Food & Nutrition Chapter 1
Introductory Human Nutrition

Nutrition

Why do we eat when we do, how our eating patterns differ alone or w people

Factors Affecting Food Choices

- Preferences (taste: the most important factor)
- Habit
- Tradition
- Social Interactions
- Availability
- Convenience
- Economy
- Positive/Negative Associations
- Emotions
- Values
- Body Weight/Image
- Health Benefits

Nutrients

- Carbs, fats, and proteins are macronutrients (have calories and we need in larger amounts [g])
- Vitamins, minerals, and water (we need less of [mcg to mg])

- Organic: containing carbon
- CHO=carbohydrates
- All organics contain Carbon, Hydrogen, and Oxygen; protein also includes nitrogen
- Alcohol contains 7kcals per gram

Pg 4 Activity

- 55gx4= 220 kcal
- 15gx4= 60 kcal
- 2gx9= 18 kcal

Energy Density

- How much energy is in a food

- When bonds break in different nutrient molecules, they release different amounts of energy, and therefore, there's a big difference btwn the energy values

Vitamins

- Essential
- Can be:
    - Water soluble: can dissolve in water; found in more watery foods
        - C and all the Bs
        - If your body does not need them, the body excretes in urine
        - Less likely to be deficient with these
    - Fat soluble: can dissolve in fat; found in more fatty foods
        - A, D, E, K
        - Dissolve easily in oils and fats
        - Can be stored in the body (and accessed)
        - These deficiencies are very serious
- Vitamins don't have calories but help us use the calories
- Can be changed or modified in some way

Minerals

- Sodium, calcium, potassium, and magnesium are needed in larger amounts
- Iron is needed in smaller amounts
- Cannot be broken down
    - Because of how they're found in food, they can bind easier or harder to different foods
- Don't give us calories, help us use energy

Water

- Is part of all chemical reactions in the human body

DRI (Dietary Reference Intakes)

- A group of numbers put together by scientists
- This set of standards lets ppl know the amounts of nutrients ppl need
- Set for healthy individuals
- Specific for age groups
- Clustered by genders
- What it really means: for age and sex hormones
- For a healthy balance, eat between the RDA and UL daily
- RDA (Recommended Dietary Allowances)
    - Amount you need per day
    - Don't go below the RDA
- UL (Tolerable Upper Intake Levels)
    - The most you should have
    - It could be toxic to have more than the recommended UL
- EAR (Estimated Average Requirements)
    - The number used to figure out the RDA

- AI (Adequate Intakes)
    - The number we use if we don't have enough info to determine the RDA
- AMDR (Acceptable Macronutrient Distribution Ranges)
    - 45-65% kcals from carbs
    - 20-35% kcals from fat
    - 10-35% kcals from protein
    - If we go below, we won't have enough for our needs
    - If we are on the higher end, we can devleop chronic diseases

Food and Nutrition Chapter 2
Planning a Healthy Diet

- Four of the ten leading causes of death in Canada are easily linked to nutrition
- Chronic diseases ex. Obesity, diabetes, heart disease
- One of the biggest risks for chronic disease is a bad diet

Basic diet planning principles

- Adequacy: enough nutrients, energy, etc.
- Balance: picking lots of different foods (picking food groups/ensures you reach adequacy)
- Energy control: energy intake is too much (what *you* need)
- Nutrient density: has a lot of nutrients
- Moderation: enough but not too much
- Variety: picking lots of different foods within a food group ex. Apples, oranges, etc.

Must understand what a food consists of! (Ex. which one of these is a high protein food?)

- All oils are fats (are not in any food group) [butter would be others bc it's just fat; regular pasta would be others]

Fruits	Vegetables	Protein	Whole grain	Others
• Canned pear	• Corn • Kale • Broccoli • Lettuce • Carrot • Tomato juice (or others)	• Almonds • Peanuts • Pork • Yogurt • Tofu • Eggs • Milk • Salmon • Cheese • Chickpeas	• Millet • Popcorn • Pasta • Couscous • Brown rice • Corn tortillas	• Chocolate bar • Coconut oil • Beer • Olive oil • Margarine

Grocery Tips

- Variety of colours (orange, green, etc.)
- Fresh, frozen, canned are all okay
- Choose whole fruits and veggies over juice
- Choose whole grain!
- Lower-fat meat/dairy
- Fish/poultry
- Meat alternatives (beans, nuts, seeds, tofu)

On every packaged food: Nutrition facts table, ingredients label, claims
Spices, tea, coffee, alcohol don't have labels

1 tsp = 5 mL
1 tbsp = 15 mL
1 cup (C) = 240 mL

Nutrition Facts Labels have 13 core nutrients:

• Fat • Saturated fat • Trans fat • Cholestrol • Sodium • Carbohydrate	• Fibre • Sugars • Protein • Vitamin A • Vitamin C • Calcium • Iron

- Ppl need to be aware of not getting too much (ex. Not getting too much fat/sodium) or getting enough (ex. Some ppl need more iron)
- These are going to be changing

Daily Values

- If the number is 15% or more, that food has a lot of that nutrient in one serving
- How much certain nutrients are in a food
- Need to know! If the DV for iron is 14 mg, and the % DV is 21%, how much iron is in one serving?
    - 14x0.21 = 3 mg in one serving

Nutrient and Health Claims

- **Nutrient Claims**
    - Only about nutrients (how much are in a food)
    - Ex. 'cholestrol-free', 'good source of fibre'
- **Health Claims**

- Disease risk reduction claims ex. This product is lower in fat, so it will lower risk of heart disease
- Function claims ex. Vitamin E acts as an antioxidant
- General health claims ex. Why you might want to eat something (orange and green vegetables are healthy)

Food and Nutrition Chapter 3
Digestion, Absorption, and Transport

Digestion

- **Gastro Intestinal Tract**
  - Series of organs arranged as a long tube
  - Includes organs like the stomach, intestines
  - Sphincters (muscles that control the passage of material from one organ to the next)

- **Challenges**
  - Multi-tasks of the mouth
  - Diaphragm
    - Keeps everything (organs) in place
    - Pushes on organs and how things are able to get through the tract
    - Good thing, but a bit of a bother
  - Steady movement
    - Too quickly: diarrhea, too much water, not able to absorb nutrients
    - Too slowly: constipation
  - Lubrication of food
    - We don't want it to stick, to hurt
    - Must be continuously lubricated
  - Digestive enzyme functions
    - Need specific environments (right amount of water, pH)
  - Management of waste
    - When to release and how much
- Some food that gets ingested doesn't break down at all
- Mechanical Digestion: physical churning, chewing
- Chemical Digestion: enzymes breaking down the molecules

Process of Digestion

- Enzymes end in -ase, and describe where they are
- Mouth
  - Not all the enzymes are active in the mouth
  - Mainly mechanical (chewing)
  - Saliva helps break the food down more
  - Chemical digestion
    - Salivary amylase breaks down the starch component
- Swallowing (we don't need to know)

