milk powder, wheat bran”
- Nutrition claims

## Permitted Diet-Related Health Claims

**TABLE 2-8 DIET-RELATED HEALTH CLAIMS**

- Potassium, sodium, and reduced risk of high blood pressure
- Calcium, vitamin D, and regular physical activity and reduced risk of osteoporosis
- Saturated and *trans* fats and reduced risk of heart disease
- Vegetables and fruit and reduced risk of some types of cancer
- Minimal fermentable carbohydrates in products such as gum and a reduction in the risk of cavities/caries.

Specific requirements related to the claims can be found in the *Guide to Food Labelling and Advertising* Chapter 8, Section 8.4: Diet-Related Health Claims,

**TABLE 2-7 DESCRIPTIVE TERMS USED ON FOOD LABELS**

**Energy Terms**




- **low calorie** 40 calories or fewer per serving.
- **reduced calorie** at least 25% lower in calories than a "regular," or reference, food.
- **calorie free** fewer than 5 calories per serving.

**Fat Terms (Meat and Poultry Products)**

- **extra lean**  
less than 5 g of fat *and*  
less than 2 g of saturated fat and *trans* fat combined, *and*  
less than 95 mg of cholesterol per serving.
- **lean<sup>a</sup>**  
less than 10 g of fat *and*  
less than 4 g of saturated fat and *trans* fat combined, *and*  
less than 95 mg of cholesterol per serving.

**General health claims**

General health claims are generally developed:

by third party organizations	by corporations
	 

Consumers should not solely rely on general health claims to make informed food choices.

<http://guidingstars.ca/news/>

**Proposed Changes**

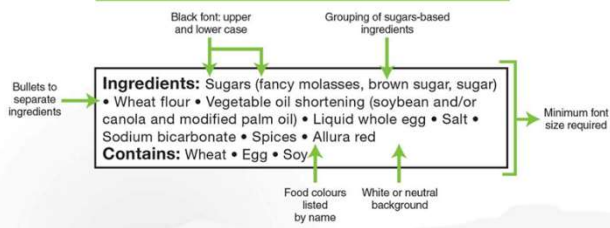
Nutrition Facts Valeur nutritive	
Per 1/2 cup (125 mL) pour 1/2 tasse (125 mL)	
<b>Calories 80</b>	% Daily Value* % valeur quotidienne
<b>Fat / Lipides 0.5 g</b>	1 %
Saturated / saturés 0 g + Trans / trans 0 g	0 %
<b>Carbohydrate / Glucides 18 g</b>	
Fibre / Fibres 2 g	
Sugars / Sucres 15 g	15 %
<b>Protein / Protéines 3 g</b>	
<b>Cholesterol / Cholestérol 0 mg</b>	
<b>Sodium 0 mg</b>	0 %
<b>Potassium 200 mg</b>	4 %
<b>Calcium 0 mg</b>	0 %
<b>Iron / Fer 0.3 mg</b>	2 %
*5% or less is a little / 5% ou moins c'est peu 15% or more is a lot / 15% ou plus c'est beaucoup	

Annotations:

- Increased size of Calories, with thick underline
- Nutrients that provide Calories are listed below Calories
- Sodium is moved down close to Potassium
- Vitamin A and Vitamin C are removed; Potassium is added
- Quick rule
- Serving Size information increased
- % Daily Value for Sugars is added
- Amounts of Potassium, Calcium and Iron are shown

**Proposed changes**

## PROPOSED LIST OF INGREDIENTS



## General health claims

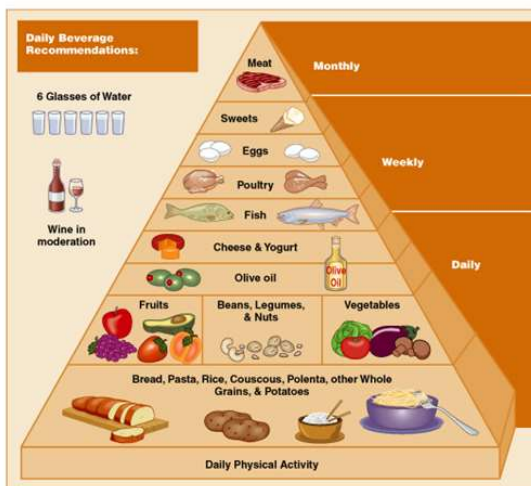


## Vegetarian Food Guide Pyramid



(a) Vegetarian diet pyramid

## Mediterranean Food Guide Pyramid



(b) Mediterranean diet pyramid

## Naturally occurring food components that may have other roles than nutrition

- Phytochemicals:
  - nonnutrients derived from plants
  - have biological activity in the body
  - may support health beyond roles of traditional nutrients
- Functional Foods
  - contain naturally occurring or added nonnutrients

## Phytochemicals in Foods

- Potential cancer protection
  - whole foods & flavanoids
  - chocolate & flavanoids
  - soybeans & phytosterols, phytoestrogens
    - less osteoporosis e.g. Asia
  - flaxseed & lignans
  - tomatoes & lycopene
  - garlic & organosulfure compounds

## Phytochemicals in Pills

- Alter body functions, sometimes powerfully, in ways only partly understood
- Lack of safety evidence for isolated phytochemicals in humans
  - genistein (from soybeans) increases cancer in laboratory animals
- No regulatory body for safety, efficacy
- Unsubstantiated claims on labels

## Phytochemicals from Food

- Food, not supplements, is the most effective and safest source of phytochemicals
- Tips for consuming phytochemicals (more vegetables, fruit, grains, legumes)

## Functional Foods

- Natural sources
  - e.g. yogurt contains Lactobacillus or other bacteria that ferment milk into yoghurt
  - Probiotic: alters native bacterial colonies in gut & may reduce disease
- Added (making a food into a drug?)
  - e.g. cholesterol-reducing margarine containing phytosterols to reduce blood cholesterol (US & Europe; expensive)

## Diet plans

- When making choices in each food group, nutrient dense foods are the best choice.
- Nutrient density: the relative amount of nutrients per Calorie of food.
- Diet Plans can be used to design a healthy diet.
  - Eating Well with Canada's Food Guide
  - The 5 to 10 a Day for Better Health
  - The DASH Diet Plan
- Eating Well with Canada's Food Guide
  - Use to design a diet with adequacy, moderation, balance and variety
  - Visit Health Canada's website to create your own customized My Food Guide
- The 5-to-10-a-Day for Better Health
  - A campaign involving the Heart and Stroke Foundation of Canada, the Canadian Cancer Society, and the Canadian Produce Marketing Association.
  - Recommends everyone over 4 years of age consume 5 to 10 servings of fruits and vegetables every day.
- The DASH Diet Plan
  - Dietary Approaches to Stop Hypertension
  - Similar to the Food Guide in that it is low in fat and high in fibre

## Can eating out be nutritious?

- Eating in restaurants often involves:
  - High-fat foods
  - Large portion sizes
- A restaurant meal can be equivalent to the recommended fat or calorie intake for an entire day!

## Can eating out be nutritious?

Tips for restaurant meals include:

- Avoid whole-milk or cream in beverages
- Avoid breaded or fried foods
- Share your entrée with a friend or take half of your order home for another meal
- Order broth-based instead of cream-based soup
- Order salad with dressing on the side
- Ask for steamed vegetables instead of potatoes or rice
- Skip dessert or share one with a friend.

## Chapter 3: Utilization of Nutrients

### Learning outcomes

1. List the basic needs of cells and describe how cells are organized into tissues, organs, and systems.
2. Describe the major functions of the cardiovascular, hormonal, nervous, digestive, and excretory systems.
3. Describe the mechanical and chemical digestive processes in order of their occurrence in the body.

4. Discuss the processes of absorption, transportation, and storage of nutrients

#### Why do we eat?

- Foods provide energy
- Stimulate our senses
- Building blocks for growth and maintenance of body tissues

#### Why do we want to eat?

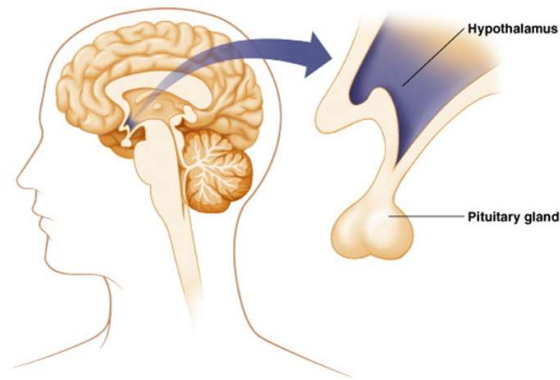
- Appetite: psychological desire to eat certain foods
  - Strong cravings even when we're not hungry are due to appetite
- Hunger: physiological sensation that prompts us to eat
  - *There are certain hormones that will make you want to eat*
- Satiety: the feeling of being full
  - *Fat has the highest satiety, then Protein and finally Carbs*

#### Why do we want to eat?

The signals that prompt us to eat include:

- Nerve receptors in the stomach send signals to the brain to indicate if the stomach is full or empty.
- Blood glucose levels trigger the release of hormones called insulin and glucagon
- The hypothalamus region of the brain receives these signals.
- *When a specific level of nutrient is low in the body, hormones will be released*

#### Why do we want to eat?



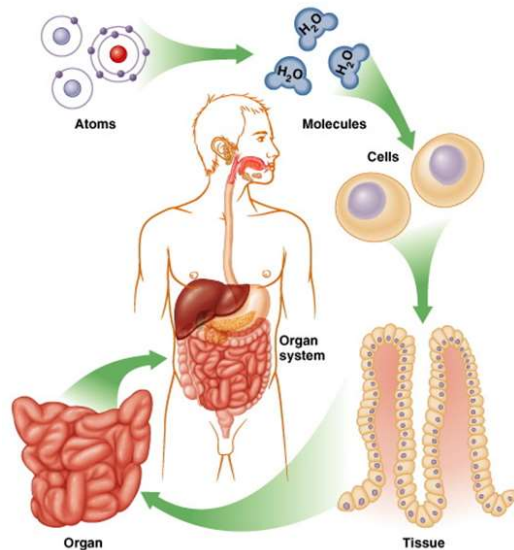
#### Regulation

Communication between organs & cells

- Hormones
  - e.g. insulin & glucagon regulate blood glucose
- Nervous system
  - e.g. responds to need for food (hunger), regulates digestion (gastric juices)
- Regulation
- Combination of hormones and nervous system
- e.g. fight or flight reaction: epinephrine or adrenaline (hormone) and body responses/movements

#### Organization of the body

- Atoms: the smallest units of matter.  
Molecules: groups of atoms bonded in specific configurations.
- E.g., H<sub>2</sub>O (water), CO<sub>2</sub> (carbon dioxide)
- Carbohydrates, proteins, fats and vitamins are usually very large molecules.
- The goals of digestion:
- Break these large molecules down to smaller molecules
- Absorb the smaller molecules into the cells of the body



