NUTRITION AND METABOLISM

Introduction:

Definition of: Nutrients, Adequate Diet, Malnutrition, Nutrition, Malabsorption and Metabolism

Nutrients include:

A - CHO, Lipid, Proteins, Nucleic Acids
B - Essential Amino Acids and Essential Fatty Acids
C - Vitamins, Minerals, Water

CHO

$ Sources $ Catabolism
$ Metabolism $ (see separate handout) $ Anabolism
$ Regulation of Glucose Level
$ Requirement
$ Clinical Application: Glucose Tolerance Test

Lipid

$ Sources $ Saturated $ Unsaturated $ Essential Fatty Acids
$ Metabolism
$ Regulation
$ Requirement
$ Clinical Application: Colon Cancer

Proteins

$ Sources - Essential a.a. $ Anabolism (utilization of a.a.)
$ Metabolism $ Deamination
$ Requirements
$ Clinical Application: Nitrogen Balance

Vitamins

Fat Soluble
Water Soluble

Minerals

Major: Ca, P, K, S, Na, CL, Mg ($\geq 0.05\%$ of Body Weight)
Minor: Fe, Mn, Cu, I, Co, Z ($< 0.005\%$ of Body Weight)

Energy Value of Food

BMR, Factors Affecting BMR

Clinical Application: Obesity vs. Protein-Calorie Deficiency

Marasmus
Kwashiorkor
FATE OF GLUCOSE AFTER ABSORPTION

**Anabolism**
- Glucose (Blood) → Insulin → Glucose (Cell) → Phosphorylation → G6P

**Catabolism**
- Enz + Mg++

**Glycogenesis**
- Formation of glucose from sources other than CHO (e.g. amino acids, glycerol)
  - Occurs in hepatocytes
  - Helps maintaining blood sugar (homeostasis)

**Glucogenesis**
- Polymerisation of glucose to glycogen

**Glucokinase**
- (Cytoplasm)
- Fructose 6-Phosphate
- ATP → ADP
- Cellular Respiration
- ATPase
- Pyruvic Acid → ↑ ATP

**Glycolysis**
- Anaerobic phase of cellular respiration

**Glycogenolysis**
- Hydrolysis of glycogen to glucose 6 phosphate (muscle) or free glucose (liver)

**Glucuronogenesis**
- Formation of glucose from sources other than CHO (e.g. amino acids, glycerol)
  - Occurs in hepatocytes
  - Helps maintaining blood sugar (homeostasis)

**Lipogenesis**
- When blood sugar level is still ↑ after glycogenesis + catabolism. Note insulin level should be normal → stored as adipose tissue with unlimited amount (obesity)

**Glycogen**
- Glycoprotein
- Mucopolysaccharide
- 5 C sugar (Ribose, deoxyribose)
- Lactose
- Heparin
- Hyaluronic Acid

**Fat Oxidative**
- phosphorylation ↑ ↑ ATP + heat
- CO₂ + H₂O
CARBOHYDRATES

**Carbohydrates** provide the body with fuel. They are the main source of energy for training and for growth, as well as for everyday activities. During the digestive process, complex carbohydrates are broken down into glucose. Glucose circulates in the blood and is the chief source of energy for refueling liver and muscle glycogen that are used up during exercise.

A **glycemic index** is a list of foods which shows the rate at which a carbohydrate breaks down as **sugar** or **glucose** into the bloodstream. Foods with a **high glycemic index** are considered to be fast acting because they release glucose into the bloodstream quickly, causing a rapid rise in blood sugar which can **increase insulin** and ultimately result in increased fat storage. Foods with a **low glycemic index** are considered slow-acting and release glucose into the bloodstream slowly drawing forth a **minimum insulin** secretion and provide more sustained energy levels. (Refer to chart 1-A glycemic index.

Since these are energy foods, you should try to consume the higher calorie carbohydrates early in the day.

We need to eat more **natural carbohydrates**. Try to limit your consumption of **processed carbohydrates** such as…

**BREADS:** white or whole wheat bread, French bread, bagel

**PASTA:** spaghetti (white or whole wheat), macaroni

**CEREALS:** corn flakes, raisin bran, puffed rice, Special K

**SNACK FOODS:** potato chips, cakes or cookies, ice cream

**NATURAL CARBOHYDRATES ARE BASICALLY BROKEN DOWN INTO THREE (3) CATEGORIES**

**(1) SIMPLE SUGARS:** (F/Y) cause a relatively sharp rise in blood sugar which can increase insulin and ultimately result in increased fat storage. **Examples…**

**FRUITS:** apricots, bananas, dates, mangos, papaya, pineapples, raisins, watermelon, etc.

**FRUIT JUICES:** apple juice, cranberry juice, grape juice, grapefruit juice, orange juice, etc.

**LOW-FAT OR FAT-FREE DAIRIES:** ice cream, frozen yogurt, etc.

**Basic Guidelines:** 2-3 servings per day of either a low glycemic fresh fruit or a fat-free sugar-free snack food would be a better choice.
(2) **STARCHY CARBOHYRATES: (S)** supply a slow steady release of glucose into the bloodstream. Therefore, glucose from a starchy carbohydrate tends to draw forth a minimum insulin secretion and provide more sustained energy levels. **Examples:**

Oatmeal, cream of rice, grits, potatoes, yams, sweet potatoes, white rice, brown rice, corn, lima beans, kidney beans, peas, lentils and other legumes.

