Chapter 25: Metabolism and Nutrition
(Pages 950 - 991)

Food (chemical energy)- the source of energy for all biological work. Chemical energy is measured in kilocalories (kcals) or (*C*). *Humans are *heterotrophs*. Yah, so?
* *Calorie* – the amount of energy required to raise 1 gram of water 1 degree Celsius.
(see page 976)

I. Regulation of Food Intake: (See page 979)
* most mature animals maintain a stable body wt.
* no sensory receptors that monitor one's wt.
* depends on many factors: endocrine system, nutrients in the blood, psychological, signals from GI tract, special senses, & neural connections.

2 regions in the *hypothalamus* (primitive region in the brain):
*(See fig. 14.1, page 476)

1. Hunger "feeding" center - upon stimulation the animal eats. *NOTE: it is constantly active "always a gas pedal"

2. Satiety(say-sha-tee) "fullness" center - upon stimulation the animal will stop eating.
i.e. inhibits the "feeding center"
* "a brake pedal"
* these regions receive info. from other parts of the brain which have received info. from other systems such as the digestive system or endocrine system.
* Phen–Fen (a diet drug) acts as a feeding inhibitor in the brain!

A. Theories on how the hypothalamus regs. feeding:
1. Glucostatic Theory: When blood glucose levels are low(hypoglycemia); feeding increases. This decreases the neuronal activity in the satiety center, so that they no longer inhibit the feeding center and the person eats.

↓ glucose; ↓ satiety center activity; ↑ feeding

2. Protein Theory- Same scenario for a.a's levels in the blood.

↓ amino acids; ↓ satiety center activity; ↑ feeding

3. Lipostatic theory: As the amount of adipose tissue increases in the body, the rate of feeding usually decreases. Fatty acids are released from adipose stores that activate neurons of the satiety center, and in turn, inhibit the feeding center. * also, fats in small intestine (increase in CCK hormone) which inhibits eating.

↑ CCK hormones; ↑ satiety center activity; ↓ feeding

* Other factors:

4. Temperature
- warm climate - depresses eating
  ↑ satiety center activity; ↓ feeding
- cold climate - enhances eating
  ↓ satiety center activity; ↑ feeding

5. Distension of GI tract – stretching the stomach & small intestine (a stretch reflex).

↑ satiety center activity; ↓ feeding

6. Psychological factors can override the physiological mechanics, e.g. bulimia, anorexia and obesity, learned??

II. Nutrients:
* any substance that serves one or more of the following functions:
1. provides energy to sustain life processes.

??Question: Like what life processes??

2. used to synthesize hormones, proteins, enzymes, muscles, cell parts, etc...

3. stored for future use, e.g. glycogen in the liver

A. Historical Perspective of Nutrition: * 4 eras in the study of nutrition.

Nutrition - study of how the body uses nutrients.

Malnutrition - imbalance of nutrients; too much or too little. Caused by diet or various diseases.
* Registered Dietician (RD): 4 yr. degree in nutrition + 1 yr. for license to practice.

B. Six classes of nutrients: (See page 980); *** nutrients needed in greatest quantity**
1. ***Carbs** - monosaccs; CHO(1:2:1); 4 kcals/gram
2. ***Lipids** - glycerol & f. acids; CHO; 9 kcals/gram
3. ***Proteins** - amino acids; CHONS; 4 kcals/gram
4. **Minerals** - involved in breaking down #1-3 (supplement)
5. **Vitamins** - involved in breaking down #1-3 (supplement)
6. ***Water** - water has major functions.

??Question: What are some functions of water??

US Daily Dietary Goals(caloric intake)

	Recommended:	**Currently:**
Protein:	**12 - 15%**	**18%**
Carbs:	**50 - 60%(no more than 15% simple sugar)**	**40%**
Fats:	**< 30% (no more than 10% saturated fats)**	**42%**

III. Metabolism: An Overview: (See page 951 – 952)
MET - all the chem rxns. of the body.
* the body's met. is an energy balancing act between anabolic (synth.) rxns., and catabolic (decomp.) rxns. this is a continuous recycling of molecules in living tissue with the help of enzymes (enzymes help ↓ **activation energy**; ↑ **rate of chemical rxns.**).