## Genes

- DNA you receive from your mother and father
- Many are little changes from thousands of centuries ago
- There is no guarantee that a diet chosen from today's foods will meet the needs of your "ancient" body
- Unlike your ancestors you must learn how to select foods to meet your body's needs
- *There may be phosphorylation and mutation that can impact the genes. That's why we don't necessarily consume the same food as everyone and through time. Food we had before and compared to what we have now are very different, so the genes will be regulated based off what is offered and what we have now.*

## The body's cells

Cells require nutrients

- Each of the body's cell is a self-contained, living entity
- However, each cell depends on the rest to supply its needs
- These needs include energy, oxygen, water, building blocks, control systems, and especially the essential nutrients
- The body's cells

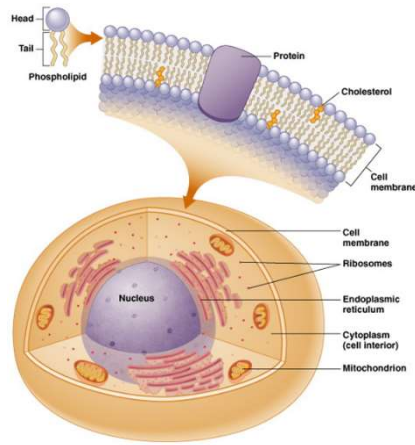
All living things including cells die

- Some skin cells and red blood cells must replenish themselves **every 10 to 120 days**
- Cells lining the digestive tract replace themselves every **three days**
- *If the telomere stops decaying it would not be good cause there are cells that can mutate to cancer cells which could be bad cause then they would not die.*
- *Some cells could be damage that need to die.*
- *Different cells have different length of telomeres that can divide.*
- Ordinarily, many muscle cells reproduce only **once every few years**
- Liver cells have the ability to reproduce quickly and do so whenever repairs are necessary
- Certain brain cells do **not reproduce at all**
- *If a number of cell decrease in the liver, then it will not be able to recover.*
- *The center of all other nutrients all occur in the liver, especially for metabolism.*

The Workings of Genes

- Each gene is a **blueprint** that directs the production of protein machinery, often an **enzyme**
- Genes provide the instructions for the structural components cells need to survive
- Trillions of cells

Organization of the body



What happens to the food we eat?

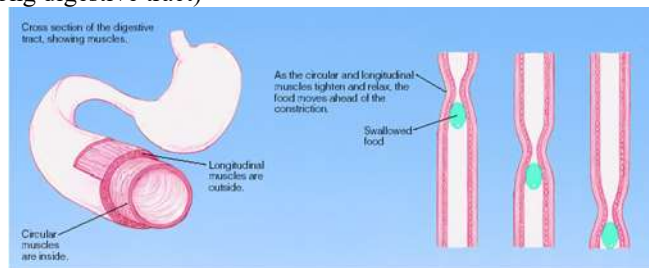
- The food we eat undergoes three processes:
  - i. Digestion
  - ii. Absorption
  - iii. Elimination
- These processes occur in the gastrointestinal tract.

### Digestion

- Breakdown of nutrients into their smallest subunits for absorption into the body
- CHO--> begins in the mouth. The amylase in the saliva break down the polysaccharides in the carbohydrate food.
- Protein--> begins in the stomach via pepsin (protein digesting enzyme) breaks the bonds that hold the protein together. Polypeptides are further broken down in the small intestine
- Fat--> begin in the small intestines; break down by bile

### Mouth

- chews and mixes food with saliva (mucus and enzymes)
- Esophagus passes food to the stomach via peristalsis (wave-like muscular squeezing along digestive tract)



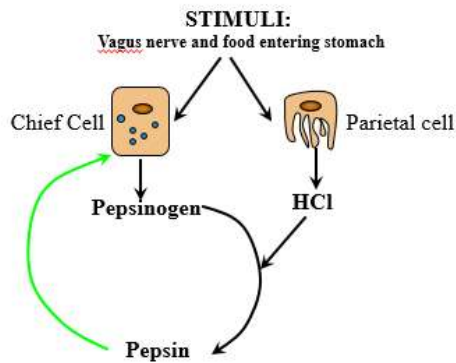
### Digestion: Choking

- Cut your food into small pieces
- Chew your food until it is crushed and moistened with saliva
- Refrain from talking or laughing before swallowing
- Learn the abdominal thrust (technique formerly known as the Heimlich Maneuver)

### Stomach

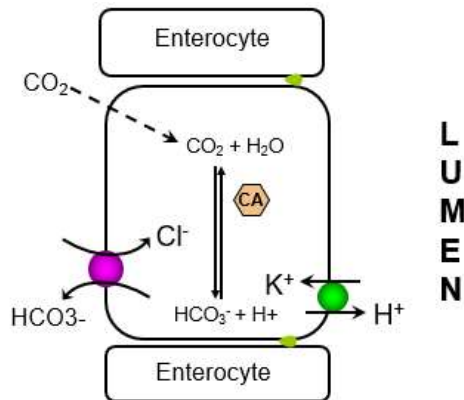
- adds gastric acid, enzymes and fluid:
- gastric acid is pH 1-2
  - denatures protein and releases minerals and vitamins, *so enzymes can have access.*
- kills microorganisms
- mucus protects the stomach wall
- *Babies have a pH of 4 in their stomach, because it is not well developed.*

### Roles of chief and parietal cells



- The vagus nerve will signal the chief cell and parietal cells which will tell them nutrients are low. Parietal cell will secrete HCL. Then will serve a pepsin (protein).

### H<sup>+</sup> Secretion by parietal cells



- CO<sub>2</sub> will get into the cell, and will convert to bicarbonate which will move into the lumen.

### Stomach

- churns and mixes food to a liquid mass (chyme)
- muscle movement of food controlled by
  - cardiac sphincter (into stomach)
  - pyloric sphincter (into small intestine)
- **Heartburn** (gastric ulcer): burning sensation in the chest caused by backflow of stomach acid into the esophagus
  - Antacids for temporary heartburn relief
- Ulcer: bacterial infection, or too much acid & pepsin
  - *Damage to the cells that are protected.*
  - *Main microorganism: Heliobacter Pylori*
    - *Some people already have it but ulcer isn't caused.*
    - *Over-activation of pepsin could contribute to it or an infection*

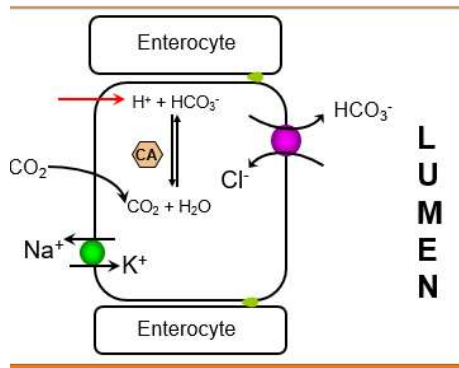
### Small Intestine

- major site of digestion
- 20 feet long
- pancreas secretes bicarbonate that neutralizes the acidic contents from the stomach

### Intestinal phase

- After GASTRIN stimulates stomach, secretion must be inhibited
- This is done by:
  - SECRETIN
  - GIP (gastric inhibitory peptide)
  - CCK (cholecystokinin)
- Vagus nerve is inhibited, Sympathetic stimulated
- Duodenum now processes chyme

### HCO<sub>3</sub><sup>-</sup> Secretion by pancreatic cells

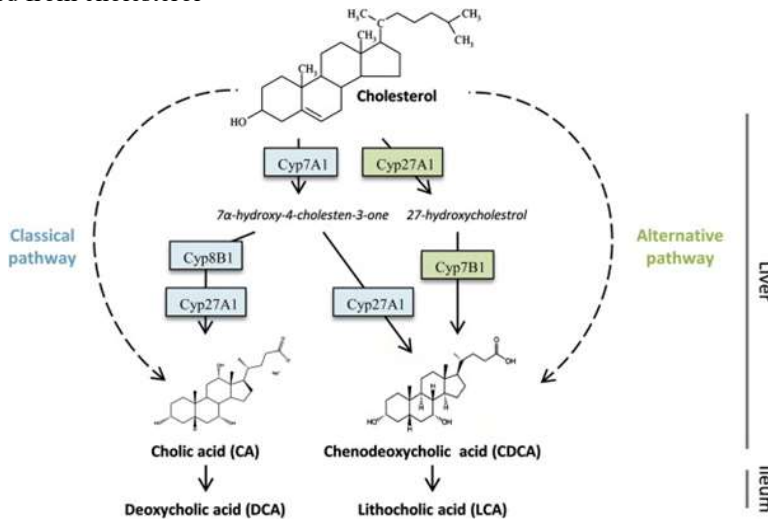


**Small Intestine**

- enzymes from pancreas and small intestine digest CHO, protein and fat (pancreas --> pancreatic duct --> small intestine)
- bile emulsifies fat to assist digestion
  - bile is synthesized in the liver
  - bile is stored in the gall bladder
  - bile enters small intestine via bile duct
- *If secretion doesn't match the amount of fat consumed, then less fat must be consumed. When gall bladder is removed, then the fat consume has to be reduced!*

**Bile acids (BA)**

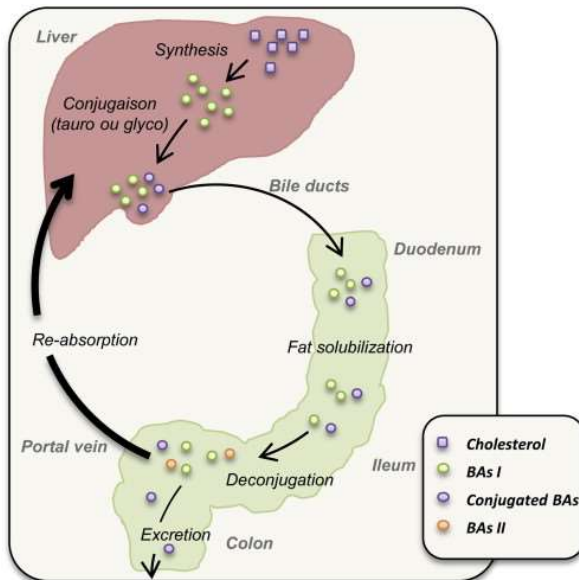
- Synthesis occurs in the liver
  - Formed from cholesterol



- BAs are conjugated with glycine or taurine

**SEPTEMBER 27th, 2017**

**Entero-hepatic circulation of Bas**



- *First part of digestions starts in stomach but main part is in small intestine*
- *Cholesterol or a part of the cholesterol is reused by the body, and a part of it is excreted.*

#### Absorption

- Movement of nutrients from small intestine into the blood (water-soluble nutrients) or lymph (fat-soluble nutrients)
- Large absorptive area created by folds of villi and smaller projections of microvilli What is not absorbed e.g. fibre stays in small intestine and passes into the large intestine (colon)
- Lower gut

#### Large intestine

- reabsorbs water and minerals
- passes wastes (fibre, bacteria, any unabsorbed nutrients) and some water to rectum

#### Rectum

- stores wastes (feces) prior to elimination

#### Lower gut

##### Diarrhea

- frequent, watery bowel movements
- if severe and prolonged --> dehydration
- *Cause: Bacteria, food we are not used to, chemicals,*

