Macronutrients, Minerals and Vitamins
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Disclosures
• Some slides adapted from lectures by John Bagnulo, MPH, PhD

Chronic Diseases
• 7 of 10 deaths each year are from chronic diseases; CHD, cancer and CVA account for >50%
• Roughly 68% of the US population is overweight or obese
• DM is the leading cause of renal failure, lower extremity amputations and blindness among those 20-74.

http://www.cdc.gov/chronicdisease/overview/index.htm

Obesity Trends* Among U.S. Adults
BRFSS, 1989
(*BMI ≥ 30, or ~30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
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Complications of Obesity

- DM
- HTN
- CVA
- Dyslipidemia
- CVD

- Cancer
- Asthma
- OSA
- Depression
- Osteoarthritis
- Shortened life-span

Obesity Trends* Among U.S. Adults
BRFSS, 2009
(*BMI ≥30, or ~30 lbs. overweight for 5’4” person)
ALL THESE CONDITIONS ARE RELATED TO...

POOR NUTRITION!

Objectives

- Identify difference between macronutrients, minerals and vitamins
- To recognize role of key macronutrients, minerals and vitamins
- To review the most common minerals and vitamins in which patients are deficient
- Identify food sources for different macronutrients, minerals and vitamins

- Macronutrients
  - Fatty Acids and Cholesterol
  - Carbohydrates
  - Protein

- Minerals and Vitamins

- Small group exercises
Macronutrients

• Building blocks of nutrition:
  – Fatty Acids and Cholesterol
  – Proteins
  – Carbohydrates

Fatty Acids

Nomenclature

• C refers to the number of carbons
  C18 contains 18 carbons
• :0 refers to the number of double bonds
  – C18:2 contains 2 double bonds (poly)
  – number of bonds reflects ease of oxidation
• \( \omega \) refers to the place in the chain where the first double bond occurs
Types of Fatty Acids

- Saturated
- Polyunsaturated
- Monounsaturated
- Cholesterol

Saturated Fatty Acids

**Saturated Fatty Acids**

- NO double bonds
  - Can be packed together very tightly
  - Stiff and rigid structure
  - Lack of permeability can work against efficacy of cell membrane
  - Long shelf life, excellent for high temperature cooking
**Saturated Fatty Acids**

- Characteristics:
  - Resistant to oxidation
  - Decreased fluidity leads to loss of water, nutrients and electrolytes, and communication with other cells
  - Abnormal cell membrane structure leads to impaired insulin response

- Primary sources are from animal tissue (meat, milk) and tropical nuts/oils

**Polyunsaturated Fats**
Arachadonic Acids

- C20:4ω6 (long-chain)

- Used to produce eicosanoid series II (promote platelet aggregation and inflammation)

- Found in poultry and meat of animals fed a diet high in linoleic acid (corn-based)

Arachadonic Acids

- **Nutrition inhibition**
  - Phospholipase A2
    - Turmeric, Quercetin
  - Cyclooxygenase
    - Ginger, Turmeric
    - EPA, DHA
  - Lipoxygenase
    - Turmeric, Onion
    - Garlic
    - Quercetin

- **Synthetic inhibitors**
  - Phospholipase A2
    - Corticosteroids
  - Cyclooxygenase
    - NSAIDs, Acetaminophen
  - Lipoxygenase
    - Sulfasalazine


Sun J et al, Yonsei Med J, 2005
Omega 3s
DHA, EPA

- Docosahexaneoic Acid (DHA)
- Eicosapentaenoic Acid (EPA)

- Fish oils available have varying levels of ratio, usually higher on EPA, ideally DHA:EPA 1:1 (kids, pregnant women).
- Cod liver usually has good balance
- Δ6 desaturase- necessary for conversion, susceptible to etoh, meds, stress
  - Long-term depression from etoh sec/2 insufficient DHA, EPA

Adapted from the US Dietary Reference Intake Series, National Academies Press. Copyright 2008 by the National Academies of Science.
Trans Fatty Acid

- Partially or Fully Hydrogenated Oils
- Uniform texture in oil containing foods
- Long shelf life (processed foods - cookies, crackers, cakes, chips, fried foods, etc.)
- Angle in Fatty Acid is physiologically disruptive
- Blocks formation of long chain omega 3s (blocks Δ6 desaturase)

Monounsaturated Fats

Monounsaturated Fats

- Oleic Acid
  - C18:1ω9
  - Somewhat resistant to oxidative stress
  - Promote cell membrane fluidity
  - No significant influence on eicosanoid production

MUFA Sources

- Avocados
- Canola oil
- Nuts
  - almonds
  - cashews
  - pecans
  - macadamias
- Nut butters
- Olive oil
- Olives
- Peanut oil
- Sesame seeds

http://www.mayoclinic.com/health/mufas/AN02120
Monounsaturated Fats

- Aim to prioritize these kinds of fats;
  - Convenient/easy to eat
  - Resistant to oxidation but also creates fluidity of protein membrane
  - Cook with at temperatures lower than low-medium heat
Cholesterol

- Important component of cell membrane
- Necessary for hormone and bile synthesis
- Dietary cholesterol affects serum level in small % of people, saturate fat more the problem
- METHOD of cooking much more important (oxidation, high-temp cooking)
- Eggs - make sure YOLKS NOT OXIDIZED (worse scenario is powdered)
- Once oxidized creates oxysterol, which advances atherogenesis

Dietary Cholesterol

- Meta-analysis of 224 studies (>8,000 subjects) investigated relationship between diet and blood cholesterol:
  - Changes in SFA and PUFA were the best predictors of change in LDL.
  - “Changes of cholesterol had significant relation to change in LDL, but it was its joint relation with changes in SFA and PUFA that affected LDL, rather than independent effect.”