A. Atomic Collision Theory:
*In order for molecules to react with one another, they must have a certain amount of energy, known as **Kinetic Energy** (the energy of motion).
**Heat* is a form of *Kinetic Energy*.
↑ Temp.; ↑Kinetic Energy; ↑# of Collisions; ↑Rate of Rxn.

Question: Why would heating up a cell in order to speed up chemical reactions (MET), be a problem in living systems?

Example Metabolic rxns:
1. Anabolism - rxns. that combine simple subs. into more complex subs.; requires energy. Synthesis rxns.
* Rxns. end in the suffux ***-genesis***
eg. building proteins from a.a's
eg. Glycogenesis: glucose + **energy(ATP) →** glycogen

2. Catabolism - rxns. that break down complex subs. into simple ones.; release energy from molecules.
*decomposition rxns.
* Rxns. end in the suffux ***-lysis***
eg. digestion of food, cellular respiration (ATP is made from the decomposition of glycogen & glucose)
eg. Glycolysis: **glycogen → glucose + energy(ATP)**

ATP - adenosine triphosphate. The molecule involved in energy exchange in the cell. "It is like money; readily available to buy cellular activity". 125 lbs/day is made;
* 7.3 kcal/1 mole of ATP
* it is not stored; must be continually synthesized.
* it couples the anabolic rxns. to the catabolic rxns.

IV. Energy(ATP) Production:
(2 important mechanisms for generating ATP)
* ATP generation - made by energy from *redox rxns*.
A. Anaerobically; not efficient. Occurs in the cytoplasm. (used in glycolysis)
(See Figure 25.3; page 955)

B. Aerobically; efficient. Occurs in the mitochondria. (used in Kreb's & ETC.)
(See Figure 25.5 & 25.6; page 957-958)

Oxidation-Reduction rxns. – (See pages 952 -953)
"an energy extraction mechanism" via the loss and gain (or transfer) of e- from one molecule to another.
* most biological redox rxns. have to do w/ the loss or gain of **hydrogen atoms and their electrons (**e-).
* redox rxns. are always coupled; that is, when one molecule is oxidized, the other is reduced. "like hand & glove"
* liberated H atoms are transferred to other molecules by coenzymes " electron shuttle busses"
2 coenzymes commonly used by the cell:
* NAD^+ … derived from vitamin B niacin
* FAD^{2+} ....derived from B_2 riboflavin
(see "redox football player" diagram)

Example rxn:
* when glucose is oxidized to CO_2

$C_6H_{12}O_6$ + NAD^+ → CO_2 + NADH (pot. energy)
(oxidized) (reduced)
loses e- gains e-

* Remember! Cells degrade nutrients from energy rich molecules(with many H atoms), to lower energy poor molecules (with fewer H atoms); ie. **$C_6H_{12}O_6$ (glucose) → CO_2**
eg. *glucose* (C_6 H_{12} O_6) is a *highly reduced* molecule, thus has a lot of potential energy to do work when it is oxidized by the cell into CO_2!!

GEE, why is glucose such a valuable molecule??

V. Carbohydrate Metabolism: "glucose metabolism" (See Figure 25.3; page 955)
* ~80% of all carbos. ingested are converted to glucose.
* the fate of glucose depends on the energy needs of the cell:
↑ energy demands by the cell; ↑ glucose breakdown

1. ATP production - glucose is the bodies preferred source for synth. of ATP.
* Glucose that is not needed by the cell for ATP synth. can enter one of the following met. pathways:

2. Amino acid synthesis (nonessential a.a's)
3. Glyco*genesis* - liver converts glucose to glycogen & stores it in liver(20%) & muscles(80%) for later demands.
(see fig 25.11, page 963)

(*insulin*-hormone)
glucose (in blood) → glycogen(stored in muscle & liver)

4. Lipo*genesis* - if liver storage is full, then liver cells & fat cells convert the glucose to adipose tissue.
5. Excretion in urine - excess glucose is released in the urine.

A. Glucose Catabolism -"breakdown" of carbos.
* requires 6 O_2 to burn one glucose molecule.
* skeletal muscle prefers to burn glucose over fat!
* oxidation of glucose is called "cellular respiration"
which involves:
glycolysis >> Kreb's cycle >> ETC

* all 3 processes (above) liberate 36 to 38 total ATP's/glucose molecule.

