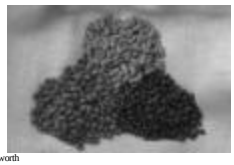
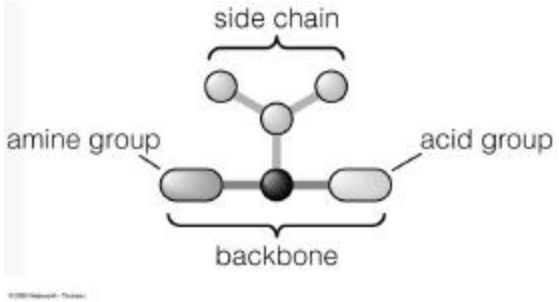
Protein

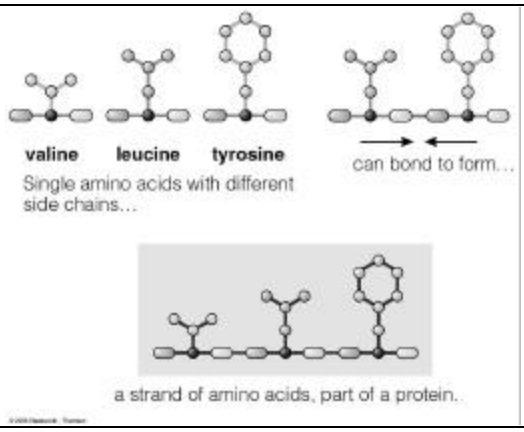
- 4 calories/gram
- Made up of amino acids
- 20 different amino acids
- Amino: nitrogen





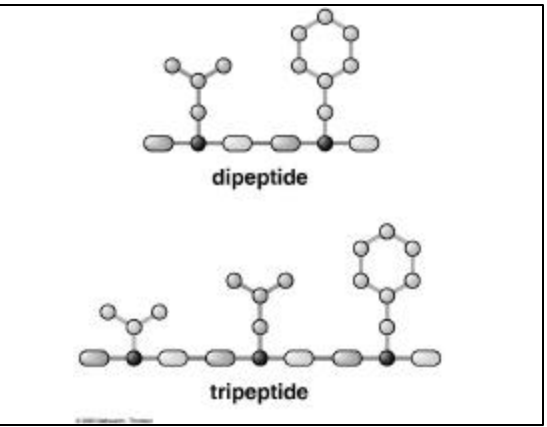
Protein

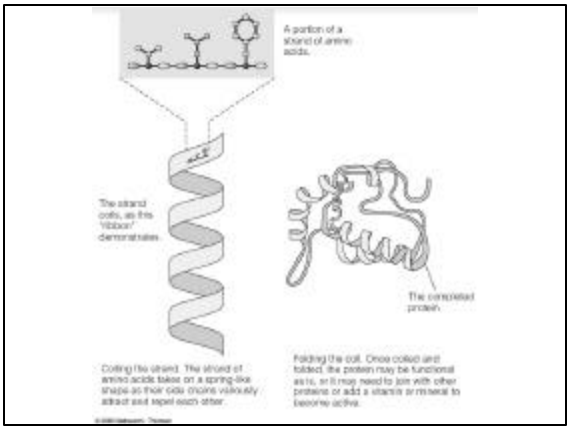
- 9 essential amino acids
  - Histidine
  - Threonine
  - Valine
  - Tryptophan
  - Isoleucine
  - Leucine
  - Lysine
  - Phenylalanine
  - Methionine

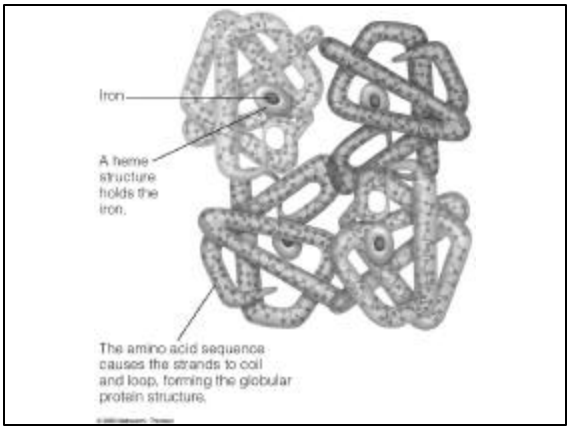


Protein

- Proteins are chains of amino acids connected by peptide bonds
  - Dipeptides, tripeptides, polypeptides
- 20 aas make infinite different proteins
- Proteins fold and coil







Protein

- Denaturing protein = unfolding
  - Heat
  - Agitation
  - Acid
  - Base
  - Alcohol

