

The word “protein”

Derived from the Greek word *proteios*, which means “of the first rank”

Coined by Jon Berzelius
Swedish chemist

discovered that an extract of potatoes is more effective than concentrated sulfuric acid in promoting the breakdown of starch



Protein Structure

(Review)

- 1° : The linear sequence of amino acids and disulfide bonds eg. ARDV:Ala·Arg·Asp·Val.
- 2° : Local structures which include, folds, turns, α -helices and β -sheets held in place by hydrogen bonds.
- 3° : 3-D arrangement of all atoms in a single polypeptide chain.
- 4° : Arrangement of polypeptide chains into a functional protein, eg. hemoglobin.

Enzymes

- Enzymes are globular proteins which act as biological catalysts.
- Over 1500 have been isolated.
- Human genome project scientists estimate that there are about 30,000 (>100,000) enzymes in a human.
- Active (catalytic) site is a crevice which binds a substrate. Lock & key metaphorebut, protein can change conformation.
- The active site is evolutionarily conserved.

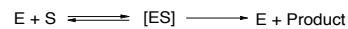
Enzymes



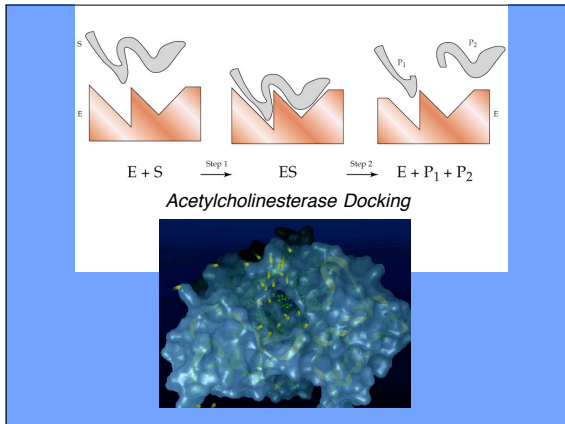
Enzyme Types: -ases

- *Oxidoreductases*
Oxidases: cytochrome p-450; Reductases
- *Transferases*: group transfer
- *Hydrolases*: hydrolysis / bond cleavage
- *Lyases*: double bonds, form or break
- *Isomerases*: isomerism, eg. R- -> S-
- *Ligases*: covalent bond formation

Enzyme Inhibitors / Effectors



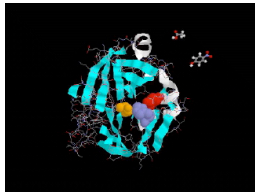
- E = Enzyme; S = Substrate
- Enzyme Activity is reduced by inhibitors.
- Four types of inhibitors:
Reversible, Irreversible, Competitive, Non-competitive
- Equilibrium Constant & Free Energy
 $K_{[ES]eq} = 10^2 \text{ to } 10^6$; Free Energies -3 to -12 kcal/mol
vs. covalent bonds -50 to -110 kcal/mol
- Effectors increase enzyme activity.



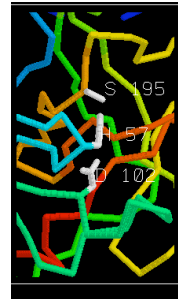
Serine Proteases

- Catalyze the hydrolysis of peptide bonds through addition-elimination mechanism common to carboxylic acid derivatives.
- Trypsin, Chymotrypsin
Pancreatic digestive enzymes
- Elastase, Kallikrein
Mammalian enzymes
- Subtilisin family
Bacterial Enzymes