Cellular respiration:
* energy from glucose is used to phosphorylate ADP (add a phosphate group to ADP);
ie. ADP → ATP

$C_6H_{12}O_6 + 6O_2 + ADP \rightarrow 6CO_2 + 6H_2O + 36\text{-}38$ ATP
(complete aerobic respiration of glucose)

1. Glycolysis - "anaerobic cellular met."
* does not require O_2
* liberates 2 ATP's of the 36 to 38, and 2 pyruvic acid.

A. Pyruvic acid which has two fates:
1. lactic acid - if O_2 is scarce (anaerobic conditions)
2. acetyl Co-A - if O_2 is plentiful (aerobic conditions)
*NOTE: acetyl Co-A links glycolysis & the Kreb's cycle

2. Kreb's Cycle & ETC- "aerobic cellular met."
* requires O_2
* occurs in mitochondria
* produces the remaining 34 - 36 ATP's
** Both Kreb's (indirectly) & ETC (directly) generate the remaining 32 to 34 ATP's of the 36 to 38 ATP's/glucose molecule.

Clinical: Carbohydrate Loading
* consuming large amounts of carbs. because the liver & muscle can only store so much glycogen ~ 400 grams. It is designed to max. body stores of carbs. for athletic events.

What types of athletic events might require this??

B. Glucose Anabolism – synthesis of carbos.
Two mechanisms:
1. Glycogenolysis - converting glycogen (in the liver) back to glucose. Occurs between meals.
(see fig 25.11, page 963)

(*glucagon*-hormone)
glycogen(stored in muscle & liver) → glucose(in blood)

2. Gluconeogenesis - glucose is formed from proteins and/or lipids. Occurs when starving, or eating meals w/ few carbs.
* If intake < 50 grams/day. (See Figure 25.12, page 963)

VI. Nutritional Value for Carbos - RDA recommendations:
* Based on a total of 2000 kcal diet/day
* 50 - 60% of total kcals (1160kcal), should come from carbs.
* 10% of Carbos. should come from Dietary Fiber
* 1 gram of carbos. = 4kcal
* 290 grams/day of Carbos; 20 - 30 grams of which should be fiber (10%); ** 20% is better!
* American diet is 44 - 47% Carbos. (mostly simple sugars)
* liver(400 kcal) & muscles(1400 kcal) are major storage sites for glycogen (1800 kcal)
* almost always found in plant foods

A. Putting Carbos. to Work:
* Important for fueling the body; 6 sm. feedings/day
* carbohydrates are used by the muscle for endurance-type activity.
* If intake < 50 grams/day, the body is forced to make glucose from certain a.a's which are needed for producing proteins needed for vital tissues. Not good!

Question:
What is the above metabolic pathway called???

* *Ketosis* - results from not eating enough carbos.; causes incomplete "burning" of fats; producing ketone bodies which disrupt the acid-base balance in the ECF.
* can occur w/ diabetics..... Why?

B. Dietary Fiber: aka; crude fiber, roughage; plant cell wall.
* Polysaccharides – complex carbohydrates
* Nondigestible by human enzymes; we can't break the chemical bonds of cellulose.
* RDA = 20 - 30 grams/day; US consumes nearly half of RDA!
* O kcals; we can't break the chemical bonds of cellulose, so we can't access the energy.

2 Types of Fiber:
** Soluble fiber - dissolves or swells when in water
eg. oat, barley, legumes

** Insoluble fiber - insoluble in water; not metabolized by intestinal bacteria. eg. cellulose(plant cell wall), wheat bran, most fruits
*most foods contain a little of each fiber

C. Importance of Fiber:
1. Absorbs water & holds it into the intestine; helps to soften stools/easy elimination
* increases *peristalsis* of large intestine for regular BM's
* too little fiber causes the opposite to result.... various disorders assoc.

2. Plays a key role in preventing colon cancer.
* 2nd most deadly cancer in the US
* research suggests that potential cancer-causing molecules in the intestine are bound to the fiber & quickly eliminated in feces.
* soluble fiber can decrease blood cholesterol by binding cholesterol in the blood to fiber & then eliminated via the stool

Disorders associated w/ low fiber diets:
1. *Constipation* – can't defecate; leads to dry stools.
2. *Hemorrhoids* – blood vessels in the anal sphincter rupture.
3. *Diverticulitis* – lazy large intestines; food (like seeds) get caught in the folds (haustra) of the large intestines.
4. *Colon cancer* – toxins can build-up in the colon due to lack of bowel movements and certain diets.