##### Constipation

- infrequent difficult bowel movements, often caused by diet, inactivity, dehydration or medication
- change diet slowly: more fibre and water
- *When you have more fibre, it will absorb more water which will allow the bowel movement to occur normally.*

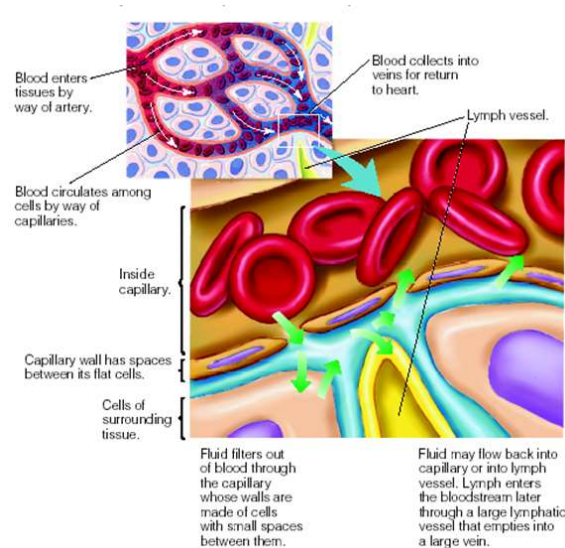
#### The body fluids and the circulatory system

- Body fluids supply tissues with energy, oxygen, and nutrients, including water
- Fluids circulate to pick up fresh supplies and deliver waste to points of disposal
- The body fluids and the circulatory system
- **Extracellular fluid**
  - Fluid surrounding cells
  - Derived from blood in the capillaries
    - Flows around the outside of cells, permitting exchange of materials
  - Some returns to the blood by reentering capillaries
  - The remaining fluid forms lymph

#### Transport of nutrients

- Blood (carries water-soluble nutrients) goes from small intestine to liver to heart
- Lymph (carries fat-soluble nutrients) goes from small intestine via the lymphatic system to the thoracic duct where lymph enters the bloodstream near the heart (“mixing oil with water”)
- *Any nutrient will get absorbed will mainly happen in the liver, then the liver will use it for metabolism.*

#### Fluids circulation around cells



#### Transport of nutrients

- arteries carry oxygen and nutrients to the tissues
- blood circulates among cells by capillaries
- exchange of materials between the cell fluid and the extracellular fluid
  - delivery of oxygen and nutrients
  - picks up carbon dioxide and wastes

#### Blood flow in cardiovascular system

- Through the body

- Portion

#### Utilization/metabolism

- Cells need energy, oxygen, water and nutrients to do their work
  - Genes/DNA directs the making of each cell's machinery, including enzymes
  - Mitochondria are important for releasing energy from CHO and fat
- TCA cycle
- Body's energy stores
  - Fat in fat cells/adipose tissue (large amount)
  - CHO as glycogen in liver and muscle (smaller amount)
  - *Enzyme will break someone of the fat store to make something that the body needs.*

#### Elimination

- Undigested food components move through a sphincter called the ileocecal valve to the large intestine.
- In the large intestine:
  - Bacteria ferment undigested food particles
  - Material is stored 12-24 hours prior to elimination while water and some nutrients are absorbed

#### Hormonal and nervous systems

- Each gland monitors a condition
  - And produces one or more hormones to regulate it
  - Each hormone acts as a messenger that stimulates various organs to take appropriate action
- High concentration of blood glucose pancrea releases **insulin**
- Both the nervous and hormonal systems regulate hunger and affect appetite
- Sensations of hunger and appetite are perceived by the brain's cortex
- As a result of the release of these neurotransmitters and hormones **metabolism** speeds up

#### Disorders related to digestion

- The lining of the stomach is designed to cope with hydrochloric acid but other regions of the GI tract are not

Heartburn is caused by hydrochloric acid in the esophagus

- *Avoid eating too much if you already have it.*
- *The muscle that keeps the stomach acid out of the esophagus could be damaged.*

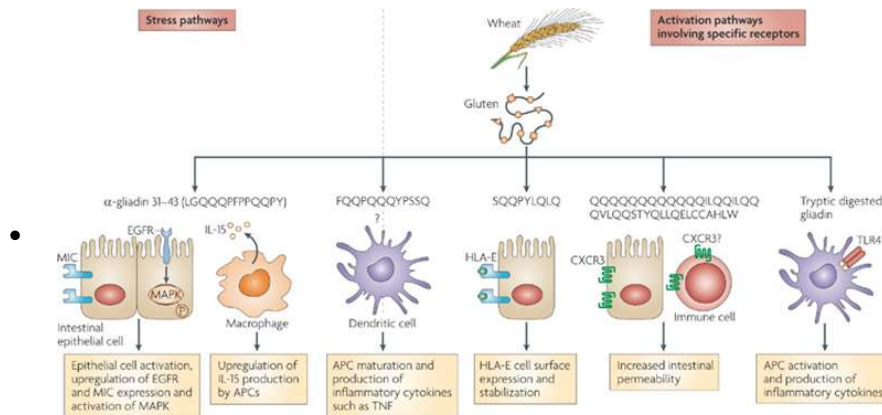
GERD, or gastroesophageal reflux disease, is painful, persistent heartburn

- *Tomato may also be responsible for that.*

Peptic ulcers are regions of the GI tract that have been eroded by HCl and pepsin

- The bacterium *Helicobacter pylori* contributes to the production of both gastric and duodenal ulcers

Celiac disease



Nature Reviews | Immunology

Effects of gluten on intestinal epithelial cells and antigen-presenting cells.

- Complete intolerance for gluten, a protein found in wheat, rye, triticale, and barley.
- Can damage the small intestine leading to poor absorption of nutrients.
- Requires a diet lacking wheat, rye, triticale, and barley.
- There may be a genetic component to the disease.

*The compound in the food causes damage to the...*

*Allergic reactions are caused by a # of proteins.*

Inflammatory bowel disease (IBD) includes two diseases causing inflammation:

- Crohn's disease affects the small intestine
  - Interferes with absorption
- Ulcerative colitis affects the colon
  - Results in bloody diarrhea
- In either case, surgery may be needed to remove damaged intestine.

Irritable bowel syndrome (IBS) is a disorder that interferes with normal colon function. Symptoms include

- Abdominal cramps and bloating
- Diarrhea and/or constipation
- IBS is more common in women than in men

Diarrhea

- Can be caused by food intolerances, infection of the GI tract, chronic disease, stress, reaction to medications, or bowel disorders
- Can lead to severe dehydration
- Is more dangerous for children and the elderly

Constipation

- Fibre, water and exercise may prevent

Colon cleansing: does the body need help flushing toxins?

- *Fibres can help*
- *Flushing colon; Helps improve it*
- *There has to be frequent movement as usual*
- *The friction might cause damage over time*
- *So cleansing is useful*
- *Detoxifying agents are useful :Herbal products or chlorophyll?*
- *Detoxifying will just speed up the movement.*
- *The chemical it contains will cause irritation to the colon, which will cause contraction to help movement.*

Key points

- Metabolism is influenced by genes --> proteins, enzymes, hormones
- Body's cells require nutrients
- Cells die (replace every 3 days for digestive tract)
- Digestion: Mouth --> stomach --> small intestine --> large intestine.
- Acid burn, Ulcer, Constipation, Diarrhea
- Transport (Blood, lymph)
- Metabolize, store, or used as energy
- Process regulated by hormones

## Chapter 4: Carbohydrates

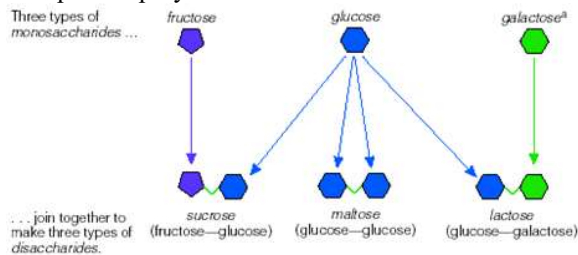
### Learning outcomes

- Distinguish various carbohydrates found in foods and in the human body
- Describe the body's use of glucose to provide energy or to make glycogen and fat.
- Discuss diabetes, hypoglycemia, and lactose intolerance and their relationships to carbohydrate intake.
- Discuss the role of fibres rich foods in the maintenance of the body's health and identify foods rich in fibres

### Definition

- Carbohydrates: carbon, hydrogen, oxygen (CHO)
- Types:

- Simple sugars
- Complex or polysaccharides



<sup>a</sup>Galactose does not occur in foods singly but only as part of lactose.

### Simple Sugars

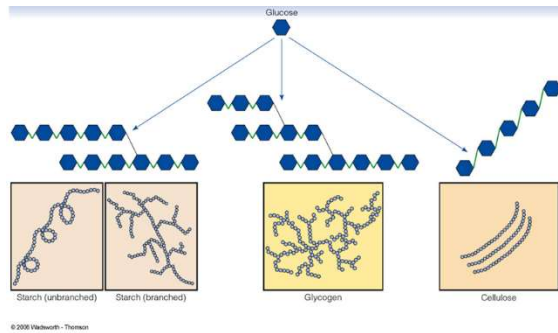
1. Monosaccharides
  - Glucose
  - Galactose
  - Fructose
2. Disaccharides

- Sucrose (glucose + fructose)
- Maltose (glucose + glucose)
- Lactose (glucose + galactose)

### Complex CHO or Polysaccharides

- Chains of glucose linked together
- Plant forms: starch and fibre
  - human digestive enzymes can break the bonds between glucose units in starch but not in fibre e.g. cellulose
- Animal form: glycogen (more branched)
  - human digestive enzymes can break the bonds found in liver and muscle (meat)

### Complex carbohydrates



### Fibres

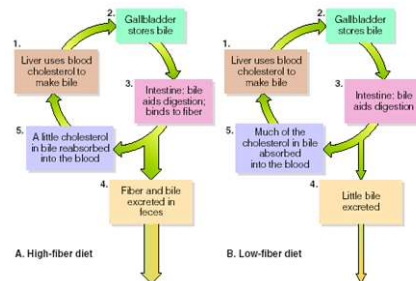
- Some plant fibres provide support to plant structures
  - Fibres retain water to protect seeds from drying out
  - Most fibres are polysaccharides
- Human digestive enzymes cannot break the bonds that hold together the sugar units of starch
  - Thus, most fibres pass through the human body without providing energy
- Bacteria within the human large intestine can digest fibres to varying degrees

### Types of Fibres

1. Water soluble fibre
  - Soluble fibres dissolve in water
    - Form gels (are viscous)
    - Easily digested by bacteria in the human colon
      - *If you have Bifidobacteria which is a lactic acid bacteria*
    - Types: gums, mucilages (Okra), pectins, psyllium, some hemicellulose
    - Sources: oats, oat bran, barley, rye, seeds, fruits, vegetables, legumes

### Water Soluble Fibre

- Benefits:
  - lower blood cholesterol
  - slow glucose absorption
  - slow transit of food through upper digestive tract and soften stools (holds more water)



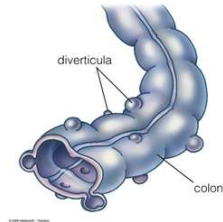
### Types of Fibres

2. Water Insoluble Fibres
  - Are less easily fermented
  - outer layers of whole grains, strings of celery, etc.
  - retain their structure and texture even after hours of cooking
  - **Types:** cellulose, lignin, and some hemicellulose
  - **Sources:** brown rice, wheat bran, whole grains, seeds, fruits, vegetables, legumes

### Water Insoluble Fibres

- Benefits:

- soften stools (more bulk)
- increase colonic transit
- reduces risk for colon cancer and diverticular disease (intestinal wall bulges out due to weakening of muscle layers)
- *Because of friction from constipation, there might be some damage to the cell, which can cause colon cancer*
- Total fibres sum of fibres: Dietary fibres & Functional fibres
  - *Functional Fibres: extra fibre in it*



### DRI recommendations for fibres

- Recommendations and Intakes
  - Men, age 19-50: 38 g/day
  - Men, age 51+: 30 g/day
  - Women age 19-50: 25 g/day
  - Women age 51+: 21 g/day

**TABLE 4•4 GRAMS OF FIBRE IN ONE CUP OF CANADIAN FLOUR**

Light rye, 15.7 g
Whole grain, 16 g
Light rye, 14 g
Buckwheat, 4.4 g
Cornmeal, 3.8 g
Enriched white, 4.1 g

### Energy Cycles

- Through photosynthesis, plants combine carbon dioxide, water and the sun's energy to form glucose.
- When humans metabolize glucose, energy and carbon dioxide are released.