    - Voluntary and involuntary
- Esophagus
    - Peristalsis: muscle contractions that moves food down (gravity also helps food go down)
    - Goes through the lower esophigeal sphincter into the stomach
- Stomach
    - No digestion of carbs or fats
    - Mechanical Digestion: mixing and churning with gastric juices
    - Chemical Digestion: proteins really get digested here
        - Gastric lipase breaks down fats partially but doesn't work very well bc it is a water soluble enzyme (think of oil and vinegar; oil lays on top)
    - Gastric glands secrete gastric juices that contain
        - Hydrochloric Acid (HCl): pH 2
            - Denatures protein and activates enzyme (pepsin) involved in protein digestion
        - Some enzymes
        - Mucus is being released to protect the stomach lining
        - Amylase is no longer active bc of the pH balance
    - Food turns into chyme (semi-solid)
    - Three types of mucles in the stomach to help the food move
        - Longitudinal
        - Circular
        - Diagonal
    - Most absorption takes place in the small intestine, but also takes place in the stomach
        - Some water gets absorbed in the stomach
        - The more dehydrated you are, the more your stomach will absorb the water
        - Alcohol can get absorbed quicker in different ppl; around 10-20% of alcohol gets absorbed through the stomach
        - Caffeine, some minerals
- Small Intestine
    - Goes through pyloric sphincter
    - A lot of chemical digestion
    - Enzymes released from the pancreas and intestinal wall
    - Bile gets released
    - Three sections of the small intestine
        - Duodenum
        - Jejunum
        - Ileum
- Accessory Organs
    - Pancreas
        - Produces many digestive enzymes
        - Produces bicarbonate to neutralize chyme
    - Liver produces bile

        - Bile emulsifies fat (breaking it down into smaller pieces and making it more water soluble)
    - Gall bladder stores bile
- Absorption of Nutrients
    - Most absorption needs help
    - The intestinal wall has a continuous supply of blood to move nutrients to other parts of the body and to transport nutrients *to* the small intestine
    - Large folds: villi
    - Smaller folds: microvilli
    - If a nutrient is water soluble, it goes directly to the blood
    - If it's fat soluble, it goes into the lymph first, and then into the blood
    - None of the intestinal lining should be damaged
    - Three main kinds of absorption
        - Simple Diffusion
            - Straight absorption through the membrane
        - Facilitated Diffusion
            - There is a specific carrier that is responsible for bringing the nutrient in (ex. Glucose helps control how much goes into the blood)
        - Active Transport
            - Requires energy to get in
- Food Combination
    - Our bodies are made to digest many foods at once
    - Some nutrients are absorbed better if they are eaten with other ones
        - Ex. vitamin C and iron eaten together, 3x as much can be absorbed
- Large Intestine
    - A lot of water ends up going to large intestine and is absorbed there
    - Receives undigested residue: fibre pulling along water, minerals, bile
    - Has a lot of bacteria
        - Continues the digestive process
        - Ferments fibre; turns into short-chain fatty acids that get absorbed
    - Sodium and potassium absorb here
    - Not all fibre gets broken down by bacteria; remaining bits get eliminated
    - Has three parts
        - Ascending Colon
        - Transverse Colon
        - Descending Colon
    - Rectum: storage for 12-24 hours
    - Anus: elimination
- Excretion
    - Kidneys filter all the blood and decide how much should be excreted/kept; ex. decide how much sodium gets kept in water
- GI Hormones and Nerve Pathways
    - Endocrine System
        - Gastrin: produced by the lining of the stomach
    - Nerve Stimulation

        - As you eat, your stomach expands, and your brain tells you you're full
        - If the stomach is empty, you don't have the nerve stimulation

Common Digestive Problems

- **Choking**
    - Talking while eating (swallow something too big or eating too quickly)
    - Trachea is blocked
    - Food is lodged in the trachea
    - Can't get air in
- **Vomiting**
    - The food could be spoiled
    - Stomach reacting
    - Opens the sphincters
    - An adaptive mechanism to get rid of something the body doesn't need/want
    - Getting rid of a lot of fluids and electrolytes that need to be replaced
- **Heartburn**
    - Too much food in the stomach and gets pushed into the esophigeal sphincter (contents from the stomach into the esophagus)
    - Can increase risk of esophigeal cancer, ulcers
    - Eating smaller meals, make sure it's digested properly before lying down
- **Constipation**
    - Lack of water
    - Lack of fiber
    - Hard stools
    - Physical activity is a prevention method
- **Diarrhea**
    - Not enough water gets absorbed by the body
    - The food has gone through too quickly
    - Bad food, toxins, bacteria, viruses, illnesses
- **Gas**
    - Extensive swallowing of air with the food
    - Eating foods that produce gas during digestion
    - When partially digested carbs reach the large intestine, bacteria ferment them, giving gas
- **Additional Problems**
    - **IBS**
    - **IBD**
    - **Celiac Disease**
    - **Hemorrhoids**

Food & Nutrition Chapter 4
The Carbohydrates: Sugars, Starches, and Fibres

Calorie = kCal; No need to know joules

- One of three macronutrients

- Carbohydrate: carbon, hydrogen, oxygen

Dietary Carbohydrate Family

- Monosaccharides (simple)
    - Single sugars
    - Glucose, fructose, galactose (all have different levels of sweetness)
    - Glucose:
        - Dextrose is the same as glucose
        - Glucose is in maltose, sucrose, lactose
        - We store it in our bodies
        - Is in polysaccharides
    - Fructose:
        - Found in fruits
        - Sweetest of all monosaccharides
- Disaccharides (simple)
    - Pairs of monosaccharides
    - Maltose, sucrose, lactose
    - Two molecules of sugar joined together
    - Lactose
        - Glucose + galactose
    - Sucrose
        - Table sugar
        - Glucose + fructose
    - Maltose
        - Glucose + glucose
        - Produced during digestion of large monosaccharide chains
- Polysaccharides (complex)
    - Large chains of monosaccharides (usually chains of glucose)
    - Glycogen, starches, fibres
    - Polymers
    - Glycogen
        - Not found in diet
        - In muscles (maybe meat)
        - Breaks down very quickly
        - Storage form for glucose in animals (including humans)
    - Starches
        - Storage form for glucose in plants
        - Branched (amylopectin)
        - Unbranched (amylose)
        - Energy for plants
    - Fibre
        - Responsible for giving plants their structure
        - Very resistant to being broken down
        - Soluble
        - Insoluble

Fibre

- **Dietary Fibre**
    - Non-digestible part of plant found naturally in food ex. Grains, rice
    - Soluble and insoluble
    - Soluble (dissolvable in water; thickens and makes a gel)
        - Easily digested by bacteria in the colon
        - Found in foods like fruits, oats, barley, and beans
        - Reduces risk for cardiovascular disease and type 2 diabetes (lowers blood cholestrol and glucose levels)
    - Insoluble (don't dissolve in water, but absorb water)
        - Found in whole grains, husks of grains, and many veggies
        - Promotes regular bowel movements, alleviates constipation, and reduce risk for diverticulosis
- **Functional Fibre**
    - Extracted from plants and added to foods ex. Guar gum (found in ice cream), pectin (found in jam)
- **Total Fibre**
    - Dietary + functional fibre