C. Simple Sugars: "empty calories"
* soft drinks, baked goods, candy, sugar bowl & processed foods i.e. hostess cupcakes
* ~80 grams/day in US; or 137 lbs./person/yr.
* 10% of total carbo. kcals/day is recommended
(~10 teaspoons/day); 1 soda = 8 tsp.
NO MORE SODA SOLD IN SCHOOLS! YAH!!

Is Sugar Bad For You??
* simple sugars supply few vitamins, minerals & proteins/kcal; however, if you can afford to consume extra kcals there is nothing wrong with eating moderate amounts of simple sugars.
* nutritional anemia – iron poor blood.
* cavities – dental caries.
* obesity – simple sugars tend to replace better food choices.

VII. Lipid (triglycerides) Metabolism:
*(See Figure 25.14; page 966)
* digested into 1-glycerol & 3-fatty acids
* dissolve poorly in water (hydrophobic molecules)
* are transported in the blood by lipoproteins
* LDL's(bad; lousy), & HDL's(good; healthy)

A. Importance of Lipids:
* can be oxidized to produce ATP (like carbs)
* stored in the body in adipose tissue & liver
* used as structural molecules such as: cell membranes, lipoproteins, hormones, energy storage, insulation of heat & protection of organs.
* triglycerides are stored as an energy reserve; are used to make ATP & body stores are renewed ~ every 2 weeks

B. Lipid Catabolism: "Lipolysis"
* 98% of all energy reserve - adipose tissue
* heart muscle prefers to oxidize lipids over glucose!
* during glucose scarcity; hormones (liver) trigger the breakdown of adipose tissue to make ATP
* depending on the demand for ATP, *glycerol* can enter the glycolytic pathway...
ie. Gluconeogenesis (see Metabolic Mill)

4 things needed to Burn Fats (ie. Fatty acids):
1. *oxygen* - (beta oxidation of fatty acids)
   Note: it takes 23 O_2 molecules to burn 1 fat molecule!
2. *glucose* - (needed to produce acetyl Co-A)
   Note: it takes 6 O_2 molecules to burn 1 glucose molecule!
3. *fat* - (need the fatty acids)
4. *aerobic exercise* - on feet & should be able to talk; 15-20 min., 3-5X/week.

C. **Ketosis** - results from not eating enough carbos.; causes incomplete "burning" of fats; producing ketone bodies(acid) which disrupt the acid-base balance in the ECF.
* can occur w/ diabetics..... Why? (see page 967)

Ketogenesis – synthesis of ketone bodies; a state of "metabolic acidosis".
*The liver processes fatty acids by producing *acetyl -CoA* which then enters the Kreb's cycle for ATP synthesis.
* When excessive fats are burned incompletely, *acetyl -CoA* accumulates in the liver which is converted to **acetoacetic acid** and **acetone** (*"ketone bodies"*).

Acetyl -Co A (many) → Acetoacetic acid + Acetone (ketone bodies in the liver)

* Ketone bodies(acidic) diffuse into the blood then into the lungs.
The lungs release the acetone in the exhale → sweet breath (acetone)!
Diabetic "shock": lack of glucose delivery to the cell. The cell is forced to convert fats to glucose; "gluconeogensis". An extreme state of Ketosis occurs.

D. Lipid Anabolism: "Lipogenesis"
* Lipogenesis - liver cells & adipose cells can synthesize lipids from glucose or amino acids.
* occurs when you consume more kcals than are needed to satisfy ATP needs. ie. carbos, fats, proteins, ... all have the same fate!! *(See Figure 25.14; page 966)

VIII. Nutritional Value - RDA recs:
* Based on a total of 2000 kcal diet/day
* 1 gram of fat = 9kcal
* < 30% of total kcals (600 kcal), should come from Fats
* 65 grams/day
* US = 35 - 38% of total kcals
* US: 60% from animal sources; 40% from plant
* fats vary depending on the type & mixture of fatty acid chains attached to the glycerol backbone.

Questions:
?? What makes fats different from one another?
?? How is butter different from car wax?

A. Three Types of Fats:
1. saturated fats - no C to C double bonds;
solid @ R.T; most animal fats; few plant; longer shelf life; increase LDL cholesterol levels.
Exceptions: palm/coconut oil.