### Glycogen

- Glycogen is the storage form of glucose in animals
  - The glucose chains that make up glycogen are longer and more highly branched than those that make up starch
  - There is little glycogen in meats because it breaks down rapidly when the animal is slaughtered

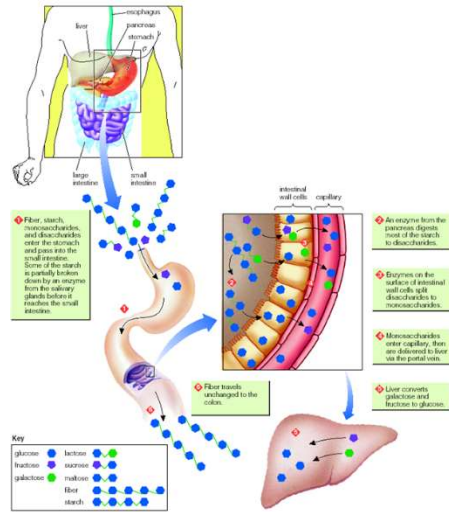
### The Need for Carbohydrates

- Provide energy
- DRI 45-65%
  - Glucose is the primary energy source for nerve cells
  - Complex sugar molecules coat almost every cell of the body
  - Sugars can alter protein shape and function; affect cell communication; and may play roles in disease processes
- Recommendations are for complex carbohydrates not refined sugars
  - Complex carbohydrates contribute needed nutrients
  - Pure sugars displace nutrient-dense foods from the diet
    - Contain no other nutrients and thus are empty-calorie foods
- Most people should increase their intake of fibre-rich, whole foods
  - Such as whole grains, fruits, and vegetables
- Fibre-rich foods supply vitamins, minerals, and phytochemicals

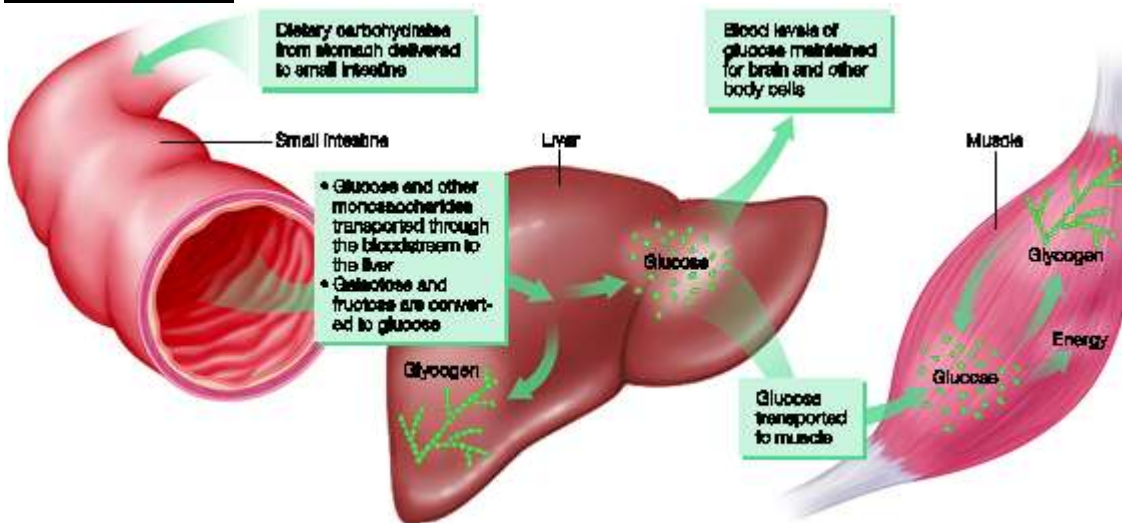
### How carbohydrate in food becomes glucose in the body

- **Mouth:** minor digestion by salivary amylase
- **Stomach:** mixed with acid and other juices, salivary enzymes are deactivated by the acid
- **Small intestine:** digestion by pancreatic amylase (starch --> maltose) and enzymes on intestinal wall (disaccharides --> monosaccharides)
- Fibre travels unchanged to the colon
- Absorption of glucose, fructose and galactose into bloodstream --> liver
- Liver converts galactose and fructose to glucose
- All digestible CHO becomes glucose in the body and is used for
  - energy (directly, or from glycogen stores)

- glycoproteins (CHO attached to proteins) e.g. mucus, cell membranes



### Storage of Glycogen



### Postprandial CHO Metabolism

- Blood glucose rises after eating CHO and amount of increase reflects
  - amount of CHO consumed
  - rate of digestion and rate of glucose entry into bloodstream
  - rate of glucose uptake by the cells

### Glycemic effect of food

- Extent to which foods elevate blood glucose compared to a glucose solution or white bread
- Low number is best: legumes, peas
- High number: white bread, juice

### Glycemic Index

- Definition of glycemic index (GI)
- Blood glucose response curve of a 50g CHO portion of a test food expressed as a % of the response to the same amount of CHO from a standard food taken by the same subject.

### Glycemic effect of food

- Factors:
  - type of food:
    - apple < apple juice (*You pretty much take out all the fibers*)
- cooking method:
  - baked potato < mashed
- eaten alone or part of a mixed meal

### Glycemic index of some foods

Food	GI	Food	GI
Peanuts	14	Brown rice	55
Bean sprouts	25	Honey	55

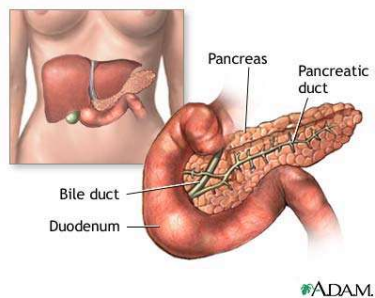
Grapefruit	25	Oatmeal	58
Pizza	30	Ice cream	61
Lowfat yogurt	33	Macaroni and cheese	64
Apples	38	Raisins	64
Spaghetti	42	White rice	64
Carrots	47	Sugar (sucrose)	68
Oranges	48	White bread	70
Bananas	52	Watermelon	72
Potato chips	54	Popcorn	72
Snickers Bar	55	Baked potato	85
		<b>Glucose</b>	<b>100</b>

### **Glycemic Index of Meal**

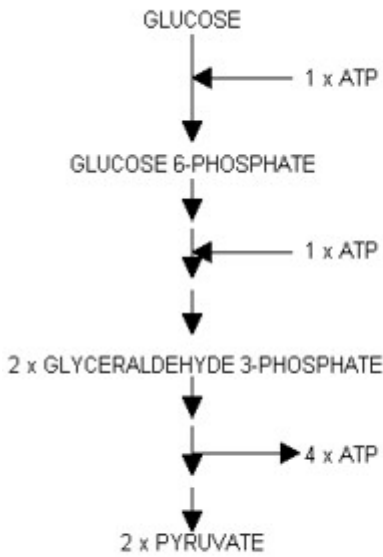
Food	Grams Glycemic Carbohydrate	Proportion of total Glycemic Carbohydrate	Food Glycemic Index	Meal Glycemic Index
Bread	25	$25/73=0.3425$	100	$0.34*100=34.0$
Cereal	25	$25/73=0.3425$	72	$0.3425*72=24.66$
Milk	6	$6/73=0.0822$	39	$0.0822*39=3.2058$
Sucrose	5	$5/73=0.0685$	87	$0.0685*87=5.9595$
Orange juice	12	$12/73=0.1644$	74	$0.1644*74=12.1656$
<b>TOTAL</b>	<b>73</b>			<b>80.0</b>

### **Postprandial CHO Metabolism (Hidden Slide)**

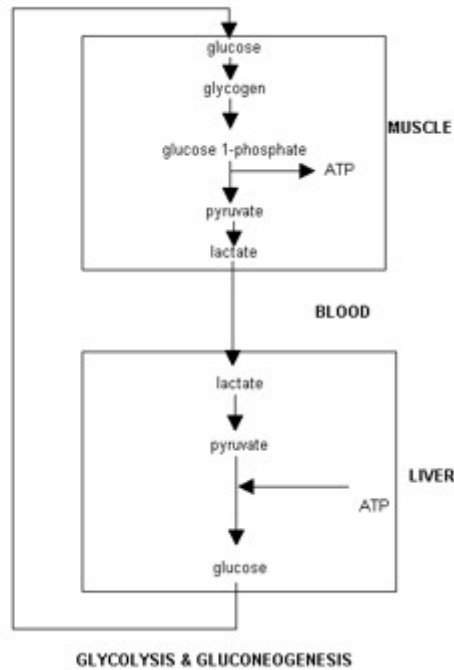
- Glucose is transported into most cells via insulin (hormone) i.e. insulin “opens the gate” to let glucose into the cells
  - except brain, nerves, red blood cells, mammary glands



## OUTLINE OF GLYCOLYSIS



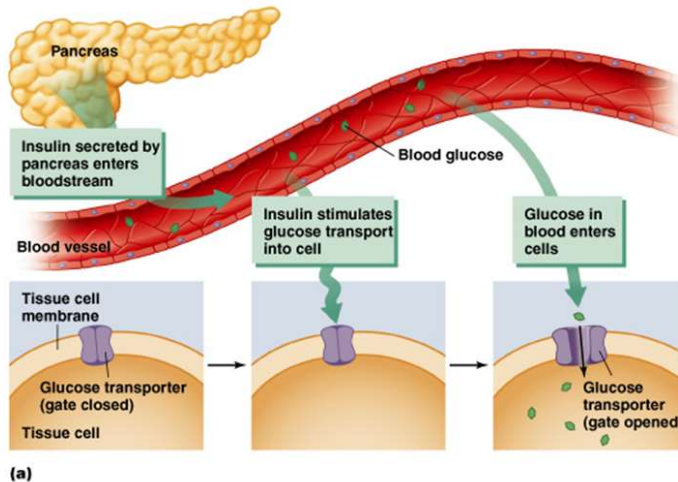
nett ATP synthesis is 2/glucose



## Blood Glucose

- Under homeostasis: is tightly regulated
- When blood glucose is high (fed state), the pancreas releases **insulin** (hormone)
  - 2/3 glucose taken up by muscle and stored as glycogen for future use by the muscle
  - 1/3 glucose taken up by liver and stored as glycogen for future release of glucose into the bloodstream
- *Insulin allows cells to take glucose to produce energy for the cells*

## Blood Glucose: Insulin



## Blood Glucose

- When blood glucose is low, the pancreas releases glucagon (hormone)
  - breakdown of liver glycogen-->glucose-->blood-->tissues for energy
  - glucose is produced from protein (gluconeogenesis)
    - if this occurs on a long term basis e.g. disease states, then muscle wasting

October 4th, 2017

## Ketosis

- If liver glycogen is depleted,
  - ketosis occurs
  - brain adapt to ketone bodies which are produced from fat
- Need 100 g CHO/day (DRI: 130 g/d) to prevent ketosis & to spare protein (muscle)
- Usually consume 200-400 g CHO/d
- Liver glycogen lasts 12-18 h depending on CHO intake, exercise, etc.