Why We Need Carbs

- Energy
    - Fuels daily activity and exercise
    - Helps preserves protein
    - Sources high in fibre reduce risk for obesity, heart disease, diabetes
    - Some parts of the body (ex. Red blood cells and brain) really require or prefer glucose
    - If we don't consume enough energy as carbs, we make *ketones*
        - Used as an alternate energy source
        - Excessive ketones can result in high blood acidity and *ketoacidosis*
        - High blood acidity can damage body tissues
        - Produces bad breath if there's too many ketones
- Sparing proteins
    - If we need more glucose, the body breaks down protein to make the glucose
    - Gluconeogenesis: breakdown of protein building blocks (amino acids) for production of glucose
- Fibre
    - Can help reduce risk of some chronic diseases, especially colon cancer, heart disease, and type 2 diabetes
    - Can enhance weight loss
    - Helps prevents hemorrhoids, constipation, and diverticulosis
    - Carbs are found in dairy (the only group from animal products)

Where We Find Simple Carbs

- Glucose: sweetened products

- Fructose: fruit sugar, added to foods
- Lactose: milk/other dairy (smaller amounts)
- Sucrose: table sugar, many sweetened products

Where We Find Complex Carbs

- Starch: legumes (beans), grains, root veggies
- Soluble Fibres: oats, barley, grains, beans, fruits/veggies
- Insoluble Fibres: brown rice, wheat bran, beans, fruits/veggies
- Many grains and legumes are a mix of starch, soluble fibre, and insoluble

Digestion of Carbs

- Salivary amylase: begins digestion in the mouth, deactivated by pH in stomach
- Pancreatic amylase: most chemical digestion of carbs occurs in the SI
    - Enzyme produced in the pancreas and secreted into the small intestine
    - Enzymatically breaks down starch to maltose
    - Happens in the duodenum
- Small intestine secretes enzymes breaking down maltose and other disaccharides to monosaccharides
- Monosaccharides are absorbed into the cells lining the SI and into the blood
- Monos are converted to glucose by the liver and released into the bloodstream (bc we need glucose)
- Fibre passes through the SI undigested, and enters the colon
- Some soluble fibre broken down by bacteria to short chain fatty acids
- Remaining fibre adds bulk to stools and is excreted

Glucose in the Body

- Storing glucose as glycogen
    - Liver storage
        - Release of glucose into blood when needed
    - Muscle storage
        - Hoards glycogen for its own use
- A steady supply of glucose is needed in the blood
    - Obtained from intestines (food), liver

Fat cannot be converted to glucose (we can only do it from glucose -> fat)
We need 50-100g (200-400 kCal) of carbs per day (prevents gluconeogenesis)

How Much Carbohydrate Do We Need

Recommended Intakes of Sugar

- Limit intake of the following

    - Chocolate and candies
    - Fruit flavoured drinks
    - Soft drinks
    - Sports and energy drinks
    - Sweetened hot/cold drinks
- WHO and FAO
    - Less than 10% of total daily energy intake as sugar
    - Less than 5% is better

Whole Grains

- Brown bread means nothing except the bread is brown (nothing to do with the health of it)
- Enriched white bread: extra nutrients are added (ex. Iron and folate)
- Whole wheat bread: at least 60% whole wheat flour
- Whole wheat flour: flour made with at least 95% of actual grain

Lactose Intolerance/Lactase Deficiency

- Lack of lactase enzyme
    - In the cells in the lining of the SI
    - Required to help digest and absorb lactose
    - Highest immediately after birth
    - Will remain active in most ppl if it's needed
    - Some ppl stop making lactase after a certain age
- Symptoms of lactase deficiency include:
    - Bloating/gas
    - Abdominal discomfort
    - Diarrhea
- Causes
    - Diseases causing damage to intestinal villi
    - Some medicines
    - Prolonged diarrhea
    - Malnutrition
    - Genetics
- Treatment
    - Managing symptoms
    - Strategies
        - Lactose free food
        - Ex. lactose free milk (they add lactase to the milk to break down the lactose)

Diabetes

- Type 1
    - Requires insulin to get glucose out of the body
    - Mostly genetic
- Type 2
    - Doesn't require insulin (other meds)

    - Heart disease, obesity, chronic disorders (mainly from western type diets)
- Gestational
- Hypoglycemia
    - Low levels of glucose in the body
    - Normally associated with not getting enough insulin from type 1

Regulation of Blood Glucose

- Glycemic index
    - A measure of a food's ability to raise blood glucose levels
    - Foods with a low glycemic index
        - Cause mild fluctuations in blood glucose level
        - Are better for ppl with diabetes

Sugars' Share in the Problem

- Sugar vs kCals
    - Obesity rates have paralleled sugar intake
    - When energy is controlled, sugar doesn't really cause obesity
- Potential issues
    - Addictive properties of sugar
    - Liquid sugar
    - Appetite control
        - Doesn't help us feel full
    - Energy regulation

Insulin's Response

- After food (sugar) is consumed, blood glucose rises, triggering the release of insulin
- Insulin signals:
    - Glucose uptake by cells
    - Fat storage
    - Synthesis of cholestrol
- Low glycemic index diets

Food & Nutrition Chapter 5
The Lipids: Triglycerides, Phospholipids, and Sterols

Fats and Lipids

- Can be used interchangeably
- Fats: triglycerides

Types of Lipids

- Triglycerides
    - 1 glycerol and 3 fatty acids (a line and three lines horizontal to it)
    - Lipids are composed of carbon, hydrogen, and oxygen
    - Fatty acids are either saturated or unsaturated

        - Can come in many different lengths (most important ones are 18 carbons)

Fatty Acids

- Chains of Carbon with Hydrogen attached
- Long chain (14-24 C), medium chain (6-12 C), short chain (<6 C)
- Degree of unsaturation
- Saturated
    - Saturated with hydrogen (no double bonds)
    - Solid at room temp (bc fatty acids are packed very well)
    - Animal based or tropical oils ex. Lard, butter or coconut, palm oil
    - Foods rich in this type of fat:
        - Meat, dairy, eggs, tropical oils
- Unsaturated
    - Monounsaturated
        - One double bonds
        - Some vegetable oils ex. Olive oil or canola oil
        - Foods rich: olive oil/canola oil, olives, avocados, nuts
    - Polyunsaturated
        - More than one
        - Many vegetable oils ex. Corn oil, soybean oil (omega 6) flaxseed oil or fish oil (omega 3)
        - Foods rich: beans, nuts, seeds, fish
    - Liquid at room temp
- Every fat/oil we eat is a mix of saturated, monounsaturated, polyunsaturated
- Location of double bonds
    - If the double bonds are in the 3rd position, it will be Omega 3
    - If the double bonds are in the 6th position, it will be Omega 6
- Omega 3 and Omega 6 are important for us
    - Omega 3 cannot convert to Omega 6, but each can become shorter or longer
    - Linolenic (shortest omega 6 (18:2n-6) [18=number of carbons]) and alpha-linolenic acid (shortest omega 3 (18:3n-3)) are essential for us
    - Linolenic acid is converted to AA
    - Alpha-linolenic acid are converted to EPA and DHA
    - Many mono/polyunsaturated fats have more omega 6
- Hydrogenation
    - H atoms added to unsaturated fatty acids
    - Saturates some double bonds
    - Makes liquid fat more solid at room temp
    - Increases shelf life of food
    - Prepared baked goods, fast food
- Trans fatty acids
    - Derive from the process of hydrogenation
    - Behave like saturated fats in the body
    - H's are on opposite side of bond
    - A lot of them are not allowed in food