2. unsaturated fats - has one C to C double bond; liquid @ R.T; derived from plant; most plant oils, egs. canola, peanut, olive
* decrease LDL cholesterol levels,

3. polyunsaturated fats - 2 or more C to C double bonds; liquid @ R.T; derived from plant
egs. safflower, sunflower
* decreases CHD
** Omega-3 fatty acids & Omega-6 fatty acids
RDA = 1 tbls/day

** Essential fatty acids - humans can't make these;
help in immune processes, and hormone production.
* Obtain them from plant oils, or coldwater fish.
eg. linoleic acid
* Research shows that individuals who eat fish
2X/ week have lower risk of CHD
* Deficiencies of: flaky, itchy skin; diarrhea

Hydrogenation of fats - polyunsaturated fats become more saturated w/ H atoms, ie. more solid @ R.T
* increases shelf life; decreases rancidity(oxidation)
* tend to raise blood cholesterol levels as do other saturated fats; increases CHD
egs. commercially made baked goods, deep fried foods in restaurants.

* soft spread is less saturated than stick
**cis* (natural fatty acid) vs. *trans* (modified fatty acids due to hydrogenation)

*_trans_ fatty acids increase LDL's ("lousy lipoproteins")
*_trans_ fatty acids also may create _free radicals_ in the body, ie. unpaired electrons that are looking for a molecule such as DNA or the cell membranes to reduce; leads to destruction of tissues.

B. Putting Fats To Work:
* fats are the main fuel for muscles while @ rest & light activity.
* fat storage in the body is limitless
* adipocytes are energy dense; 80% fat, 20% water
* fats carry _fat-soluble vitamins_ to the small intestine
* fats give us satiety - they trigger hormones that causes the stomach to retain food longer
* provide flavor & texture to foods; "creamy foods"

C. Cholesterol: * a ringed molecule (lipid)
* RDA: 400 mg/day
* used to make sex hormones, bile, cell parts, vit. D
* made in the liver; is found in _animal-based foods_
* liver can make all the cholesterol that the body needs!
* plant products don't have cholesterol

* _Familial Hypercholesterolnemia_ - genetic predisposition to high blood cholesterol levels. This can effect young adults too because the LDL receptors on the liver cells are absent or nonfunctional, so uptake of cholesterol by the liver is slow,
ie. ↑ blood cholesterol levels.
** (watch your sat. fat intake rather than cholesterol!)

D. Transporting Fats in the Body: (see pages 964 -965)
* _Lipoproteins_ - a fat transport molecule.
* Two types of lipoproteins:
Low-Density-Lipoprotein(LDL's)- "lousy guys"
High-Density-Lipoprotein(HDL's)- "healthy guys"

* made of protein, phospholipids, & cholesterol.
* the liver coats the cholesterols & fats it makes w/ a lipoprotein coat so that it may be transported in a hydrophilic (water loving) environment. ie, blood
* once the fat in the lipoprotein is released to body cells, the remaining lipoprotein contains primarily cholesterol is a _Low-Density-Lipoprotein(LDL's)_

* LDL's in the blood are taken up by the liver

Studies show: diets low in saturated fats encourage the liver to take up the LDL's, so ….
i.e. ↓ sat. fats ; ↑ LDL uptake by the liver

* diets high in saturated fats discourage the liver to take up the LDL's, so ….
i.e. ↑ sat. fats ; ↓ LDL uptake by the liver eventually, the excess cholesterol in the LDL's is deposited on the walls of blood vessels = plaque

* _Atherosclerosis_ - hardening of the arteries due to plaque build-up.

** HDL's - produced by the liver too.
* roam the bloodstream, picking up cholesterol from dying cells & other sources; "cholesterol scavengers"
* transport the cholesterol to the liver to be excreted.
* HDL levels in the blood can closely predict the risk for premature heart disease.

Coronary Heart Disease - #1 killer in US

Studies show:
* risk for heart disease increases for individuals w/ low HDL blood levels. WHY?