*Ketone bodies are produced more in the fasting period (example when you sleep)*

## What happens if excess CHO intake?

- When glycogen stores are filled, glucose is converted to fat in the liver and transported to fat cells for storage (glucose-->fat)
- when body needs energy, fat-->energy
- however, fat cannot be converted to glucose
- need some glucose for body to convert fat-->energy (if no glucose, then fat-->ketone bodies, resulting in ketosis)

### What happens if excess CHO intake?

- If energy intake=energy expenditure
  - Converting glucose to fat is only temporary i.e. a few hours
- Controversial area: does excess dietary CHO or fat contributing to weight gain & obesity?
- High CHO intakes lead to elevated blood triglycerides in some people
- Need to optimize CHO intake

### CHO loading for exercise performance

- Glycogen storage capacity is limited: 150 g in muscle, 75 g in liver
- Due to genetics, some people store above average amounts
- With training:
  - muscle adapts to store more glycogen
  - better recovery of glycogen stores post-exercise and post-meal
  - diet: 55-65% energy from CHO is fine

### Energy Stores in Body (70 kg)

- **Liver glycogen:** 6% of liver weight
  - $75 \text{ g} \times 4 \text{ Cal/g} = 300 \text{ Cal}$
- **Muscle glycogen:** 1% of muscle weight
  - $150 \text{ g} \times 4 \text{ Cal/g} = 600 \text{ Cal}$
- Blood glucose
  - $20 \text{ g} \times 4 \text{ Cal/g} = 80 \text{ Cal}$
- **Lipid stores/adipose tissue** (eg. 21% body fat)
  - $15,000 \text{ g} \times 9 \text{ Cal/g} = 135,000 \text{ Cal}$

### Blood Glucose

- Normal:
  - 70-110mg/100ml of blood
- Hyperglycemia:
  - fasting blood glucose > 140mg/100 ml
- Hypoglycemia:
  - fasting blood glucose < 60 mg/100ml

There are # of problems associated with hyperglycemia

### Health Disorders

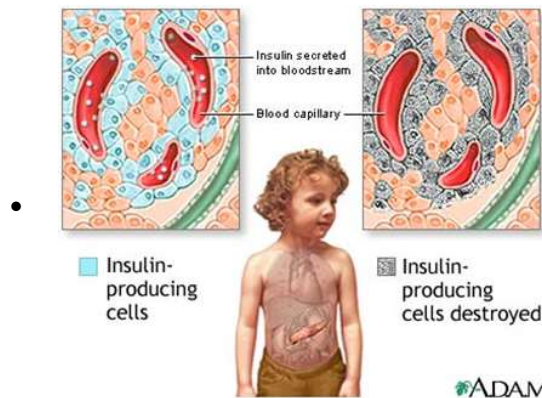
- Three health disorders related to carbohydrate metabolism are:
  - Diabetes
  - Hypoglycemia
  - Lactose intolerance

### What Is Diabetes?

- Complications include:
  - Amputations
    - *High blood sugar can cause # of damage. Example: causes poor circulation, which causes poor recovery when injured.*
  - Complications in pregnancy
    - *Excess sugar in the blood, can cause the weight gain which could cause problems in the pregnancy.*
  - Heart disease
  - Kidney disease
    - *Since the kidney controls the blood pressure and the # is decreasing, then it will release hormones to increase the pressure. (Two enzymes produced by the kidney involved in regulating the blood pressure are Angiotensin and Renin)*
    - *Reduce the removal of solutes in the blood system.*
  - Premature death
  - Increased risk of death from flu or pneumonia

### Diabetes mellitus

- Type I diabetes:
  - Destruction of the insulin producing cells in the pancreas



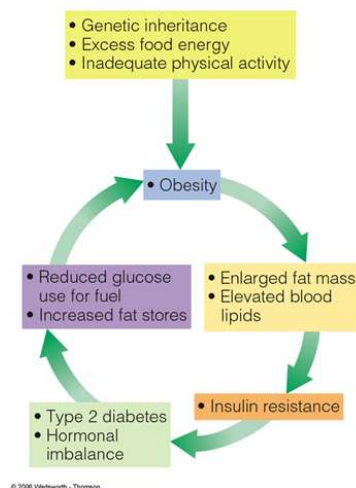
(autoimmune disease - genetics, viruses, and other toxins have been implicated).

- Symptoms: polyuria, glucosuria, polydipsia
- Strikes children and young adults. All are insulin dependent, i.e. must have insulin injections.
- Type 1 (early or mid-life, <10% cases)
  - hyperglycemia due to little or no insulin produced by the pancreas
    - auto-immune response
  - untreated: glucose wasting (urine) and weight loss
  - treatment: insulin is injected to match food intake and physical activity

### Diabetes

- Type 2 (usually adult, now teenagers; >90% cases)
  - hyperglycemia due to insulin resistance (associated with overweight and obesity)
    - pancreas produces lots of insulin but cells respond poorly
- chronic hyperglycemia increases risk of cardiovascular disease, kidney disease, cataracts/blindness, amputations, etc.

### Type 2 diabetes and obesity



### Managing Diabetes

- A diet high in antioxidant-containing vegetables and fruits may be protective
- Weight control
  - This diet:
    - Is adequate in nutrients
    - Provides the recommended amount of fibre
    - Is moderate in added sugars
    - Provides a controlled amount of total carbohydrates
    - Is low in saturated fat and may provide some monounsaturated fat
    - Is adequate but not too high in protein

Proteins will cause problems to the kidney when you have diabetes. It has to be taken in moderation since it will cause the kidney to work harder.

### Hypoglycemia

- Postprandial hypoglycemia
  - Fatigue
  - Dizziness
  - Rapid heartbeat
- Fasting hypoglycemia
  - 8 to 14 hours after fasting

## Lactose Intolerance

- Insufficient lactase enzyme activity to digest lactose → glucose + galactose
  - Rare in newborns
  - develops mostly in adults of non-Northern European background
- Signs: nausea, pain, diarrhea and gas
  - more osmotic particles draws water
  - bacterial fermentation in intestine
- Management:
  - Consume milk in small amounts (1/2 – 1 cup) with meals
  - Yogurt, aged cheeses
  - Products treated with lactase e.g.
  - Lactaid milk, ice cream
  - Add enzyme drops to milk-based foods

## Milk Allergy

- Immune response to protein in milk
- Need non-dairy sources of calcium:
  - calcium-fortified soy milk and orange juice
  - canned sardines or salmon with bones
  - vegetables e.g. broccoli, bok choy
  - consider a calcium supplement

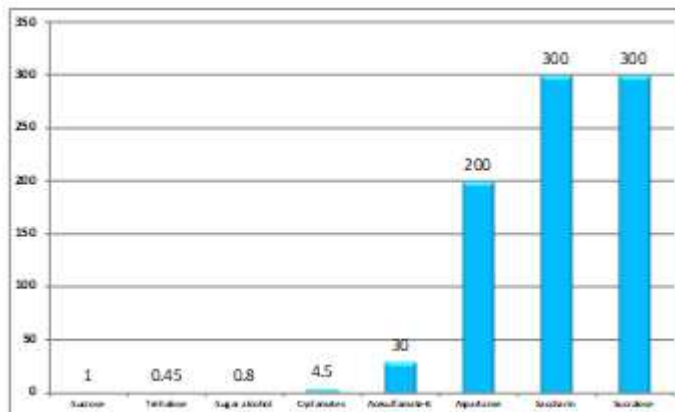
## Sugar and alternative sweeteners: are they bad for you?

- Preference for sweets diminishes with adulthood
  - In Canada, the consumption of sugar and sweeteners remains high
  - Statistics Canada estimates that:
    - Canadians consume on average 20 teaspoons (100 mL) of sugar per day
    - Over 39.4 kg of sugar & syrup in 2001
- Soft drinks and sugar-sweetened fruit juices may account for 80% of this increase

## Sugar and alternative sweeteners

- People are also consuming more artificial sweeteners
- The DRI suggests
  - 25% of calories or less from added sugars
- The WHO recommends
  - No more than 10% of calories from added sugar
- The Canadian Diabetes Association
  - also recommends no more than 10% of calories from added sugar
- Sugars and Health: a role in
  - Obesity?
  - Aggravating diabetes?
  - Increasing risk for heart disease?
  - Behavioral problems?
  - Dental problems
- Use sugar in moderation: <10% Calories from added sugars

## Relative sweetness



## Sweeteners

- Sucrose and fructose (1.7 x sweetness of sucrose), both have 4 Calories/g
- Sugar alcohols:
  - sorbitol (0.5 x sweetness), mannitol (0.7 x), xylitol (1 x), isomalt (0.6 x)
  - all have 3-5 Calories/g but poorly absorbed

- primarily chewing gum as not readily used by mouth bacteria
- Artificial Sweeteners
  - aspartame (200 x), acesulfame-K (200 x), sucralose (600 x)
  - cyclamate and saccharin (300x) have restricted uses in Canada
- Calorie-free (aspartame = phenylalanine + aspartic acid, 4 Cal/g from the amino acids but calorie-free because so little is used; product warning for people with PKU (phenylketonuria); Do they reduce obesity?