**Basic Guidelines:** These are your higher calorie carbohydrates and should be consumed early in the day. Two (2) servings are recommended before dinner. (1 cup or 1 medium whole equals 1 serving.)

(3) **FIBROUS CARBOHYDRATES: (V)** come from plants that contain a relatively greater amount of fiber, which slows the release of carbohydrate into the bloodstream even more. The RDA: 25-30 grams of fiber per day. **Examples…**

Asparagus, broccoli, cabbage, cauliflower, celery, spinach, green beans, zucchini, and other salad vegetables.

**Basic Guidelines:** These are your lower calorie carbohydrates and can usually be consumed throughout the day with **NO LIMITATIONS.**
## CHART 1-A

### Glycemic Index

<table>
<thead>
<tr>
<th>Glycemic Index</th>
<th>Lower Insulin Secretion</th>
<th>Moderate Inducers of Insulin</th>
<th>Rapid Inducers of Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>40% or LESS</strong></td>
<td><strong>40-60%</strong></td>
<td><strong>60-80%</strong></td>
<td><strong>80-100%</strong></td>
</tr>
<tr>
<td>Cherries</td>
<td>Oatmeal (slow-cooking)</td>
<td>Spaghetti (white)</td>
<td>White Bread</td>
</tr>
<tr>
<td>Fructose</td>
<td>Whole-grain Rye Bread</td>
<td>Spaghetti (whole wheat)</td>
<td>Grapenuts</td>
</tr>
<tr>
<td>Soy Beans</td>
<td>Apple</td>
<td>Pasta</td>
<td>Whole Wheat Bread</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>Applesauce</td>
<td>Pumpernickel Bread</td>
<td>Rolled Oats</td>
</tr>
<tr>
<td>Peanuts</td>
<td>Pears</td>
<td>All-Bran Cereal</td>
<td>Oat Bran</td>
</tr>
<tr>
<td>Rice Bran Cereal</td>
<td>Peaches</td>
<td>Orange</td>
<td>Instant Mashed Potatoes</td>
</tr>
<tr>
<td>Yogurt</td>
<td>Kidney Beans (fresh/dried)</td>
<td>Garbanzo Beans</td>
<td>Baked Potato (oven)</td>
</tr>
<tr>
<td></td>
<td>Lentils</td>
<td>Kidney Beans</td>
<td>White Rice</td>
</tr>
<tr>
<td></td>
<td>Lima Beans</td>
<td>Navy Beans</td>
<td>Brown Rice</td>
</tr>
<tr>
<td></td>
<td>Chick-Beans</td>
<td>Lactose</td>
<td>Shredded Wheat</td>
</tr>
<tr>
<td></td>
<td>Tomato Soup</td>
<td>Carrots</td>
<td>Beets</td>
</tr>
<tr>
<td></td>
<td>Peas</td>
<td>Yams</td>
<td>Dates</td>
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<tr>
<td></td>
<td>Skim Milk</td>
<td>Melons</td>
<td>Popcorn</td>
</tr>
<tr>
<td></td>
<td>Whole Milk</td>
<td>Cantalope</td>
<td>Sucrose</td>
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<tr>
<td></td>
<td></td>
<td>Blueberries</td>
<td>Corn</td>
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<tr>
<td></td>
<td></td>
<td>Strawberries</td>
<td>Banana</td>
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<td></td>
<td></td>
<td>Avocados</td>
<td>Raisins</td>
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<td></td>
<td></td>
<td>Kiwis</td>
<td>Apricots</td>
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<td></td>
<td></td>
<td>Artichokes</td>
<td>Papaya</td>
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<tr>
<td></td>
<td></td>
<td>Polaner All-Fruit Jelly</td>
<td>Mango</td>
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<tr>
<td></td>
<td></td>
<td>Grapes</td>
<td>Low-Fat Ice Cream</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Corn Chips</td>
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<td></td>
<td></td>
<td></td>
<td>Rye Crisp</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Baked Beans</td>
</tr>
</tbody>
</table>

**INSULIN:** This is an anabolic hormone secreted by the pancreas that aids the body in maintaining proper blood sugar levels and promoting glycogen storage. Insulin secretion speeds the movement of nutrients through the blood stream and into muscle for growth. When chronically elevated, as with a high-carbohydrate diet, insulin can cause you to **gain fat**. However, short burst of **insulin**, caused by consuming high-glycemic carbs, may help enhance the up-take of nutrients like creatine and glutamine by muscle cells.
**PROTEIN**

Protein makes up the structure of every cell in the body. Protein is specifically involved in the growth, repair and maintenance of cells. Protein keeps muscles healthy and firm and is made up of individual organic compounds called amino acids.