        - Prepared baked goods, fast food
- Phospholipids
    - Used as emulsifiers (even in our bodies)
    - Ex. lecithin
- Sterols
    - Multiple ring structures
    - Ex. cholesterol
        - Highest amount in our diets
        - Animal products only
        - Made by the liver
        - Makes bile acids, hormones, vitamin D
        - Structural component of cells
    - Plant sterols
        - Inhibits cholesterol absorption

Recommended Intakes of Fat

- 20-35% of daily energy intake
- 10% of total energy intake for saturated fat
- As low as possible for *trans* fat

Guidelines for Fat Intake

- We must get *enough* fat
- Replace saturated and tans fats with mono and polyunsaturated fats
    - Animal fats to vegetable oils, nuts, fish

Lipid Transport

- Most fat absorbed into the body is packaged as chylomicrons (clusters of lipids and proteins; looks like a cell; goes to the liver)
- Transport vehicles for fats called lipoproteins
    - Full of trigylcerides
- Body uses other types of lipoproteins also to transport fat (just not from the diet):
    - VLDL (Very Low Density Lipoprotein)
    - LDL (Low Density Lipoprotein); ‘bad’
        - Transports cholestrol to all body cells
    - HDL (High Density Lipoprotein)
        - Removes cholestrol from cells and back to liver for recycling or disposal

Fat’s Importance

- Essential fatty acids
    - Involved in cell signaling and other functions
    - Linolenic acid and alpha-linolenic acid deficiencies are rare
- Energy (9 kcal/g; provides us energy for a long time) and other functions
- Unlimited storage form of energy
- Adipose tissue
    - Stores fat

    - Involved in regulation of energy balance and other body functions
    - Other functions
        - Insulation, shock absorbers, structural material for cell membranes, cell signalling

Risks of Too Much Fat

- Heart disease
    - Major risk factor: elevated blood cholestrol
    - High LDL is most important risk factor; accumulates in arteries
    - Restricts blood flow
    - Can lead to heart attacks or strokes
    - When we eat saturated fats and trans fats, our body tells us to make more cholestrol
    - Mono and poly unsaturated fats don't tell our bodies to make more cholestrol

Food and Nutrition Chapter 6
Protein: Amino Acids

Protein

- Proteins: large complex molecules composed of amino acids
- Contains C, H, O, N
- All 20 amino acids (contain anine group; the amino acids we're interested in make up very essential functions for us ex. In muscles, hormones)
    - Central carbon
        - Has a side group, amino group, acid group
        - Side group can give different sizes or charges within different proteins
    - Hydrogen
    - An acid group (COOH)
    - An amino group (NH2)
    - Unique side group
- 9 essential and 11 non-essential (and conditional)
    - Non-essential: made by fragments of carbs with nitrogen from other broken down amino acids
    - Conditional: normally it's non-essential, but in specific circumstances (ex. Specific ppl, during disease) becomes essential
        - Ex. ppl with PKU where one amino acid is toxic to them and they are unable to make a different amino acid

Amino Acids

- Essential/indispensable: must be provided to the body in the form; absence is incompatible with life
    - MUST KNOW
    - Histidine

    - Isoleucine
    - Leucine
    - Lysine
    - Methionine
    - Phenlyalanine
    - Threonine
    - Tryptophan
    - Valine

- **Peptide bond:** bond btwn two amino acids
- **Dipeptide bond:** bond btwn two peptide bonds
- **Tripeptide:** 3
- **Oligopeptide:** 4-9
- **Polypeptide:** 10-100
- **Protein:** more than 100 peptide bonds

- Primary structure
    - Sequence of amino acids
- Secondary structure
    - Determined by weak electrical attractions within chain
    - Results in twisting or folding of protein
    - Provides strength and rigidity
- Tertiary structure
    - Complex structures
    - Due to side chain properties
    - 3D shape: fibrous or globular
- Quaternary structure
    - Interactions btwn polypeptide chains
    - 2 or more chains (subunits) stuck together

Ex. insulin has properties of all of these structures

- If there is a mistake in your amino acids (ex. Genetic anomaly), you can get a disease (ex. Sickle cell anemia)
    - Can result in reduced function or death

Protein Denaturation

- Something disturbs the protein's stability (they lose their shape and uncoil [becomes their primary structure; a long line of amino acids])
- This can happen through
    - Heat (ex. Cooking an egg)
    - Acids and bases (ex. During digestion)
    - Heavy metals
    - Alcohol
    - Other damaging substances

- Denaturation results in irreversible loss in protein function (think about a cooked egg not being able to be uncooked again)

Protein in Food

- All food contains some protein
- Fruits and veggies are negligible
- Protein highest in:
    - Meats and seafood
    - Dairy
    - Soy
    - Other beans and nuts
    - Grains
- How much protein to eat (for adults)
    - RDA
    - 0.8 grams of protein per kg of body weight/day
    - 10-35% of total energy intake should be from protein
- Which groups need more protein?
    - Children and adolescent
    - Pregnant/lactating women
    - Athletes
    - Vegetarians

Digestion of Proteins

- Stomach
    - HCl denatures the protein (uncoils them so there is a primary sequence)
    - The enzymes reach the amino acids (the peptide bonds are exposed now)
    - The enzyme that starts the digestion is pepsin (only active in the highly acidic environment)
        - Pepsin doesn't break up all peptide bonds, but instead turns them into polypeptides
    - The polypeptides go into the
- Small Intestine
    - Pancreas helps break down the polypeptides
    - Trypsin and cyhmotrypsin break down polypeptides into oligopeptides, which are then broken down into tri and dipeptides
    - Di and tripeptidases help break down the di and tripeptides
    - However, not everyone has the same intestinal lining, so they can have larger chunks of peptides that get absorbed

Protein Absorption

- Ex. allergy to peptides in the blood
- Amino acids must transport into intestinal cells
    - Specific carriers for amino acids and small peptides
    - Once amino acids are in intestinal cells, they are used right away for energy or synthesis of other compounds

- Unused proteins are sent to the liver via the bloodstream (and around the body)