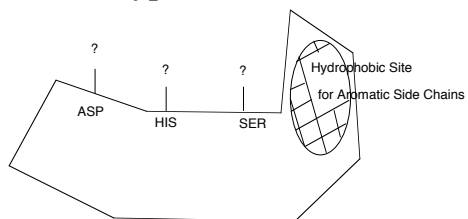
Trypsin: *Hydrolysis*



Trypsin: *Active Site Triad*

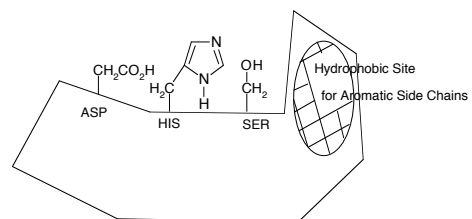


Trypsin: Active Site



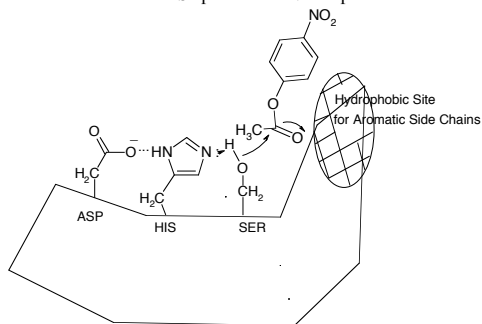
- What are the amino acid side chains?

Trypsin: Active Site



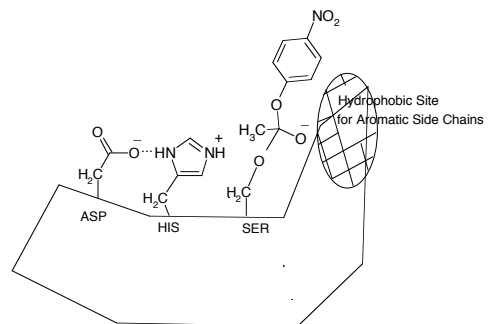
Trypsin Catalyzed Hydrolysis

Addition Step: Alcohol Nucleophile



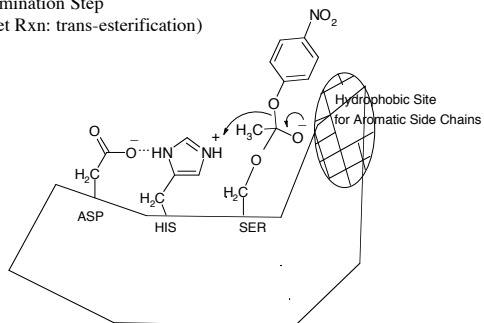
Trypsin Catalyzed Hydrolysis

Tetrahedral Intermediate



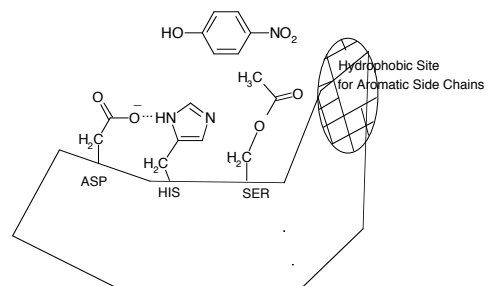
Trypsin Catalyzed Hydrolysis

Elimination Step
(Net Rxn: trans-esterification)