### Artificial Sweeteners

- Aspartame
  - Used to sweeten foods not exposed to cooking temperatures, 4 calories per gram
  - In powder form, it is mixed with lactose
  - Flavor is almost identical to sugar
- Saccharin
  - Used as a tabletop sweetener
  - Slightly elevated risk of some cancers in:
    - Women who drink 2+ saccharin-sweetened sodas a day
    - Men and women who smoke heavily and use artificial sweeteners
    - Other studies have shown no increased risk of bladder cancer
- Acesulfame-K
  - After 15 years of testing and use, there have been no reported health problems
  - About as sweet as aspartame (200x) as sucrose
    - To some, it has a slight aftertaste; which is solved by blending it with other sweeteners
    - Used in chewing gum, beverages, instant coffee and tea, gelatins, puddings, table use
- Sucralose
  - Only artificial sweetener made from sucrose
- Stevia (200x) is a naturally sweet herb
  - Used as a sugar substitute, especially in beverages
  - forms: leaves, extract, glycoside

### Artificial sweeteners - safety

- Acceptable daily intake (ADI) is the estimated amount of sweetener that can be consumed daily over a person's lifetime without any adverse effects
- ADI = 40 mg/kg body weight for aspartame in Canada
  - 132 lb person: 80 packets of Equal or 15 soft drinks; NB. Children & food choices
- NB. Moderate intake

### OCTOBER 6th 2017

#### Healthy diets (DRIs)

- 45-65% of energy from carbohydrates, emphasis on complex and whole grain
- 21-38 g fibres/day (based on gender and age); Fibre sources
- <25% of energy from added sugars
- Food sources: pasta, rice, cereals, breads, milk/milk products, fruits, starchy vegetables (potatoes, peas, corn, squash)
- Empty calories of sugar:

#### Nutri-case

*Last night, my mom made sausages and she let me make the mashed potatoes from the Mr. Instant Potato box. They're my favourite, and I ate a big mountain with lots of butter. My mom said I did such a good job on my supper that I could have a popsicle for dessert. But today in school my science teacher said we shouldn't eat mashed potatoes, because that's kind of the same thing as eating a bunch of sugar. I don't get it. I mean, potatoes don't taste anything like sugar!"*

Was the advice that the science teacher gave sound? How would you explain to the student, in ways that he could understand, what happens to the foods he eats, and why the body responds similarly to some foods that seem very different? Suppose you learned that he drank a glass of apple juice with her dinner and had no vegetables other than the instant potatoes. What might you propose to his mother, about the food choices?

#### Key Points

- Types of Carbohydrates
- Digestion absorption & Transport
- Lactose intolerance & Milk allergy
- Carbohydrates and Diabetes
- Artificial sweeteners
- Glycemic index

## Chapter 5: Lipids

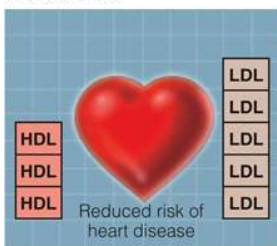
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### Cardiovascular Diseases

- Diet high in saturated fat a major contributor plaques development
- Damage may begin from a number of factors interacting with the cells that line the arteries
  - High LDL cholesterol
  - Hypertension
  - Blood homocysteine levels
- Pressure increase may weaken arterial wall and balloon out, forming an **aneurysm**
  - can burst --> massive bleeding and death
- Clot may grow until it shuts off the blood supply
  - Tissue may die slowly --> **thrombus**
  - large enough to close off blood vessel, it is a **thrombosis**
- A clot can break loose becoming an embolus
- Opposing the clot-forming actions of platelets are active products of omega-3 fatty acids
  - A diet lacking in sea foods that contain these essential fatty acids may contribute to clot formation
    - *The omega 3 you get from fish is better than the one you get from plants.*
- On many occasions, heart attacks and stroke occur with no apparent blockage
  - An artery may go into spasm
    - Restricting or cutting off the supply of blood to a portion of the heart muscle or brain
- Hypertension and atherosclerosis worsen CVD
  - And each worsens the other
  - Hypertension worsens atherosclerosis because a stiffened artery, already strained by each pulse of blood surging through it, is stressed further by high internal pressure
    - Injuries multiply, more plaques grow, and more weakened vessels become likely to burst and bleed
- Since hardened arteries cannot expand, the heart's beat raises blood pressure
- Hardened arteries also fail to let blood flow freely through the kidneys, which control blood pressure
  - The kidneys sense the reduced flow of blood and respond as if the blood pressure were too low

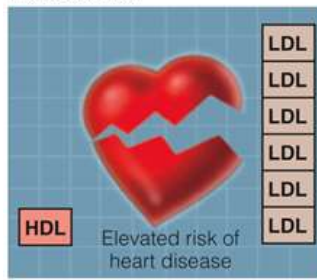
### Risk Factors for CVD

- **Age**
  - All people reaching middle age exhibit at least one of these factors
- **Diet**
  - not the only
- **Gender**
  - Men: age becomes a significant risk factor for heart disease at age 45 or older
  - Women: age becomes a significant risk factor after age 55
- Family history
  - Early heart disease in immediate family members is a major risk factor
    - The more family members affected and the earlier the age at which they become ill, the greater the risk to the individual
- **High LDL**  
High HDL relative to LDL decreases risk



- Low HDL Cholesterol

Low HDL relative to LDL  
increases risk



## Diet to Reduce CVD Risk

**TABLE 11-3 HOW MUCH DOES CHANGING THE DIET CHANGE LDL CHOLESTEROL?<sup>a</sup>**

Diet-Related Component	Modification	Possible LDL Reduction
Saturated fat	<7% of calories	8–10%
Dietary cholesterol	<200 mg/day	3–5%
Weight reduction (if overweight)	Lose 10 lb	5–8%
Soluble, viscous fiber	5–10 g/day	3–5%

<sup>a</sup>See Table 11-4, p. 408 for other dietary changes believed to influence risk of CVD.

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- Absence of fiber, there will be more cholesterol being absorbed.
- Losing weight will significantly reduce the chances of developing cardiovascular disease.
- Diets high in saturated fats and low in fish, fruits, and vegetables = blood cholesterol **increase**, heart disease **increase**
- Dietary fat: mostly unsaturated fats abundant in fish, fruits, and vegetables
  - Blood cholesterol and the rate of heart disease is low
  - Saturated fat, including trans fatty acids, no more than 10% of calories
  - Limit cholesterol to 300 mg/day
- Fish oils
  - Rich in omega-3 polyunsaturated fatty acids
  - Lower triglycerides
  - Prevent blood clots
  - May reduce the sudden death associated with CVD
- Effects of Fiber, Nutrients, and Phytochemicals
  - The viscous (soluble) fiber of oats, barley, legumes, and pectin-rich fruits and vegetables helps to improve blood lipids
    - These fibers bind cholesterol and bile in the intestine, reducing their absorption
    - An extra 5 - 10 grams of viscous fiber daily lowers LDL cholesterol levels by about 5%
- Alcohol
  - Research on middle-aged and older people who drink one or two drinks a day with no binge drinking supports the idea that moderate consumption of alcohol will reduce their CVD risk
- Heavy alcohol use, more than three drinks a day:
  - Elevates blood pressure
  - Damages heart muscle
  - Elevates the risk of stroke
- Other Dietary Factors
  - Sterol and stanol esters
  - Sterol and stanol esters reduce the absorption of some potentially beneficial phytochemicals

## Heart Disease Risk that a person can control

- Risk factors that a person can often control
  - High blood LDL; low blood HDL
  - High blood pressure
  - Diabetes
  - Obesity
  - Cigarette smoking
  - Atherogenic diet
  - Physical activity

## Recommendations for Dietary Fat

- <20-35% energy from dietary fat
- <10% energy from saturated fat
- 3-7% energy from polyunsaturated fat (WHO)
- thus, approx. 10% energy from monounsaturated fat
- low saturated fat intake helps to reduce blood cholesterol and thus heart disease
- unsaturated fat reduces blood clotting

- <300 mg/day cholesterol (WHO)
  - Canada: 400 mg/d
  - about 1/3 population responds to lowering dietary cholesterol intake: limit eggs, shellfish, liver, etc. but these are nutritious foods

### Essential Fatty Acids (EFA)

<u>Linoleic acid (n-6)</u>	<u>Linolenic acid (n-3)</u>
<ul style="list-style-type: none"> <li>□ C=C: 6 carbons from end</li> <li>□ Synthesis of ARA</li> <li>□ Deficiency:               <ul style="list-style-type: none"> <li>▣ ↓ growth</li> <li>▣ skin lesions</li> <li>▣ reproductive failure</li> <li>▣ fatty liver</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>□ C=C: 3 carbons from end</li> <li>□ Synthesis of DHA, EPA</li> <li>□ Deficiency:               <ul style="list-style-type: none"> <li>▣ reduced learning</li> <li>▣ impaired vision</li> </ul> </li> </ul>

### Dietary Recommendation

- **3% energy** from n-6 fatty acids e.g. linoleic acid: vegetable oils, seeds, nuts, whole grain products
- **0.5% energy** from n-3 fatty acids e.g. linolenic acid: flaxseed, flaxseed oil, canola oil, fish (especially deep sea fish)
- N.B. ratio of n-6/n-3: need more n-3 in our diet (like ancestors) to prevent heart disease

### Recommendation

- **Omega-3 Fatty Acids**
  - Eicosapentaenoic acid (EPA):
    - May reduce risk of death from a heart attack.
  - Docosahexaenoic acid (DHA):
    - Critical for development of central nervous system and retina of eyes
  - EPA and DHA are long chain polyunsaturated fatty acids found in fish and fish oils
  - Canada's Food Guide recommends eating at least two servings of fish per week

### Major dietary sources of fat

1. dairy products (excluding milk & butter)
  2. processed meat
  3. Margarine
  4. salad and cooking oils
  5. bakery products
  6. Fresh meats
  7. Butter
  8. Fluid milk
- All except salad & cooking oils are sources of saturated fat.

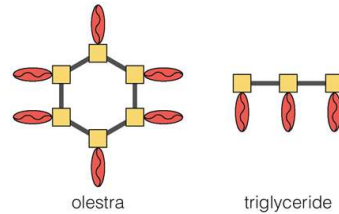
### Healthy Diet

- DRI: 20-35% calories from fat; infants & younger children 25-40% calories
- Target sources of saturated fat
  - Goal: reduce total fat by 1/3 from each major food source for saturated fat: meat, dairy, and baked goods
  - Make changes not deletions
    - e.g. need iron and calcium from a variety of sources

### Fat Replacers

- Alter preparation method, for example
  - add water or whip air into foods
  - add non-fat milk to creamy foods
  - use lean products vs. high fat
  - bake rather than fry
- Offer less than half a gram of fat
- Some contain **artificial fats**
- Some use conventional products in unconventional ways to reduce fats and calories
  - Add water or whip air into foods
  - Add fat-free milk to creamy foods
  - Use lean meats and soy protein to replace high-fat meats
  - Bake foods instead of frying them
- Fat replacers include

- Fibres
  - Those made from oats or barely have the added benefit of containing viscous fibres, while imparting desirable tastes and textures associated with real fats
- Sugars, Proteins
  - Provide calories, but fewer than do real fats
- An Artificial Fat: Olestra
  - Brand name: Olean
  - A **sucrose polymer**
    - Chemically, bears some resemblance to an ordinary fat
  - Currently not allowed to be added to foods in Canada



- Properties are identical to those of fats and oils when used in frying, cooking, and baking
- Aside from a slight aftertaste, to many people it tastes like fat
- Safe in most regards
- When consumed in large quantities can cause
  - Digestive distress
  - Nutrient losses
  - Losses of phytochemicals
- May be capable of causing
  - Diarrhea
  - Gas
  - Cramping
  - An urgent need to defecate
- Oily olestra can creep through the feces and leak uncontrollably from the anus
  - Producing smelly, dark yellow stains on underwear