Why We Need Protein

- To obtain essential amino acids (the body can't make these)
- To supply nitrogen to make other non-essential amino acids (we *can* make these)
- Amino acids are used for
  - Building materials for cells
    - Growth
    - Maintenance/repair
  - Hormones, enzymes
    - Messenger molecules
    - Released in response to stimuli
    - Travel in bloodstream to tissues
    - Elicit appropriate responses
    - Ex. insulin
    - Enzymes
      - Proteins that facilitate or help a=complete a reaction
      - Enzymes can help build substances, break them down
  - Fluid and electrolyte balance, pH balance
    - Proteins attract water
    - Found in cells and in plasma
    - Don't usually cross cell membranes
    - Ex. edema
    - Amino acids accept and release H+ ions (buffer)
    - Disruption can cause coma/death
    - Proteins accept and release hydrogen ions (pH will fall slightly)
  - Transporters
    - Transport proteins in the blood (hemoglobin)
    - Transport proteins in the cell membrane (Na-K transporter)
  - Anitbodies
    - Invading antigens are destroyed by antibodies
      - Bc antibodies are seen as less important than heart protein, it will take from there
    - Immunity
    - Low intake = weakened immune system
  - Energy source (limited source)
    - Proteins can be sacrificed when needed (starvation); we do NOT want to sacrifice our protein
    - Protein in tissues breaks down to amino acids (muscle)
      - Our skeletal muscle is broken down first
    - Deamination: removal of amine group (nitrogen) from amino acid
      - Some amino acids are used for gluconeogenesis, some are for fats
      - Nitrogen gets converted to ammonia and gets excreted, but is very bad for the kidneys

    - Others
        - Blood clotting
        - Vision

Protein Metabolism

- Protein Turnover
    - Continue making and breaking of proteins
    - Amino acid pool
        - Remains constant
        - Used to make other proteins or for energy
- Nitrogen balance
    - Nitrogen equilibrium (zero nitrogen balance): [Healthy adults]
        - N in = N out
    - Positive nitrogen
        - N in > N out
        - Retaining more than they're excreting
        - Ex. for pregnant women, children, some athletes
    - Negative nitrogen
        - N in < N out

Protein Quality

- Digestibility
    - Depends on source and other foods eaten at the same time of ingestion of the protein (can make protein digestion harder)
    - Digestibility of
        - Animal protein = 90-99%
        - Soy and legume protein = > 90%
        - Plant protein = 70-90%
    - Amino acid composition
        - If they support all 9 essential amino acids, it is of a high protein quality
        - We don't make partial proteins (it will get broken down; if we need a certain thing, if we don't have all our essential amino acids yet, it will not make that thing)
- Complementary proteins (for vegetarians or vegans!!)
    - Combining plant proteins to create full amino acid complement (getting all 9 essentials)
    - Doesn't need to be at the same meal, but has to be eaten in the same day
    - As long as healthy, varied diet
    - Problems with diets with limited protein sources
    - Legumes/grains or nuts or seeds
        - Legumes are lower in triptophine and methianine
        - Grains are lower in asolosine and losine
    - Dairy with either beans, grains, nuts, or seeds (nuts and seeds are similar to grains in terms of amino acids)

Which of these proteins are complete?

- Beans and rice: yes
- Broccoli stir fry with rice: no (you can add beans or tofu)
- Yogurt and oatmeal: yes (because it has dairy)
- Quinoa: yes (has higher levels of amino acids than other grains, but digestibility is lower)
- Tofu and red peppers: no (bc it just has legumes; you can add rice)
- Toast and peanut butter: yes (bc peanuts are legumes)

Vegetarianism

- Digestibility of proteins
    - Animals: 90-99%
    - Soy and legume: >90%
    - Plant protein: 70-90%
- Know: vegan, vegetarian, lacto-ovo-vegetarian, ovo-vegetarian
- Health benefits of vegetarianism
    - Lower intake of fat and total energy
    - Lower blood pressure
    - Reduce heart disease
    - Fewer digestive problems
    - Reduce risk of cancers
    - Reduce risk for kidney diseases, kidney stones, and gallstones

Challenges of Vegetarianism

- Low in some vitamins and minerals (iron, calcium, zinc, vitamins D, B2 and B12)
- It should include complementary proteins

Protein Deficiency and Excess

- PEM (protein-energy malnutrition)
- Insufficient intake of protein, energy, or both
- Most prevalent form of malnutrition worldwide
- Types of PEM: Marasmus/Kwashiorkor
- Marasmus
    - In children who are slightly younger (>2 years old)
    - Severe weight loss
    - No detectable edema
- Kwashiorkor
    - In children who are older (1-3 years old)
    - Some weight loss
    - Edema
    - More likely to occur after weaning
- Impact on children
    - Poor growth (height and/or weight)
    - Can be small for their weight
    - Can also happen during famine or severe illness/addiction for adults
- May impact certain adult population groups
- In Canada

    - Those in poverty in inner cities or isolated rural areas
    - Elderly living alone
    - Homeless
    - Ppl with eating disorders
    - Drug or alcohol addiciton
    - People with AIDS or cancer

Eating Too Much Protein

- High cholesterol and heart disease
    - High saturated fat content
- Possible bone loss
    - May cause excess calcium excretion, leading to bone loss

Food and Nutrition Chapter 11
Water and Electrolytes

- About 60% of our body weight is made of water
- Amount of water depends on body composition
    - ¾ of weight in lean tissue (muscles)
    - <¼ of weight in fat tissue
- Proportion of water is smallest in
    - Females
    - Obese ppl (lower amounts of muscles)
    - Elderly
- Signs of water deficiency are shown within a few hours

Functions

- Carries nutrients and waste products (ex. Blood, sweat, urine)
- Maintains the structure of large molecules (ex. protein)
- Participates in metabolic reactions
- Serves as a solvent (ex. Minerals and vitamins are solutes)
- Acts as a lubricant (ex. Synovial fluid surrounding joints, lubricants in eyes)
- Aids in body temp regulation (ex. sweating)
- Maintains blood volume (fluid in = fluid out!!)

Where Water is Found (in our bodies)

- Every cell contains fluid and is surrounded by fluid
    - Intracellular
    - Extracellular
- Continual turnover
- Rapid adjustments to maintain homeostasis

Water Intake

- Water intake is controlled by hypothalamus
    - Less water = concentrated blood = more thirst
    - More water = distension of stomach = less thirst

- Dehydration
    - Thirst
    - Dry throat, fatigue, headaches, etc.
    - Weakness, exhaustion, delirium
    - Death at worst
- Water intoxication
    - Confusion, convulsions, death
    - Hyponatremia (hypo = under, natr = sodium, emia = in blood) low amounts of sodium in blood

Water Sources and Losses

- There is a wide variety on the amount of water lost depending on the person
- Lost through (from most to least):
    - Kidneys (urine)
    - Skin (sweat)
    - Lungs (breath)
    - GI tract (feces)
- Obligatory water loss: 500 mL a day
    - Even if we haven't consumed water in the past 24 hrs, we will lose the water through urine
- Insensible water loss: sweat and breath
- We make 300 mL of water a day through metabolic reactions
- We consume water through drinking and eating