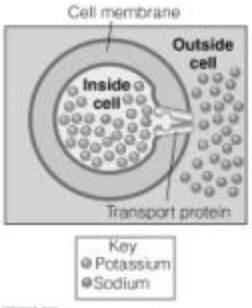
Protein in the body

- Tissues
  - Muscle, skin, connective tissue (tendons, ligaments), organs, bone, hair, nails
  - Keratin
  - Collagen
- Growth and repair
- Energy
- Enzymes
  - Lipase, lactase, etc

Protein in the body

- Hormones
  - Insulin, glucagon
- Blood clotting
- Acid-base balance in blood
- Fluid and electrolyte balance

Fluid and electrolyte balance



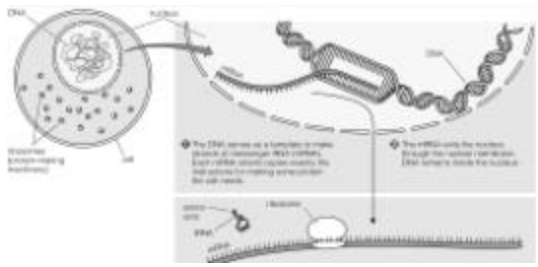
Protein in the body

- Antibodies
  - Fight off bacteria and viruses
- Melanin
- Hemoglobin

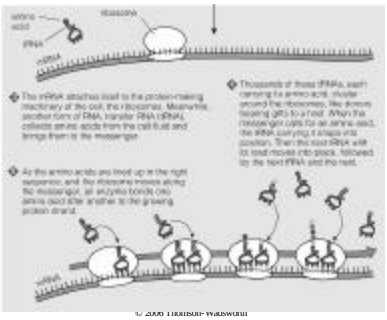
How the body makes proteins

- DNA in nucleus of each cell provides blueprints for thousands of proteins
- Cells put together amino acids in a specific sequence to make proteins (hormones, enzymes, collagen, etc.)

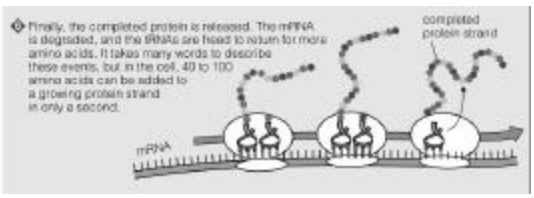
The Variety of Proteins



The Variety of Proteins

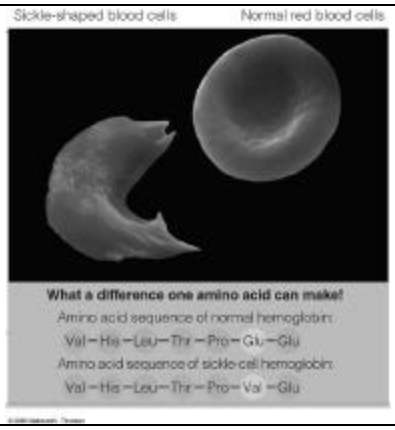


The Variety of Proteins



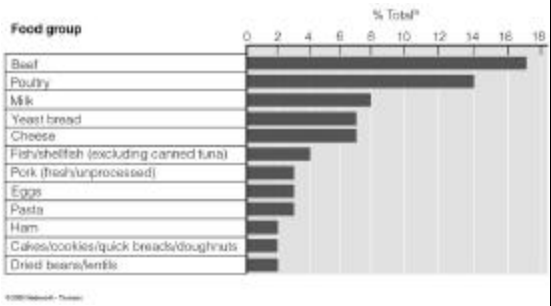
Problems in protein synthesis

- Genetic diseases can cause problems in protein synthesis, for example
- **Sickle cell anemia**
  - One amino acid is different in hemoglobin
  - Alters shape of red blood cell
  - Makes it unable to carry oxygen
  - Symptoms:
    - Abnormal blood clotting
    - Joint pain
    - Greater risk of infection



Protein in food

- DRI:
  - 10 to 35% of calories
  - 0.8 gm/kg (adults)
- Most Americans get more than enough
  - > 1 gm/kg



Sources of protein in US

Protein in food

- Sources:
  - Meat
  - Poultry
  - Fish
  - Eggs
  - Milk, cheese
  - Soy
  - Legumes
  - Grains
  - Vegetables

Protein in food

- Animal proteins
  - Generally better digested and absorbed
- Plant proteins
  - Generally less well digested and absorbed
- When you get enough protein, as most in the US do, these differences are not significant

Protein in food

- Complete protein
  - All essential amino acids
  - Animal proteins and soy
- Incomplete protein
  - Low in one or more essential aa
  - Plant proteins

Protein in food

- Limiting amino acids
- Low in grains:
  - Isoleucine
  - Lysine
- Low in legumes:
  - Methionine
  - Tryptophan