** Amer. Heart Assoc. recommends:
1. reduce *saturated fats (animal fats)* < 10% of daily Kcals.
2. lower fat intake to 20% of total kcals/day; restrict total # of kcals
3. eat fats in a 1:1:1 ratio (3 types of fats; mono: poly: sat. fat)
4. increase aerobic exercise; increase LDL uptake
5. no more than 300 mg/day of cholesterol intake
6. fruits/vegies(fiber) have anti-oxidant chems. that slow LDL uptake into plaque
7. read food labels, they may be deceiving;
   eg. a beef frank advertised as only 27% fat

*** GEE WHIZ!!** **1) 4032 kcals/1 lb. of fat**
2) 416 ATP's /1 molecule of fat

* Percent Body Fat - a measure of body fat levels.
Determines obesity. Varies for age/sex
~ < 18% for men; ~ < 25% for women

IX. Protein Metabolism: "amino acid metabolism"
*(See Figure 25.15; page 968)
* proteins are made up of **amino acids(a.a's)** bonded together
* large proteins = *polypeptides*
* are not stored for future use, unlike fats & carbos
* a.a's can be oxidized for ATP synth. or to make new proteins
* excessive a.a's are converted to glucose or fat, but not an efficient pathway.

A. Importance of proteins:
* many function as enzymes
* maintains water balance between ICF & ECF
* maintains acid/base balance (ie. buffers) in ECF
* antibodies- immune system
* hormones – egs, thyroid, insulin, adrenaline
* structural = collegen, elastin, keratin
* maintenance, growth & repair of tissues(cell parts)
* ↓ protein in the diet; ↓ metabolic processes

B. Protein Catabolism:
* amino acids from catabolized proteins can be recycled in the body.
* some a.a's are reformed to make different a.a's
** if other energy sources (fat/glucose) are used up and protein intake is high.....the liver converts protein to fat (Lipogenesis) or glucose... (Gluconeogenesis)
* various a.a's can enter Kreb's cycle to make ATP(only 2-5% of total ATP made)
* excess proteins are broken down (de-aminated) by the liver and excreted as urea (urine).
*(See figure 25.14; page 976)

C. Amino Acid Pool – the body's total supply of free amino acids needed to synthesize body proteins. Even though small amounts of a.a's are lost daily in the urine, they are replaced via your diet. If not replaced, the a.a's from tissue breakdown become part of the pool, ie. tissue catabolism.

D. Protein Anabolism: * (See figure 25.15; page 968)
* synthesis of proteins from a.a's (we don't store a.a's)
* protein synth. is stimulated by growth hormones
* there are 20 a.a's total
* 11 are **essential a.a's** - we can't synth. them.
e.g. phenylalanine
* 9 are **nonessential a.a's** – we can synth. them.

Try This: Spell **ALABAMA** without any "A's"
* the A's are the essential a.a's; and ALABAMA is the nonessential a.a.; as a result, the protein (ALABAMA) is not synthesized!
* protein synthesis is limited to the # of available amino acids in the body!

E. Nitrogen Balance in the body can be determined by "tagging" the nitrogen in the diet and analyzing the urine.

3 catagories below:
1) Zero Nitrogen Balance – protein equilibrium.
$N_{in} = N_{out}$
50g = 50g
Example case: Healthy person in homeostasis
2) Positive Nitrogen Balance – more protein retained than excreted. $N_{in} > N_{out}$
50g > 25g

Example case: During growth years. Recovering from surgery. During pregnancy.

3) Negative Nitrogen Balance – more protein excreted than retained. $N_{in} < N_{out}$
50g < 60g

Example case: Anorexic individuals. Stress (stress hormone production), starvation, cancer, burn victims. During space travel there is no protein synthesis going on (effects of microgravity).

X. Nutritional Value - RDA recs (based on body mass):
* 1 gram of protein = 4kcal
* 12-15% of total kcals/day (240 kcal); 60grams/day
* 0.8 grams protein/kilogram of desirable body weight or [1.3 to 1.5 grams/kilogram for substantial gains in muscle mass] ... usually not needed!!
* Body Builder = 2-3 g protein/kg body wt./day
* Wt. Lifting = 1-2 g protein/kg body wt./day
NOTE: increases in muscle mass must include weight bearing exercise along with increased protein intake.

* The body's primary energy sources are fats & carbs..... not protein! Carbs & fats are more easily metabolized than proteins!
* animal tissue is the most *High Quality Protein*
i.e. they have all essential a.a's for humans
e.g. human breast milk is the highest quality protein!

* plant proteins are *Low Quality Protein*
i.e. they lack 1 or more essential a.a's. Soy, or beans(legumes) & grains eaten in combo. are a good source of essential a.a's. (Good meat replacement)!
* US diet is of high quality-protein; 2/3 from animal tissue!
* famine countries very low protein intake.... Why?