Water Recommendations

- AI for total water
- Men: 3.7 L/day
- Women: 2.7 L/day
- Meets body's fluid needs
- Protects against urinary stones and constipation
- Mild dehydration
    - Interferes with daily tasks

Fluid and Electrolyte Balance

- ⅔ inside cells, ⅓ outside cells
- Balance of cations and anions inside and outside cells
- Dissociation of salt
    - NaCl separates and becomes Na+ (cation) + Cl- (anion)
    - Electrolytes carry mild electrical currents
- Potassium are the main intracellular cations
- Sodium are the main extracellular
- Some electrolytes are inside the cell
    - PO4-, K+
- Some are outside the cell
    - Na+, Cl-
- Electrolyte movement is controlled

- Water follows electrolytes (osmosis)
- Proteins also help to regulate fluid movement
    - Attract water
    - Transport proteins
        - Passage of ions across cell membranes
        - Sodium-potassium pump
- Fluid and electrolytes balanced in whole body by
    - GI tract
    - Kidneys
- Causes of imbalance
    - Prolonged vomiting or diarrhea
    - Heavy sweating
    - Burns and traumatic wounds
    - Some medications
- Solutes lost depend on why fluid is lost
- Replacing lost fluids and electrolytes

Sodium (Na)

- Preserves food and enhances taste
- Roles in food
    - Fluid balance
    - Acid-base balance
    - Nerve transmission
    - Muscle contraction
- Readily absorbed and travels freely in the blood to the kidneys
- We need a specific amount of sodium in our bodies
- If we have too much sodium, we need to drink more water to dilute the sodium (that's why we get thirsty)
- Recommendations
    - Rarely lacking in the diet
    - DRI set to protect against high blood pressure
    - UL has been set, most people are over
- Too much salt
    - Hypertension in some people - related to salt sensitivity
    - Edema
- Deficiency (rare)
    - Due to vomiting, heavy sweating, diarrhea
    - Hyponatremia
- Salt is more harmful than sodium
- Blood pressure goes up immediately after eating salt
- Food with sodium
    - Processed foods (75%)
        - Also tend to have low potassium
    - Salt added at table or cooking (15%)
    - Natural sources (10%)x
    - Cured, salted or canned meat, fish or poultry:

        - Bacon
        - Cold cuts
        - Ham
        - Hot dogs
        - Sausage
        - Sardines
        - Caviar
        - Anchovies
    - frozen, prepared meals (uses salt as a preservative)
    - Many canned foods
    - Bread
    - Cheese
    - Pickles (various pickled foods)
    - Salted nuts
    - Sauces (ex. Soy sauce, hot sauce, barbecue sauce)
        - Anything used for flavour is probably very high in salt
- Salt you can taste (ex.salted nuts) have more salt than foods you can't taste it
- DASH Diet
    - Dietary Approaches to STOP Hypertension
        - You have hypertension if your readings for high blood pressure are consistently high, not just one measurement

Chloride (Cl-)

- An essential nutrient
- Involved in fluid and electrolyte balance
- Very difficult to be deficient unless we lose a lot of chloride, such as through vomiting, such as illness, bulimia, etc. where chloride loss would be an issue
    - Deficiency is rare, as is toxicity
- Associated with sodium outside of the cell and potassium inside the cell
    - Moves passively through membrane channels
- Part of HCl (stomach)
- Abundant in foods, consumed as part of salt

Potassium (K)

- A cation, found inside cells
- Roles in the body:
    - Fluid and electrolyte balance
    - Nerve transmission and muscle contraction
        - Sodium and potassium trade places
        - Quickly revert back to normal
        - ex. Steady heart beat
- As long it is fresh and unprocessed, it will be a good source of potassium (found in all food groups)

- Hypertension
    - low potassium + high sodium = high blood pressure
- Deficiency is rare
- Toxicity
    - Not due to food, thus no UL set
    - Due to certain diseases or medication
- Calcium is the most abundant mineral, phosphorus is the second (major anion found inside the cell), found in DNA and RNA
- None of us are doing a good job with what we're eating and drinking pretty much

What Can Go Wrong?

- Dehydration
- Heat illness
- Water intoxication

Dehydration

- Water lost > water consumed
- Many causes
    - Diarrhea
    - Vomiting
    - Fever
    - Excessive sweating
    - Unmanaged diabetes
    - Laxative or diuretic use
- First symptom of dehydration: thirst
- Then fatigue, weakness, vague discomfort, etc

Heat Illnesses

- Heat cramps, heat exhaustion, heat stroke
    - Body cannot cool itself
        - If you are hydrated but still feel hot, the body can cool itself (sweating)
    - Risk is related to:
        - Environmental conditions, exercise
        - Hydration
        - Electrolyte status
- Heat cramps
    - Subtle twitches to painful spasms
- Heat exhaustion
    - Headache, nausea, dizziness, weakness, rapid breathing
    - Go to hospital
- Heat stroke

        - Serious medical condition
        - Sweating stops, body temperature increases
        - Hyperventilation, confusion, even death
- Water intoxication
    - Drinking a lot of water but losing electrolytes as they are not being replaced with the water
    - Hyponatremia: low sodium in the blood
    - Gatorade or another replacement is good for the electrolytes or intravenous through the vein

Food and Nutrition Chapter 12
Antioxidants

Oxidant: all original three oxygen were all oxygen free radicals, unpaired electrons in the body, but now there are nitrogen and other elements

The Antioxidant Nutrients

- Oxidation is part of normal metabolism
    - Oxidation and reduction reactions (Redox reactions)
    - Oxidation = loss of electrons
    - Reduction = gain of electrons
        - Redox reaction is the transfer of electrons between two compounds so that one loses and the other gains
- Can result in an unpaired electron = free radical
    - Damages lipids, DNA, RNA, proteins
- Retinol can go back in forth between retinol and retinal
- Antioxidants neutralize free radicals
- Protect cells from oxidative damage
    - Vitamins quench free radicals (think dominoes)
    - Minerals act as cofactors for enzymes
    - Phytochemicals-various-quench
- Beta-carotene is not active by itself, it has to be converted to vitamin A
    - Plays a part in the cornea and nerve energy at retina which absorbs light
- Go over retinol and retinal

Vision

- Two roles in vision
- Maintenance of the cornea (cell division)
- Conversion of light energy into nerve impulses at the retina

Vitamin A in Protein Synthesis

- Epithelial cells
    - Outside the body (skin)
    - Inside the body (mucous membranes)
    - Cornea
- Protects skin from sun damage and integrity of mucous membranes
- Promotes differentiation of epithelial and goblet cells (secrete mucous-various parts of body)

Vitamin A in Reproduction and Growth

- Sperm development in men
- Fetal development in women
- Bone remodelling
- Growth in children