Amino Acid Composition

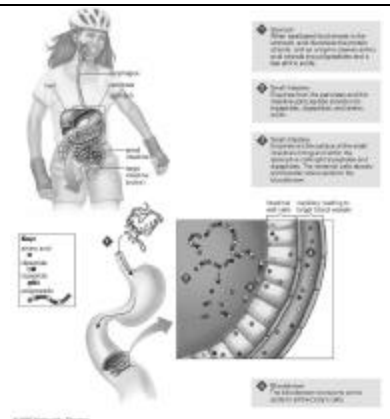
	Ile	Lys	Met	Trp
Legumes				
Grains				
Together				

Protein in food

- Complementary proteins
  - Traditional food combinations
    - Beans and rice
    - Beans and corn (tortillas)
    - Legumes and wheat (split pea soup with crackers, pasta with beans, peanut butter sandwich)
    - Small amounts of animal protein complements plant proteins (eg. Asian cuisines)

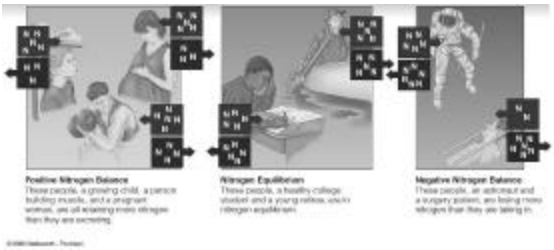
Protein digestion

- Stomach acid denatures protein
  - Pepsin enzyme begins to break it down
- Small intestine
  - Pancreatic enzymes (proteases)
  - Enzymes in villi
  - Absorbed as individual amino acids



Nitrogen balance

- Positive nitrogen balance
  - Body adding protein
  - Athletes, pregnancy, children
- Nitrogen equilibrium
  - Take in enough protein, excrete excess
  - Most adults
- Negative nitrogen balance
  - Losing protein, losing muscle
  - Starvation, anorexia, astronauts, surgery



© 2006 Thomson-Wadsworth

Protein Malnutrition

- PEM – protein energy malnutrition or PCM – protein calorie malnutrition
- Most common in children in developing countries

© 2006 Thomson-Wadsworth

Protein Malnutrition

- Marasmus
  - Chronic inadequate calories and protein
  - 'Skin and bones,' little muscle
  - Heart weakened
  - Poor growth

© 2006 Thomson-Wadsworth

Protein Malnutrition

- Marasmus
  - Affects brain development
    - Learning is impaired
  - Poor temperature regulation
  - Lethargy
  - Malabsorption
  - Infection

© 2006 Thomson-Wadsworth

Protein Malnutrition

- Kwashiorkor
  - Acute calorie and protein deprivation
  - Often in older child weaned for new baby
  - Muscle wasting, poor growth, affects brain development

© 2006 Thomson-Wadsworth

Protein Malnutrition

- Kwashiorkor
  - Edema
  - Proteins and hormones that maintain fluid balance are diminished
    - Fluids leak out of the blood and accumulate in the belly and legs
  - Enlarged belly due to fatty liver

© 2006 Thomson-Wadsworth

Protein Malnutrition

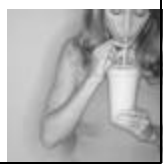
- Marasmus and kwashiorkor often overlap
- If caught in time, starvation can be reversed
  - Fluid balances are most critical
    - Electrolyte imbalances may lead to heart failure

Will extra protein build muscle?

- Adding more gas to your car won't make it go faster
- Resistance exercise builds muscle
- Some is good, more is not necessarily better

Too much protein?

- Strains kidneys, which must dispose of excess nitrogen
- Risk of dehydration
- Animal protein increases calcium loss, weakens bones
- Excess protein stored as fat



Vegetarianism

- Well-planned vegetarian diets are associated with:
  - Obesity ↓
  - Heart disease ↓
  - High blood pressure ↓
  - Cancer ↓
  - Life span ↑

Vegetarianism

- Vegetarian diets often contain more
  - Fruits, vegetables, whole grains
  - Fiber
  - Potassium
  - Phytochemicals
- And less
  - Total fat
  - Saturated fat

Vegetarianism

- Religious reasons
  - Hindu, Seventh Day Adventist, etc
- Ethical reasons
  - Not wanting to kill animals
  - Inhumane treatment of animals
  - Environment
- Health
- Occasionally, eating disorders

Vegetarianism

- Lacto-ovo
- Lacto
- Vegan
- Fruitarian
- Raw food
- Macrobiotic

Concerns for vegetarians

- Vegan children
  - Too much fiber
- Vitamin B12
  - Fermented soy foods, seaweed, supplement
- Iron
- Zinc
- Calcium
- Vitamin D
- Omega-3 fats