Protein Deficiency:
A. *Marasmus* - extreme child starvation; muscle/fat wasting; severe kcal deficit; stunted growth
B. *Kwashiorkor* - child starvation; severe protein deficit; moderate kcal deficit

Question:
?? What might be some situations in which a person may require more protein than RDA??

1. Lacto - Ovo - Vegetarian: eat animal products
2. Vegan: eat plants only; no animal products

XI. Minerals & Vitamins: (see Table 25.5, page 983 – 985 and Vitamin/Mineral Info. on line)
* hormones are primary regulators of metabolism, but ineffective w/out proper vitamins & minerals
* Vitamins/minerals do not provide energy!

A. Mineral - an inorganic substance; metals ions which help in enzymatic rxns.; difficult to destroy.
* 4% of body wt.
* play important roles in maintaining body function
eg. calcium and muscle contraction
* most are concentrated in the skeleton
* come from both plant & animal sources
Major Minerals - 100 mg or more/day
Na, K, Cl, Ca, P, Mg, and S

Trace Minerals - 20 mg or less/day
Fe, Zn, Se, I, Cu, F, Cr, Mn, and Mo

B. Vitamins - organic molecules which serves as *coenzymes*, i.e. "e- shuttle busses"
* come from both plant & animal sources
* most can't be synth. by the body, but can be modified,
eg. carotene from carrots is converted to vit. A

* RDA's varies depending on your wt.; take supplements that contain 100-200% of RDA
RDA = Recommended Daily Allowance

RDA – is set for the average healthy adult (the minimum recommendation).
*(See Table 25.2 Vitamins & Minerals; pages 955–961)

Question:
Vitamin deficiencies may lead to disorders...like what??

* 2 catagories of Vitamins:
1. Fat soluble- A, D, E & K (growth & development rxns)
* stored in the liver & adipose tissue.
* *Hypervitaminosis* - megadosing on A, D, E & K

2. Water soluble - B(8 vit.) & C (energy yielding rxns)
* more readily excreted than fat soluble vitamins; excess ends up in the urine (expensive urine?)

C. Vitamin/Mineral Supplements - most physicians don't recommend taking supplements, except in special cases. Instead, eat a well balanced diet that includes a variety of foods.

?? What might be some special cases??

XII. Metabolism During Fasting and Starvation:
* *Fasting* – without food for hours to a few days.
* *Starvation* – without food for weeks or months.

A. Factors that determine the lifespan without food
1. H_2O – prevents dehydration. A person can live ~2 months on H_2O alone.
2. The amount of adipose tissue stored on the body. The carbo stores (glycogen) is depleted within hours, then the body turns to fat catabolism & protein catabolism i.e. "gluconeogenesis"
*Adipose & muscle tissue is used to make ATP – a "wasting away" appearance!

B. *Ketosis* occurs after many weeks of starvation
* Glucose is the 1° fuel for the brain, but it is not available so the brain uses *ketone bodies* (acetone) as fuel to a point.
* This build-up of acid causes a *metabolic acidosis* state.
* The excess acid builds up and eventually depresses the nervous system → coma and death.

XIII. Production of Body Heat and BMR: (See page 976)
Heat – energy measured in temperature (kinetic energy) and expressed in units called calories.

Body heat- is produced by the oxidation of the food
we eat. The rate at which this *heat* is produced is called metabolic rate (kcals/hour) = BMR

BMR – regulated by thyroid hormones (thyroxine)
Hyper- and *Hypo-* thyroidism; +/- 15% of normal BMR

A. Measurement of BMR (kcal/m^2/hr):
* it is measured indirectly by measuring O_2 consumption using a respirometer, i.e. to release a certain amount of heat energy (kcal) from food, the nutrient must combine with a given amount of oxygen for oxidation.