Pros of Olestra	Cons of Olestra
<ul style="list-style-type: none"> <li>• Zero calories</li> <li>• Zero fat, saturated fat, and <i>trans</i> fat</li> <li>• Zero cholesterol</li> <li>• Withstands frying</li> <li>• Withstands baking</li> <li>• Tastes like fat</li> </ul>	<ul style="list-style-type: none"> <li>• Vitamin losses</li> <li>• Phytochemical losses</li> <li>• Possible digestive upset</li> <li>• Possible anal leakage</li> <li>• Slight aftertaste</li> <li>• Expensive</li> <li>• No long-term studies in children</li> </ul>

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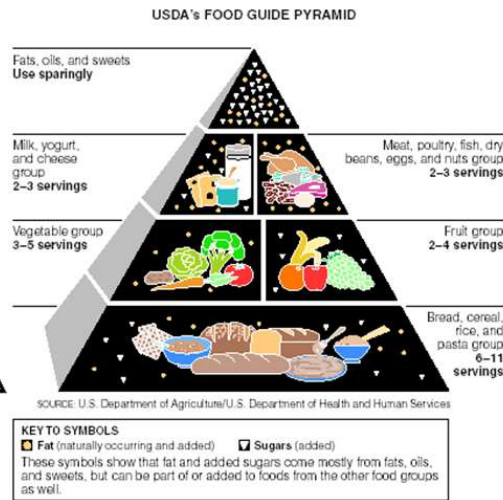
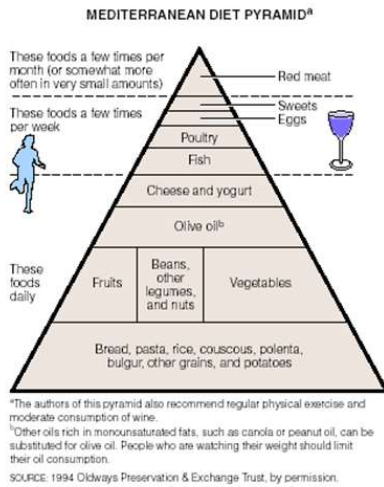
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- Warning on food label in USA:
  - **“This Product Contains Olestra”**
  - Olestra may cause abdominal cramping and loose stools.
  - Olestra inhibits the absorption of some vitamins and other nutrients.
  - Vitamins A, D, E, and K have been added.”

### Mediterranean Diet

- Mediterranean Diet: Secret for a Healthy Heart?
  - Greece: less death from heart disease and longer life expectancy compared to North America [but 2x stroke incidence]
  - Migration studies: if move to North America, increased risk of heart disease, therefore, diet (not just genetics) important
- Mixed diet (pyramid): grains, legumes (dried beans & peas), fruits, vegetables, olive oil, cheese & yogurt. Meats and sweets are occasional.
  - High in total fat (42% of calories)
    - olive oil predominant (contains monounsaturated fat like canola oil)
    - cheese has saturated fat

### Mediterranean and USDA's food pyramid



### Mediterranean Diet

- Lower in animal protein and fat
  - cheese (saturated fat)
  - beans & legumes: CHO, fiber, protein, iron, calcium [& no/little fat]
  - fish, poultry, eggs and sweet a few times per week
- High in complex CHO and fiber
  - grains, fruit & vegetables, legumes
- Yogurt & live Lactobacillus cultures (probiotic): disease prevention?
- Red wine contains phytochemicals (protective antioxidants)
- individual foods vs pattern of diet
- other lifestyle factors

### Key Points

- Fats
- Cholesterol
- Essential fatty acids
- Fat replacers
- Be active
- Saturated, *trans*, and unsaturated fats all provide energy to the body

## Chapter 6: Protein and Amino Acids

### Learning outcomes

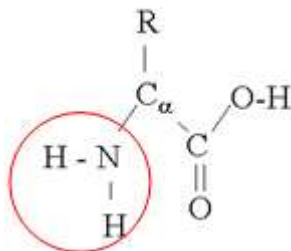
1. Describe the structure of proteins and explain why adequate amounts of all the essential amino acids are required for protein synthesis.
2. Summarize the processes of protein digestion and absorption in the body.
3. List and describe the roles of proteins in the body.
4. Discuss the importance of protein quality and mutual supplementation.
5. Calculate your individual protein RDA and describe how nitrogen balance studies are used in determining the RDA for protein.
6. Describe the consequences of both protein deficiency and protein excess

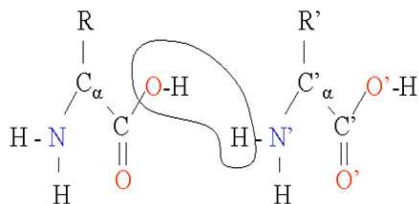
### Introduction

#### Proteins

- Compounds composed of carbon, hydrogen, oxygen, and nitrogen and arranged as strands of amino acids
- Some amino acids also contain the element sulfur
- Versatile and vital cellular working molecules

#### Amino acids (AA)





### Amino Acids

- The building blocks of protein
- Each has an amine group at one end
  - The nitrogen-containing part
- An acid group at the other end
- A distinctive side chain attached to the carbon at the center of the backbone
  - Gives identity and chemical nature to each amino acid
- Side chains
- Make the amino acids differ in
  - Size
  - Shape
  - Electrical charge
    - Some negative, some positive, some with no charge
- Long strands of amino acids form large protein molecules
  - The side chains of the amino acids ultimately help to determine the molecules' shapes and behaviors

### The Structure of Proteins

- Unlike carbohydrates and fats, proteins contain nitrogen
  - Hence the name *amino*
  - Are composed of amino acids
- The amino acids in a strand of protein are different from one another
- About 20 amino acids make up most of the proteins of living tissue

### Essential/Indispensable Amino Acids

- Histidine
- Isoleucine
- Leucine
- Lysine
- Methionine
- Phenylalanine
- Threonine
- Tryptophan
- Valine

### Nonessential Amino Acids

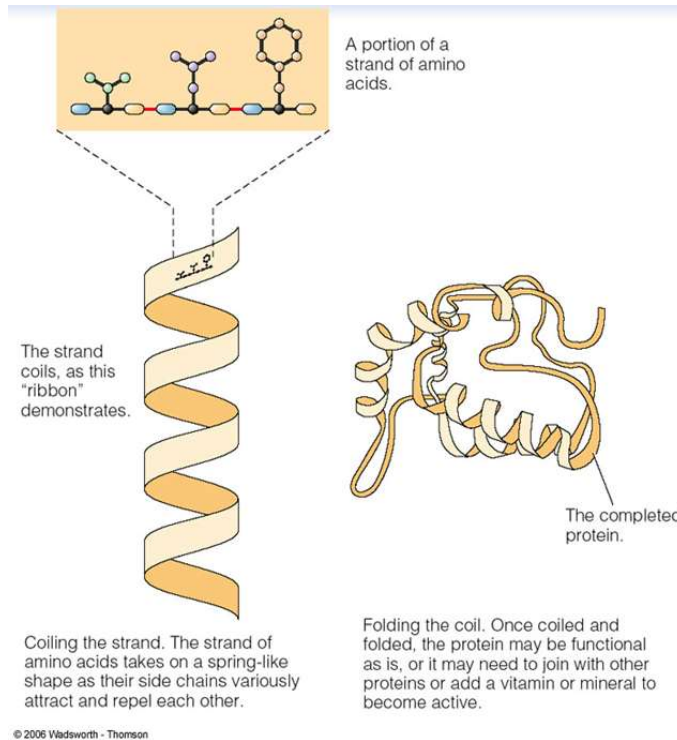
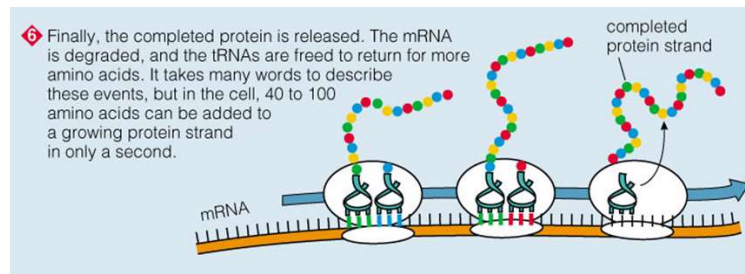
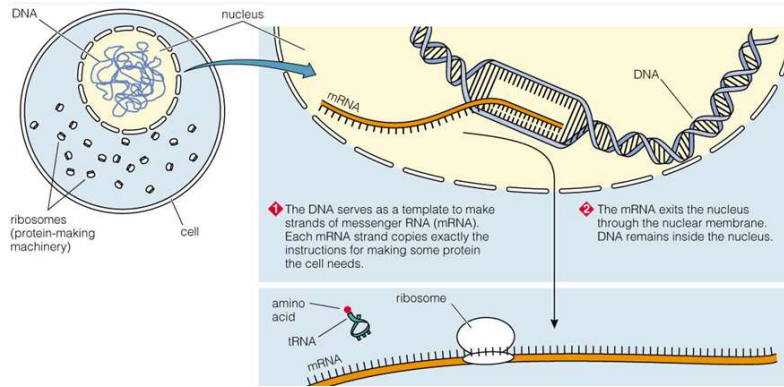
- Alanine
- Arginine
- Asparagine
- Aspartic acid
- Cysteine
- Glutamic acid
- Glutamine
- Glycine
- Proline
- Serine
- Tyrosine

### Conditionally indispensable/essential amino acid

- The body normally makes tyrosine (normally a nonessential amino acid) from phenylalanine (an essential amino acid)
- If the diet fails to supply enough phenylalanine, or if the body cannot make the conversion (as in the case of phenylketonuria), then tyrosine becomes a conditionally essential amino acid

### Protein Synthesis

- **Transcription:** use of the genetic information in DNA to make messenger RNA (mRNA).
- **Translation:** conversion of genetic information in mRNA to a chain of amino acids to form a protein.