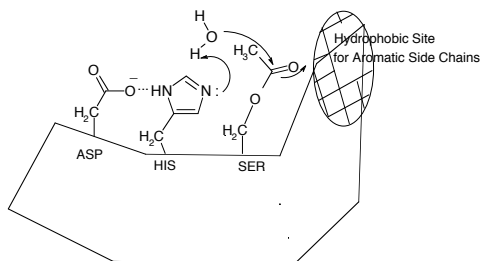
Trypsin Catalyzed Hydrolysis

Trans-esterification Products



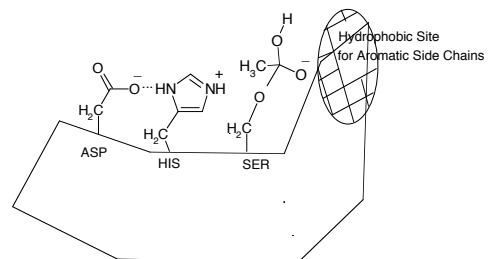
Trypsin Catalyzed Hydrolysis

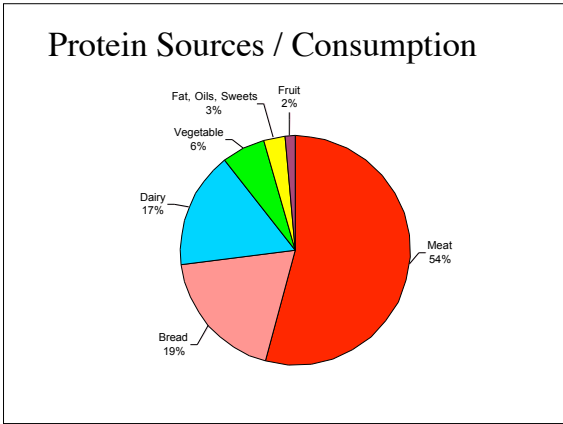
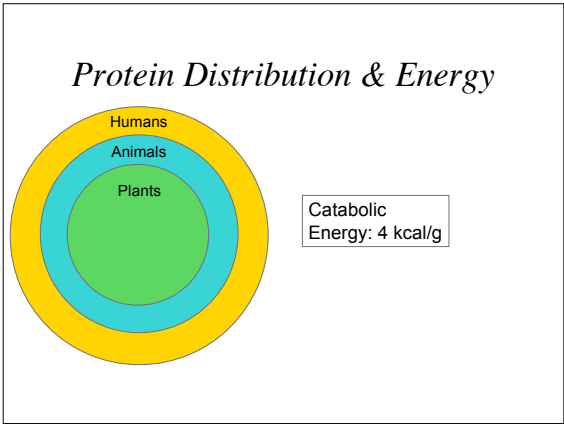
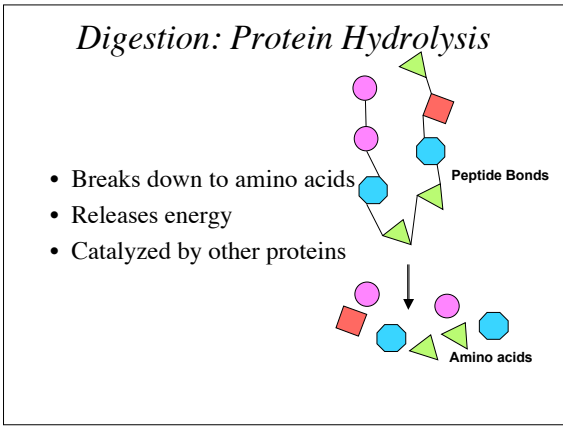
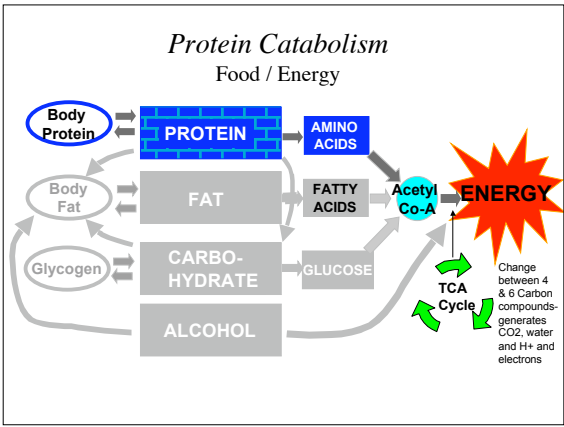
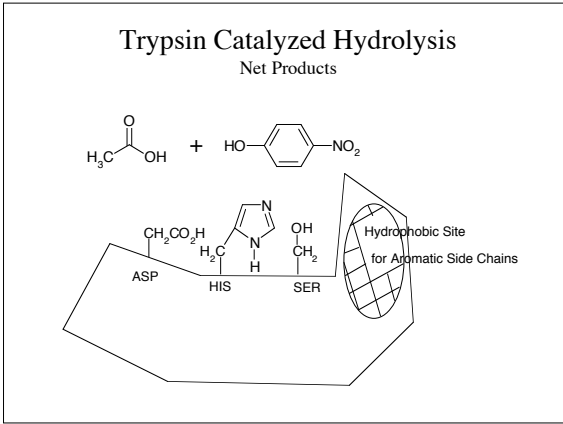
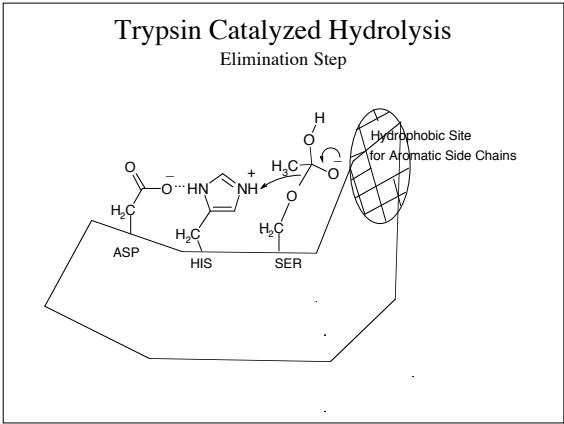
Addition Step(water as a nucleophile)