Our bodies require somewhere around 24 amino acids in order to synthesize protein for healthy muscular growth and development, healthy hair and nails, etc. All but eight (8) of these can be manufactured by the body. These eight referred to as the essential amino acids must be supplied by diet.

Protein through mechanical digestion is known to speed up your basic metabolic rate by 30%. Your basic metabolic rate is the speed at which the body burns calories while at complete rest (not sleeping). Protein is very thermic. Eating protein frequently will help increase lean tissue and burn fat.

The typically preferred sources of protein (P) are eggs, chicken, turkey, fresh fish, tuna, red meats, other animal sources and protein powders.

**Basic Guidelines:** Protein is not stored in the body. It should be consumed throughout the day over 4-6 meals. On an active workout program, you need about 0.8 to 1 gram and as high as 1.5 grams of protein per pound of lean body mass depending on your specific fitness goal just to keep yourself in a positive nitrogen balance. Nitrogen is a chemical compound derived from Protein. A positive nitrogen balance is associated with healthy muscle growth. The healthier your muscle, the better your efficiency rate of burning fat.

+NB =

<table>
<thead>
<tr>
<th>TOTAL OUNCES OF PROTEIN = ESTIMATED GRAMS OF PROTEIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four (4) XL Egg Whites = 16</td>
</tr>
<tr>
<td>Six (6) XL Egg Whites = 24</td>
</tr>
<tr>
<td>3 oz. Protein = 20</td>
</tr>
<tr>
<td>(1/4 lb.) 4 oz. Protein = 25</td>
</tr>
<tr>
<td>6 oz. Protein = 40</td>
</tr>
<tr>
<td>(1/2 lb.) 8 oz. Protein = 50</td>
</tr>
</tbody>
</table>
FAT

Fat is one of the three calorie-providing foodstuffs (along with carbohydrates and protein) and is the most concentrated source of energy in the diet, furnishing twice the calories of carbohydrates or proteins (over 9 calories per gram). The components of fat are fatty acids – saturated or unsaturated. Saturated fatty acids are generally solid at room temperature and are derived primarily from animal sources. Unsaturated fatty acids, on the other hand, are usually liquid and come from vegetables, nuts or seed sources.

**Basic Guidelines:** For balanced eating, 15-20% of your calories should come from fat depending on your goals or specific plan. However, when restricting carbohydrates, fat intake can increase because it has no affect on insulin levels. Also, when restricting carbohydrates you will control approximately 80-90% of your blood cholesterol by limiting the cholesterol made by your body. Therefore, you need not worry about dietary cholesterol from such things as egg yolk since it only contributes about 10-20% of the whole picture.

WATER

The loss of body water is the most serious consequence of profuse sweating. The amount lost through sweating depends on the severity of physical activity as well as on the environmental temperature and humidity. The most effective defense against the heat is adequate hydration, this is achieved by balancing water loss with water intake.

**SUGGESTED DAILY INTAKE:** Eight 10-ounce glasses of water per day

VITAMINS / MINERALS

**Vitamins** are essential for life and cannot be manufactured by the body. They are therefore required in the diet, but in small amounts. **The fat-soluble** vitamins, A, D, E, and K, are stored in fatty tissue and need not be supplied in the diet on a daily basis. Conversely, they are also potentially toxic, especially vitamins A and D, because they are stored and can accumulate. **Water-soluble** vitamins include vitamin C, thiamin, riboflavin, niacin, vitamin B6, folacin, vitamin B12, biotin, and pantothenic acid. Vitamin supplements should not be used to compensate for poor dietary habits.

**Minerals** are found in minute amounts in tissue, they are essential to life. Fifteen essential minerals have been identified, but there are specific recommended allowances for only seven (calcium, phosphorus, magnesium, iron, zinc, selenium, and iodine.) The major or macrominerals include calcium, potassium, magnesium, sulfur, sodium, and chloride. The trace minerals (microminerals) are iron, iodine, copper, zinc, florine, selenium, manganese, molybdenum, and chromium.

**Basic Guidelines:** To insure that all individuals receive an adequate amount of vitamins and minerals, the American Medical Association has endorsed vitamin and mineral supplementation for even apparently healthy individuals with good nutritional practices.