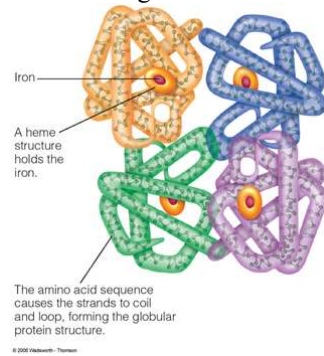
## Proteins

- DNA (genetic sequence) determines the amino acid sequence in proteins. Different sequences account for:
  - species differences, e.g. insulin, cows milk vs. goat milk
  - genetic diseases, e.g. hemoglobin and sickle cell anemia

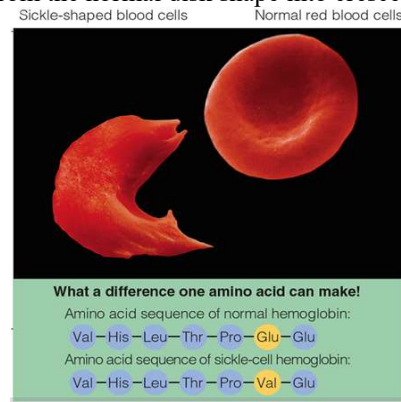
## The Variety of Proteins

- Collagen
  - A protein from which connective tissues are made
    - Tendons, ligaments, scars and the foundations of bones and teeth
  - Acts somewhat like glue between cells
- Insulin
  - Helps regulate blood sugar
- Enzymes
  - Protein catalysts
- Some protein strands function alone
- Other proteins are composed of several strands

- Hemoglobin
  - Made of 4 associated protein strands
    - Each strand holding an iron atom



- Hemoglobin
  - Sickle-cell disease
- Red blood cells collapse from the normal disk shape into crescent shapes



- Denaturation of Proteins
  - Denaturation
    - The irreversible change in a protein's shape
    - Denaturation damages body proteins
- Denaturation is important to the digestion of food protein
  - Why?
- Cooking denatures proteins
  - Exemplified by the changes that occur to egg white when an egg is cooked
  - With regard to diet this is important

### Protein Digestion

- Stomach
  - gastric acid denatures protein, and pepsin (enzyme) cleaves some peptide bonds
- Small intestine lumen
  - pancreatic enzymes cleave polypeptides to di- and tri-peptides
- Brush border membrane
  - enzymes cleave di- and tri-peptides to single amino acids

### Protein Absorption

- Intestinal cells absorb amino acids and some di- and tri-peptides and release them into the bloodstream.
  - Absorbing larger peptides may contribute to food allergies.
- Cells of the small intestine
  - Possess separate sites for absorbing different types of amino acids
    - Amino acids of the same type compete for the same absorption sites
    - Thus, when a large dose of any single amino acid is ingested the absorption of other amino acids of the same general type may be limited
- Amino acids in the bloodstream
  - Carried to the liver
- Used by the liver or released into the blood to be taken up by other cells
  - Cells can then use the amino acids to
- Make their proteins for their own use
- Make proteins that are released into the lymph or blood for other uses
  - When necessary body cells can use amino acids for energy

## Functions of Proteins

- Growth and maintenance (RBCs: 120 days)
  - structure, new tissue, repair
- Hormones and enzymes
  - e.g. growth factors, insulin
- Immune function
  - antibodies

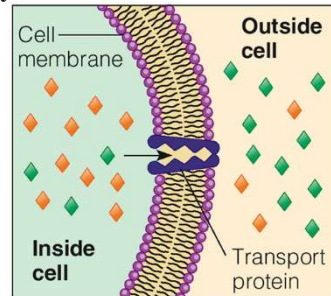
## Functions

- In addition to being building blocks for proteins, amino acids also perform other tasks
  - Example
    - Tyrosine is a component of both epinephrine and norepinephrine and is used to make both melanin and thyroxine
    - Tryptophan serves as a starting material for serotonin and niacin

## Functions of Proteins

- Acid-base balance
- Transport
  - e.g. hemoglobin and oxygen, albumin and fatty acids, minerals
- Blood clotting
- Structural components
  - skin, tendons, membranes, muscle, etc.
- Energy (secondary function)

## Maintaining Fluid and Electrolyte Balance



Molecule enters protein from inside cell.

## Protein Utilization

- Amino acids (AA) are wasted when
  - Energy is lacking
  - Protein is overabundant
  - An AA is oversupplied (e.g. supplement)
  - Diet has too few essential AA (i.e. low protein quality)
- For protein synthesis, need adequate dietary protein with essential aa in proper amounts and energy from carbohydrate and fat.

## Food Protein: Quality and Use

- Protein quality
  - Determines how well a diet supports the growth of children and the health of adults
  - Influenced by
- A protein's digestibility
- A protein's amino acid composition
- Digestibility of a protein varies from food to food

## Protein Quality & Quantity

Digestibility (improved by moist heat)

- Plant protein:
  - Legumes:  $\approx 80\%$ - $90\%$  absorbed
  - grains  $60\%$ - $90\%$  absorbed
- Animal protein:  $>90\%$  absorbed
- Quality: determined by AA content
  - complete: all 8 (9) essential amino acids
  - incomplete: missing or low amounts of some essential amino acids
  - limiting AA
- legumes limited in methionine and tryptophan
- grains limited in isoleucine and lysine
  - need complementary proteins (same day)

## Complementary Protein Combinations

<u>Grains</u>	<u>Legumes</u>	<u>Seeds &amp; Nuts</u>	<u>Vegetables</u>
Corneal Barley	Beans Peas	Cashews	Broccoli
Bulgur Rice	Lentils Soy	Sesame	Green Leafy
Pasta Oats	Peanuts	Sunflower Walnuts	Mushrooms

### Amino Acid Composition

- Complementary proteins
  - Two or more proteins whose amino acid assortments complement each other in such a way that the essential amino acids missing from one are supplied by the other



3/4 c oatmeal = 5 g  
Protein total = 5 g



1 c rice = 4 g  
1 c beans = 16 g  
Protein total = 20 g



1 1/2 c pasta = 11 g  
1 c vegetables = 2 g  
2 tbs parmesan cheese = 4 g  
Protein total = 17 g

- Complementary proteins
  - Mutual supplementation
    - The strategy of combining two incomplete proteins sources so that the amino acids in one food make up for those lacking in the other food

	Ile	Lys	Met	Trp
Legumes				
Grains				
Together				

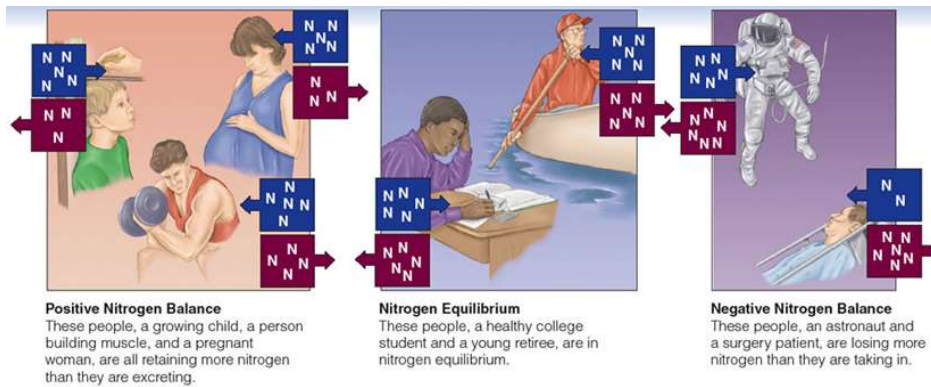
### Measuring Protein Quality

- Protein digestibility-corrected amino acid score (PDCAAS): USA food labels
- Protein efficiency ratio (PER): infant formula and baby foods
  - based on growth outcomes
  - highest are egg white, ground beef, milk protein, tuna, etc.
  - lowest is wheat protein
- 100 - 0 scale
  - 100: egg white, ground beef, tuna fish, etc.
    - Protein sources that are most readily digested and most perfectly balanced for meeting human needs.
  - 94: soybean
  - 60s-50s: most legumes
  - 25: wheat protein; gluten, formed during bread making
- % Daily Value for protein
  - On food labels
  - Manufacturers that list values for protein on food labels must use the PDCAAS to determine the protein quality of their products

### Nitrogen Balance

$$N \text{ balance} = N_{\text{intake}} - N_{\text{excretion (urine, feces, skin, sweat, body fluids)}}$$

- Depends on size and stage of growth:
  - equilibrium: normal healthy adult
- need 0.8 grams protein/kg body weight
  - positive:
  - negative:



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## Protein Energy Malnutrition

### Marasmus

<2 yrs age  
 total diet deficiency  
 malabsorption  
 slow, chronic  
 severe weight loss  
 muscle & fat loss  
 <60% wt for age  
 no edema, fatty liver  
 anxiety, apathy  
 good appetite  
 hair, skin problems

### Kwashiorkor

1-3 yrs age  
 protein deficiency  
 infection  
 rapid onset, acute  
 some wt, muscle loss  
 muscle wasting  
 60-80% wt for age  
 edema, fatty liver  
 apathy, irritability  
 loss of appetite  
 hair, skin problems

- World: 13-18 million children/yr die from PEM
- North America: PEM associated with chronic disease, poverty

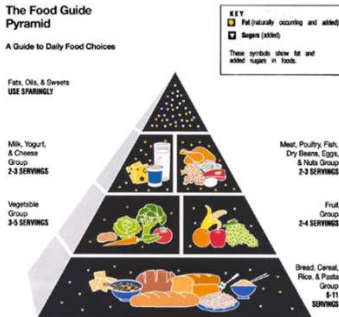
### Protein Excess

- What is excess?  $2 \times 0.8 \text{ g/kg} = 1.6 \text{ g/kg}$ ?
- High intakes of animal protein
  - associated with atherosclerosis
- soy protein reduces blood cholesterol
  - increased intake of saturated fat
  - kidney and liver problems in expt'l animals
  - more bone mineral loss
- need higher calcium intake in countries with high protein intakes
- High intakes of protein
  - worsen existing kidney disease in humans
  - increase work of the kidney to excrete nitrogen wastes: amine group of amino acids is excreted as ammonia or urea
- “High-protein” diets for weight loss: a current fad diet is to eat only protein foods
  - protein used for energy and making glucose:
    - must remove amino group and excrete it as urea via kidneys

### “All Protein/No CHO diet”

- “No” CHO: if <100 g CHO/d, then no glycogen stores and “ketotic”:
  - body fat --> ketone bodies for energy, and
  - blood glucose made from
    - dietary amino acids (after meals), &
    - muscle protein (when post-absorptive), and this results in muscle wasting
    - Initial rapid weight loss due to more water loss from body; loss of body fat and muscle mass in long term
    - Diet will be high in saturated fat: increases cardiovascular disease risk
    - Diet will be high in cholesterol (Note: only animals make cholesterol)
    - Diet will be low in some vitamins and minerals, and fibre

### Comparing diets: vegetarian and omnivorous (consume meat)



## Vegetarians

- Macrobiotic diet: mostly composed of whole grains, beans, vegetables
- Fruitarian: eats fruit, seeds, nuts
- Vegan: only food from plant sources (vegetables, grains, legumes, fruits, seeds, nuts, etc.)
- Lacto-ovo-vegetarian: vegan + eats dairy and eggs; no flesh or seafood
- Lacto-vegetarian: vegan + dairy; no eggs, flesh, seafood
- Ovo-vegetarian: vegan + eggs; no milk products, flesh, seafood
- Pesco-vegetarian: no red meat or poultry
- Partial vegetarian: no red meat

## Pros of Vegetarianism

- Reduced risk of disease (obesity, heart disease, diabetes, hypertension, cancer)
- Lifestyle often excludes smoking and alcohol and emphasizes physical activity
- Diet is high in vegetables, fruit, fibre, phytochemicals
- Lower fat diet and leaner body composition
- Better control of caloric intake due to fibre-rich bulky foods

## Pros of the Omnivorous Diet

- Growth is optimal
  - complete, more digestible protein
  - protein from meat, eggs, milk products
- Easier to meet additional requirements for pregnancy, illness, etc.
- Vit. B12, Vit. D, calcium, iron and zinc intakes are usually adequate