Not all fats are BAD!

Good fats (foods rich in omega-3s, monounsaturated fats) essential for maintaining cell fluidity, enhancing intercellular communication

Bad fats (saturated fats, trans fats, hydrogenated oils) lead to stiffened cell membranes, decreased intercellular communication, which is central factor in development of almost all diseases.
• Macronutrients
  – Fatty Acids and Cholesterol
  – Carbohydrates
  – Protein
• Minerals and Vitamins

Carbohydrates

Carbohydrate Classes
• Sugars
• Simple starches
• Resistant starches
• Fiber

Carbohydrates
• 99% of life is made of glucose
• Glucose arrangement determines if the carbohydrate is digestible or not; the bonds determine if nourishing or indigestible
Carbohydrates

- Simple vs resistant starches determine rate of glucose release
- Glucose release in blood stream also determined by manner of monosaccharide digestion and transport

Sugars

- Monosaccharides (glucose, fructose, galactose, etc): the unit of absorption
- Disaccharides (sucrose, lactose, maltose) require only minimal enzyme activity for digestion (unless missing enzyme like lactase, sucrase)
- Oligosaccharides (dextrose, fructooligosaccharides) minimal digestion required if they can be digested at all (i.e. FOS)

Simple starches

- High amylopectin load (branched)
- Easily hydrolyzed and therefore digested (e.g. potato)
- Cooking converts resistant starches to simple
- Contributes large amounts of glucose into blood quickly
- Leading source: white flour, white potatoes, white rice
Caloric Drinks

- Higher caloric consumption now vs 30 years ago, caloric beverages account for 50% of this increase
- 21% of total daily energy consumption in general US diet is from beverages
- Reduction in liquid calories has a more significant impact on weight loss than from solid calories.

Chen L et al, Am J Clin Nutr 2009

Caloric Drinks

- The average American adult drinks > 450 calories of sweetened beverages per day- 40% from soft drinks/fruit drinks, 20% from alcohol (> 100 calories a day)
- Satiety factor from drinks is very low- we don’t consume less food if we drink caloric drinks!
- Encourage patients to drink more WATER

Popkin B, The World is Fat, 2009

Resistant starches

- Larger amounts of amylose (so longer to digest)
- More difficult to digest, so smaller delivery of glucose to blood stream at one time
- Leading sources: beans, lentils, whole grains (oats, barley, rice), yams, sweet potatoes, and squash
Fiber

Insoluble
- Largely indigestible
- Provides digestive bulk and increases total colonic transit time
- Ideally half of fiber should be insoluble
- IOM recommends 7g/1000 kcals
- Best sources are fruit and vegetable skins and seeds, cellulose (vegetables, celery, etc.), grain brans; can see in skins and peels

Soluble
- Found in flesh of fruit, beans
- Feeds gut flora to nourish cells that line digestive system (prebiotics)
- Lubricates intestinal wall, assists with elimination
- IOM recommends 7g/1000 kcals (can go higher)
- Best sources: apples, pears, plums, watermelon, beans, lentils, barley, oats, onions, chicory, squash, pumpkin, buckwheat
• Macronutrients
  – Fatty Acids and Cholesterol
  – Carbohydrates
  – Protein

• Minerals and Vitamins

Proteins

• Made of amino acids, concentrations are what is important. Need sufficient HCl to absorb

• Signals to influence endocrine function and gene expression

• Complimentary essential amino acids do not have to be consumed at the same meal (i.e. beans and rice)

Sources

• Whey
• Eggs
• Cow’s milk, cheese
• Goat milk, cheese
• Fish
• Beef
• Chicken
• Soy
• Beans (i.e. lentils)
• Nuts/seeds
• Hemp

Murray, M ND, The Encyclopedia of Healing Foods, pg 367
Essential amino acids

- Phenylalanine
- Tryptophan
- Leucine
- Isoleucine
- Valine
- Methionine (enhances free radical formation)
- Lysine (rate-limiting step in vegetarians)
- Threonine
- Arginine*
- Histidine*

*essential in development

Protein Requirements for Lean Body Mass (LBM) and Exercise

- 1.0g/Kg LBM with less than 2 hours of exercise per week
- 1.4g/Kg LBM with 2-4 hrs of exercise each week
- 1.8g/Kg LBM with 4-6 hours per week
- 2.2 g/Kg LBM with 6-8 hrs per week
- 2.6g/Kg LBM with 10+ hrs per week

0.8 g protein/kg bw in adults and 1.0g/kg bw in kids and women (WHO recs)

Macronutrient Selection Summary

Fatty Acids and Cholesterol

- Extra virgin olive oil as the primary added fat and complement with fully formed omega 3’s (fatty coldwater fish, fish oil, cod liver oil)
- Avoid saturated fats from animal sources
- Avoid all hydrogenated oils and trans fatty acids
- Dietary cholesterol more important in how prepared

Osteoclasts activated by protein, so too much can lead to bone loss. Shifts acid-base equilibrium toward Acid state. Plant protein encourages glucagon activity.
Carbohydrate Summary

• Emphasize resistant starches (beans, fruit, squash, sweet potatoes/yams)
• Emphasize soluble fiber (think fruit and/or legumes/beans at meals!)
• Use honey or blackstrap molasses as favored sweeteners
• Avoid artificial sweeteners
• Avoid refined grains and overcooked starches
• Aim for 50 grams of fiber per day minimum, from whole food sources with 25-30 grams from soluble fiber sources

Protein Summary

• Limit animal protein
• Emphasize plant protein more (beans, lentils, nuts, seeds, hemp protein)
• Requirements are dependent upon the lean body mass of an individual and their overall physical workload