Vitamin A Deficiency

- Stored in our liver as backup for things to take place
- Vitamin A status dependent on stores and protein status
- Deficiency can take 1-2 years
    - Infectious disease
    - Night blindness
        - Lack of rhodopsin
        - Inability to recover from changes in light
    - Xerophthalmia (complete, total blindness - cornea hasn't been maintained)
        - Drying and softening of the cornea
        - XER = dryness
        - OPHTALMIA = of the eye
    - Keratinization of the eye
- Vitamin deficiency is very rare in Canada but very common in countries around the world
- Increased risk of infectious disease
- Involved in cell division
- Cells in immune system turn over every month so without vitamin A, they can't turn over, so your system will be weak
- Keratin = within hair and nails
- If it's orange or dark green = high in beta-carotene

Vitamin A Toxicity

- Binding proteins become swamped
- Free vitamin A causes damage
- Results from preformed vitamin A

        - Not seen with beta-carotene
- Consequences:
    - Bone defects
    - Birth defects

Vitamin E as an Antioxidant

- Fat soluble
- Tocopherols and tocotrienols
    - Alpha, beta, gamma, delta for each
    - 8 compounds
- When rats did not get vegetable oil, they could not reproduce, caused by tocopherol which allowed them to reproduce
- Primary defender against free radicals
    - Prevents free radicals from producing more free radicals at the site of the cell membrane and can prevent diseases associated with that cell
    - Cell membranes and other lipids
    - Prevent domino from hitting the next domino
- Reduces CVD risk
    - Oxidation of LDL
        - More LDL you have, more oxidized LDL you have
        - Toxic
        - Increase the risk of CVD diseases

Vitamin E Deficiency

- As long as you have enough fat, you will have enough vitamin E, premature infants get it right before birth
- Primary deficiency is rare
    - Fat malabsorption mainly
- Red blood cells break open
    - Due to oxidation of PUFAs in RBC membranes
    - Erythrocyte hemolysis
        - Premature infants
- Prolonged deficiency
    - Neuromuscular dysfunction of spinal cord and retina

Vitamin E Toxicity

- Liver regulates vitamin E
- Toxicity is rare
- May interfere with:
    - Blood clotting

- Vitamin E is a blood thinner

Vitamin E Recommendations and Sources

- RDA based on alpha tocopherol
- Goes up if we eat more polyunsaturated fat = more need for vitamin E
    - Typically occurs in foods together
- Primary source: vegetable oils
    - Easily destroyed by heat and oxidation
- Vitamin E can be easily destroyed (ex. By cooking)

Vitamin C: Roles in the Body

- Ascorbic acid
- Antioxidant
    - Loses electrons easily
    - Gives electrons up to stop free-radical damage
- Cofactor for collagen fibre binding to make lattice in bone, skin, etc.
    - People with scurvy have bleeding gums because they don't have collagen forming properly
- DON'T NEED TO KNOW RECOMMENDATIONS
- People who smoke need more vitamin C than people who don't
- Excreted in urine, so it can be harmful for kidneys if they're always being passed through

Vitamin C Deficiency and Toxicity

- Deficiency
    - Scurvy appears at 1/5 optimal levels
        - Bleeding gums, breaking of capillaries
    - Inadequate collagen, wound healing stops, teeth become loose, skin becomes dry, rough and scaly
- Toxicity
    - Supplementation side effects
        - Diarrhea
        - Sometimes kidney issues
- Any fresh fruit or any fresh vegetable but #1 source is red pepper

Selenium (Se)

- Works in partnership with vitamin E (one tries to kill the other before it goes on to make more)
- Part of the enzyme glutathione peroxidase
- Found in the soil and leaches into foods

    - Plants need to grow in good soil to be good plants
- Therefore amounts in food depend on amount in soil

SUMMARY

- Vitamin A: eggs, orange and yellow fruits and vegetables
- Beta-carotene: broccoli, spinach, most dark, leafy vegetables
- Vitamin E: almonds, peanuts, avocados
- Vitamin C: red pepper, kiwi, strawberries
- Together, these antioxidants protect cell membranes, lipoproteins, DNA and RNA and proteins

What Can Go Wrong?

- Free radicals are generated by:
    - Metabolism
    - Environmental factors (ex.smoking, UV radiation)
- Can cause widespread damage
    - Linked to cognitive performance, aging and disease (cancer, CVD, diabetes)
- Fat radicals damage DNA
- Protein radicals-change cell functions-damage DNA
- DNA and RNA radicals - cell damage, diseases
- Problem is getting more cells with damaged DNA

Defending Against Cancer

- Damage to DNA
- Inversely related to vegetable intake
- Nutrients linked to decreased cancer

Defending Against Heart Disease

- Oxidation of LDL —> atherosclerosis
- Most antioxidant nutrients are protective against development, but treatment is unclear
    - Can prevent heart disease

Food, Supplements or Both?

- Antioxidants must be replenished in PLANT FOOD
- To prevent heart disease the diet should
    - Include PUFA
    - Be high in vegetables, fruits, nuts, seeds and whole grains
- Combine with exercise, weight management and not smoking

- Supplement use is currently inconclusive
- More smokers got lung cancer that took beta-carotene
    - Too high of antioxidant levels, can act like oxidants

Food and Nutrition Chapter 13
Nutrients for Bone Health

Nutrients for Bone Health

- Calcium
- Vitamin D
- Phosphorus
- Magnesium
- Fluoride
- Vitamin K

What Are Bones Made Of?

- Composed of
    - 65% mineral crystals
        - Strength and structural support
        - Calcium and phosphorus (hydroxyapatite); is the frame and isn't strong in itself
        - $Ca5(PO4)3(OH)$
    - 35% organic substances (collagen)
        - Flexibility
- Bone mineral density = bone strength
- Two types of bone tissues
    - Cortical bone
        - Very dense; part of outer walls of larger bones and main tissue of small bones (has little holes for blood vessels to go through)
        - 80% of the skeleton
    - Trabecular bone
        - Lacy architecture, spongy; responds readily to hormones
        - 20% of the skeleton
        - Faster turnover rate (more breaking down, building up of the bone)

How Do Bones Grow?