A typical conversion: uptake of 1 liter of O_2 = 4.9 kcals

B. Four conditions for body to be in *Basal State*:
1. No exercise
2. Fast for 12 hours
3. Ambient room temperature
4. Must be at rest

C. Factors that effect metabolic rate (BMR):
Exercise - ↑ strenuous exercise ; ↑ BMR 15 - 20X
Nervous system - ↑ stress ; ↑ stimulation of the sympathetic division(NE) which ↑ BMR
Hormones – ↑ NE and Epi (adrenaline), as well as
↑ thyroid hormone, testosterone and (HGrh); ↑ BMR
Body temp - ↑ body temp. ; ↑ BMR. eg. during a fever
Ingesting food - ↑ 10 – 20% (Specific Dynamic Action)
* SDA is greatest with proteins, less w/ carbs & fats
Age - ↑ age ; ↓ BMR, less growth and development
Pregnancy - ↑ BMR during pregnancy and lactation
Others – ↓ BMR; warm climates, sleep, malnutrition

XIV. Losing Weight: (See text page 986; Disorders)
* obesity can be genetic; if both parents are overwt. then you have a 80% chance of being overwt.
* overweight = 10 -20 % above desired body weight.

Question? What might be some health risks associated with being overweight or obese?

* BMI (body mass index) – a statistical indicator of potential health risks assoc. w/ being overweight and obesity. * (See text page 988)

$$\textbf{BMI} = \frac{\textbf{wt.(pounds) X 705}}{\textbf{(Height in inches)}^2}$$

A. Recommended weight loss program:
* obesity = 20-50% above desired body weight.
* recommended weight loss program:
* 1-3 lbs./week is healthy wt. loss; anything more is H_2O loss.
* minimum kcal/day: 1000-1200 kcal/day.
* don't drop below 1000 kcal/day intake.
* aerobic exercise: 3-5x per week; for 30 mins.
* see behavioral modification techniques.

B. Behavior Modifications for Weight Loss & Maintenance
1. Don't shop for food when you're hungry.
2. Eat your meals on a smaller plate 6" not 10" plate.
3. Put your fork down between bites. It takes your brain 20 minutes to register fullness.
4. Drink 2 glasses of water before eating.
5. Impulsive eaters - wait 10 minutes before eating it.
6. Don't eat and watch TV at the same time.
7. Keep a food or emotional diary.
8. Limit eating out. Restaurants are not mandated to follow label food laws- misleading.

Extreme cases: Morbid obesity >50%; intestinal bypass, gastric balloons.

XV. Eating Disorders: distorted self-image; "obsessive-compulsive disorders" (OCD)
* most prevalent among developed countries; esp. US
1. *Anorexia nervosa* - self-starvation
Psychological - * teenage women; overachiever * see themselves as overweight.
* have ritualistic behaviors; obsessed w/food & photos of food; food magazines, etc...

Physiological -
* chapped lips; dehydration; grow body hair (lanugo)
2. *Bulimia* - "Binge/Purge"
* throw-up or use laxatives
* Greeks & Romans practiced this; had vomitoriums
* ~ 25% of all college women in dormitory settings
* don't look like skeletons; unlike anorexic women
3. *Strict Exercise program* - disorder of the 90's to the present.
* extreme exercise regimen; burn more kcals than consume, e.g. a three hour run on a regular basis?

Historical Perspective on Body Size:
egs. Marilyn Monroe - 50's
Twiggy - 60's
Cindy Crawford - 80's
"Heroine Look" - 90's

XVII. Alcohol:
* 7 kcal/gram
* Liver metabolizes alcohol
* MEOS - group of enzymes in the liver that are expended (used up) when you drink alcohol
* Average person's liver metabolizes 1 drink/hr.
* interrupts vitamin & mineral function
* destroys cell membranes & immune system
* 1 - 2 drinks/day is moderate; 1oz. of hard liquor
* for every 1 alcoholic beverage you should have a glass of water!

Study on Okinawa Japan Population:
* ave. life expectancy is 100 yrs. old
* calorie restricted diets (<1700 kcals/day)
* exercise the body & mind everyday!
* 6 glasses of water/day and,
* 7 servings of fresh fruits & veggies/day
* fresh fish in the diet daily(omega 6 & 3 fatty acids)
The CRON-diet (Calorie Restriction with Optimal Nutrition) the diet targets life extension through the use of calorie restriction (< 800 kcal/day); increases longevity by 30-40%, reduces diabetes.

XVI. Weight Gain - billion $ industry
* generally hereditary (losing or gaining)
Formula for weight gain:
* lift heavy wts. ~ 10 reps. (prevents fat gain)
* eat frequently during the day
* increase fat intake to 30% (unsaturated fats; nuts/avo)
* can use high calorie liquids such as
e.g. Ensure, Nutramet, Sustacel, Exceed