Trypsin Catalyzed Hydrolysis

Tetrahedral Intermediate (water as a nucleophile)





Protein Digestibility Corrected Amino Acid Score (PDCAAS)

Protein source	PDCAAS ^b	Takes into consideration:
Casein	1.00	• Content of essential aa
Egg white	1.00	• Digestibility
Soy protein concentrate	0.99	• Ability to supply essential aa to meet human needs
Isolated soy protein	0.92	
Beef	0.92	
Pea flour	0.69	
Kidney beans (canned)	0.68	
Rolled oats	0.57	
Lentils (canned)	0.52	
Peanut meal	0.52	
Whole wheat	0.42	
Wheat gluten	0.25	

Whey

- Milk Protein
- High in sulfur containing amino acids, which help antioxidant, anticarcinogen, and immune stimulating effects
- High concentrations of the branched chain amino acids - muscles

Composition of Whole Milk



Composition of Milk Protein



Composition of Milk Solids



<http://www.wheyoflife.org/faq.cfm#1>

Reported Whey Benefits

- Cardiovascular benefits (antihypertensive and hypocholesteremic)
- Anticarcinogenic effects
- Antibacterial and antiviral properties
- Antioxidant actions
- Immune system stimulation
- Improved bone formation/reduced bone loss
- Increased mineral absorption
- Reduction of tooth enamel demineralization and plaque formation
- Appetite suppression
- Rebuilding of muscle tissue

The Science between Protein and Sports

- In theory, amino acids could contribute to carbohydrate metabolism during exercise, but there is no hard evidence that this occurs or has any bearing on sport performance.
- Supplementation of the athlete's diet with branched-chain amino acids apparently does not benefit exercise performance.
- Maximal daily dietary protein requirements for athletes are in the range of 1.2-1.6 grams of protein per kilogram of body weight. This amount of protein can almost always be obtained in the normal diet.
- There is NO solid evidence that special mixtures of amino acids provide any advantage over normal dietary proteins in stimulating muscle growth.
- BOTTOM LINE: Exercise hard, eat right (a varied diet), rest

<http://www.gssiweb.com/reflib/refs/258/r142.cfm?pid=38>

Functions of Food Proteins

1. WATER BINDING
gelatin, non-fat dry milk solids
2. BROWNING - non enzymatic
Maillard - chemical reaction
3. STRUCTURE
gluten for bread, egg white meringue
4. SWEETENING
aspartame
5. FAT SUBSTITUTE
microsized egg protein

Functional Properties of Proteins in Food Products

- | | |
|--------------------|--------------------------------|
| Beverages | Viscosity |
| Soups, sauces | Viscosity, emulsification |
| Dough, baked goods | Matrix, gelation, browning |
| Dairy | Fat retention, Emulsification |
| Egg substitutes | Foaming, Gelation |
| Meat products | Absorption, Cohesion |
| Food coating | Cohesion |
| Confectionary | Dispersibility, emulsification |

Allergies

- Food allergens = proteins that are not broken down by the digestive tract which then cross the GI lining to enter the blood stream
- 8 foods cause 90% of all allergic reactions
 1. egg
 2. fish
 3. milk
 4. peanuts
 5. shellfish
 6. soy
 7. tree nuts
 8. Wheat (celiac/sprue)

The immune system
is involved

<http://www.foodallergy.org/index.html>