- Bond **growth:** bones grow from conception to teens
    - Ceases at around 14 for girls, 17 for boys
- Bone **modelling**: bone mineral density increases at the same time
- Bone **remodelling**: reshaping of bone
    - Osteoclast (cry) and osteoblast (blast) activity
    - Osteoclast breaks down
    - Osteoblasts build up new bone tissue
    - Occurs over lifetime

    - Osteoclast > osteoblast activity as we age
- Active growth of bone occurs up till age 20
- Peak bone mass is from 12-30
- Bone loss begins after age 30

Bone Health

- Bone remodelling involves
    - Resorption: surface of bones is broken down
        - Osteoclasts: cells that erode the surface of bones
    - Formation of new bone by cells called osteoblasts
    - Osteoblasts produce the collagen-containing component of bone

Assessing Bone Health

- Dual-energy x-ray absorptiometry (DXA or DEXA)
    - Tool to measure bone density
    - Provides a full body scan or can be used to scan peripheral regions (wrist, heel)
    - Noninvasive
    - A T-score is obtained, which compares bone density to that of a 30-year-old
    - If it is less than -2.5, the person has osteoperosis
    - Typically used for post-menopausal women

Calcium

- Most abundant mineral in the body
- 99% in bones
    - Forms a matrix on collagen (hydroxyapatite)
    - Gives strength and rigidity
    - Remodelling occurs continuously
- 1% in body fluids
    - Extracellular and intracellular compartments
    - Different functions
- If calcium is too high or low, it can be easily fixed within the body
- Functions of calcium
    - Forms and maintains bones and teeth
    - Assists in muscle contraction
    - Assists with acid-base balance
    - Transmission of nerve impulses
    - Plays a role in blood pressure regulation
- About 1g of calcium a day
- About 80% of women from 50-70 are not consuming enough calcium in diet
    - Usually told to take calcium supplement
    - About 50% of these women who take these supplements are still not getting enough calcium
    - Women over the age of 70, there are even more not getting enough calcium
- This is the same for men, though the numbers are not as high
- Calcium Absorption

    - 30% is absorbed in adults
    - 50% pregnant women
    - 50-60% children
    - 25% older adults
    - Factors
        - Enhancers: stomach acid (amount of HCl goes down as we get older), vitamin D
        - Inhibitors: lack of enhancers, high phosphorus in diet, high iron/zinc, compounds in plant foods like phytates, oxalates (spinach), fibre
            - Phytates and oxalates are found in foods high in fibre
            - However, they reduce absorption of many minerals
- Calcium Deficiency
    - Low Bond Mineral Density (BMD)
    - Osteoperosis
        - ¼ women and ⅛ men over 50
    - Blood calcium level dos NOT reflect calcium status
        - Because the bones give up calcium to the blood, but your bones will be weak and osteoporotic
    - Blood calcium is VERY tightly regulated with hormones
- Calcium Balance in Blood
    - If calcium levels are too high
        - Acts on kidneys, bones, intestines
        - Calcitonin is released, which functions to:
            - Tell kidneys to prevent reabsorption of calcium
            - Tell intestines to limit calcium absorption
            - Tell osteoclasts to not break down the bone
    - If calcium levels are too low
        - Parathyroid Hormone (PTH) is released
        - PTH stimulates activation of Vitamin D; these cause
            - Acts on kidneys, bones, intestines
            - Kidneys to retain more calcium
            - Osteoclasts to break down bone and release calcium
            - Stimulation of calcium absorption from intestines
- Food Sources of Calcium
    - Tofu
    - Many plant-based milks are fortified with calcium
    - Some orange juice is fortified
    - Nuts and seeds
    - Oysters
    - Fish with small bones
    - Dairy products (also includes ice cream :))
    - Green leafy veggies
        - However, spinach also contains oxalates, which restricts absorption of calcium

Vitamin D

- Fat-soluble vitamin
- Excess stored in liver and fat tissue
- Can be synthesized by the body by exposure to UV light
- Is a hormone bc it's synthesized in one location and acts in another
- **Functions**
    - Controls gene transcription related to regulation of blood calcium levels
    - Needed for absorption of calcium and phosphorus
    - Regulates excretion from kidneys
    - Stimulates osteoclasts
    - Needed for bone calcification
- **Synthesis**
    - Dietary
        - D2 comes from plants
            - Not as active but we can convert it into D3; however, it takes longer
        - D3 comes from animals
    - In the skin
        - Cholesterol -> 7-dehydrocholesterol; in the skin, it's turned into a pre-vitamin into Vitamin D3 (calciol)
            - It is then hydroxolated, which turns into calcidiol in the liver
            - It gets hydroxolated again, which turns into calcitriol in the kidneys
- **Deficiency**
    - True deficiencies are rare
    - Insufficiencies are more common especially among:
        - Dark skin, breastfeeding without supplementation, consuming non-fortified milk, fat malabsorption
        - Canadians can't rely on sun exposure for vitamin D synthesis from Oct to Apr
        - Elderly: low intake, low sun, low ability to make
    - Results of deficiency
        - Rickets in children
            - Growth retardation, bone abnormalities (bowed legs, beaded ribs)
        - Osteomalacia: soft bones in adults
- **Recommendations and Sources**
    - Assumption for when we have no Vit D from the sun
    - Needs increase for older adults
    - Few natural food sources
    - Fortified foods: dairy sources, soy drinks, some orange juice, margarine
    - Fatty fish, meat, milk, liver
- **Toxicity**
    - Most likely nutrient to be toxic
    - Effects include
        - Hypercalcemia - high blood calcium
        - Calcium precipitates in soft tissues

        - Stones (ex. kidneys)
        - Hardening of blood vessels
    - Take in moderation!!

Phosphorus

- 2nd in abundance in body
    - Critical to mineral composition of bone
- Combined with calcium = hydroxyapatite
- Found in many foods, mostly protein (milk, meat, eggs)
- Many of us get too much of it
- The more phosphorus we take in, the more calcium we lose

Magnesium

- 50-60% of body's Mg found in bones
    - Acts as a reservoir for blood
- Hard water, whole grains, most foods have some

Fluoride

- Trace amounts in the body
    - 99% of the body's fluoride is in teeth and bones
- Mineralization of bone
    - Replaces OH in hydroxyapatite = fluorapatite
    - Makes bones stronger and teeth more resistant to decay
- Dental caries (tooth decay) is common without fluoridated water
- Can't be too high (can get white stains on teeth) or too low (cavities, tooth decay)

Vitamin K

- Bone health needed for binding of calcium to bone
- Deficiencies and toxicities are rare
- Sources
    - GI bacteria, green veggies, vegetable oils

What Goes Wrong for Bone Health?

- **Osteoporosis**
    - Usually apparent in later years
    - Many are unaware of bone loss until a fracture occurs
    - Hip fracture is most common, leading to
        - Major surgery
        - Economic burden
        - Quality of life
        - Mortality
    - In Canada, better early diagnosis
    - 19% of women 15-70
    - 3% of men 15-70
    - 31% of women 70+
    - 6% of men 70+

    - On estrogen pills, some people can go from osteoporosis to LBD
    - Age is strongest predictor for osteoporosis
    - Critical life stages
        - Growing years
        - Bone-losing decades
    - Bone loss is inevitable
    - **Genetics and Ethnicity**
        - May be hereditary
        - Family history is a risk factor (impacts peak bone mass, rate of bone mass)
        - Ethnicity
            - Less risk in Africans
            - More risk for Asians, Hispanics, Inuits, and Caucasians
    - **Other Factors**
        - Weight-bearing activities stress and stimulate bones
        - Higher body weight may be protective
        - Caffeine intake increases calcium excretion
        - Smoking increases risk, but is reversible once smoking ceases
        - Alcohol abuse increases risk (reduced intake of nutrients, increased loss of calcium, alters bone health hormones)
- **Supplements**
    - Calcium supplements +/= Vitamin D
        - May increase heart disease risk in women
    - Get calcium supplements low in multivitamins
    - Must be taken regularly