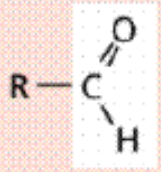
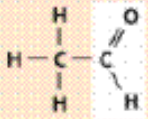
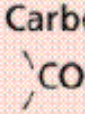
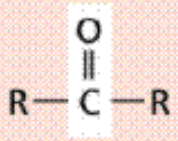
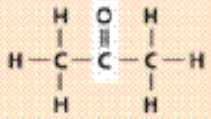
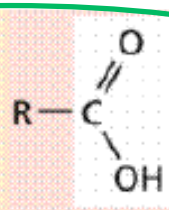
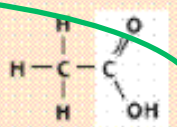
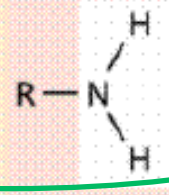
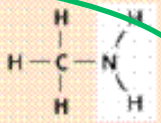
Biological Building Blocks III

Dr. James Hebda

9/16/11

Chemical Functional Group Reminder

Functional group	Class of compounds	Structural formula	Example	Ball-and-stick model
Hydroxyl –OH	Alcohols	R—OH	Ethanol	
Carbonyl –CHO	Aldehydes		Acetaldehyde	
Carbonyl 	Ketones		Acetone	
Carboxyl –COOH	Carboxylic acids		Acetic acid	
Amino –NH2	Amines		Methylamine	

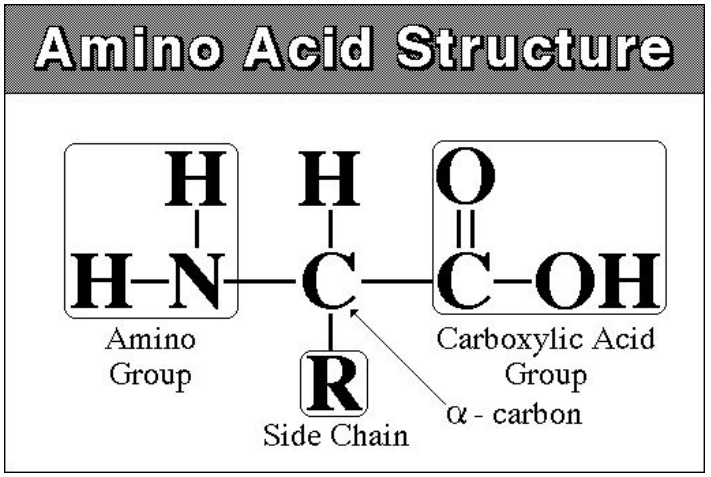
PROTEINS

Amino Acids

- Building blocks of Proteins
- Composed of two parts:
  - Backbone
  - Side-chain
- Biology employs 20 amino acids
  - Some can be modified for additional variability

Biomolecules: Amino Acid

- The general formula is
- H_2N-CHR-COOH
  - amino (H_2N----)
  - acid (----COOH)
  - ----CHR--- group varies, and gives its identity to one of 20 amino acids used in proteins



Proteins are made up of Amino Acids

- About half of the amino acids are "essential" meaning that they cannot be made by metabolic conversion from other molecules and thus need to be eaten
  - For the ten essential amino acids:
    - Threonine, Tryptophan, Valine, Arginine, Histidine, Lysine, Phenylalanine, Leucine, Isoleucine, Methionine
  - Remember this phrase:
    - **T**hese **T**en **V**aluable **A**mino Acids **H**ave **L**ong **P**reserved **L**ife **I**n **M**an
  - This means our body has the ability to make the rest of the 20 amino acids from simpler building blocks

Structures

Side chains come in 4 “flavors”

AMINO ACID	SIDE CHAIN
Aspartic acid	negative
Glutamic acid	negative
Arginine	positive
Lysine	positive
Histidine	positive
Asparagine	uncharged polar
Glutamine	uncharged polar
Serine	uncharged polar
Threonine	uncharged polar
Tyrosine	uncharged polar

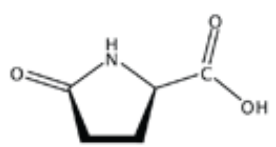
POLAR AMINO ACIDS
(hydrophilic)

AMINO ACID	SIDE CHAIN
Alanine	nonpolar
Glycine	nonpolar
Valine	nonpolar
Leucine	nonpolar
Isoleucine	nonpolar
Proline	nonpolar
Phenylalanine	nonpolar
Methionine	nonpolar
Tryptophan	nonpolar
Cysteine	nonpolar

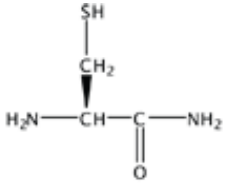
NONPOLAR AMINO ACIDS
(hydrophobic)

Amino Acids can sometimes be Modified in interesting ways

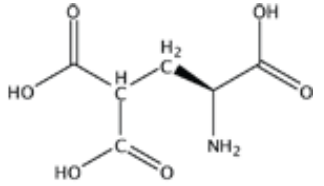
- Amino acids side groups may be further modified to have sugars, fats, other modifications
- Often these modifications are very important in changing the way the amino acid behaves



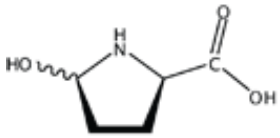
1



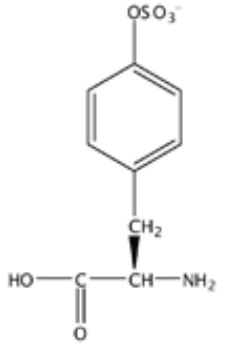
2



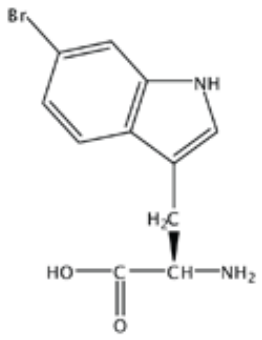
3



4



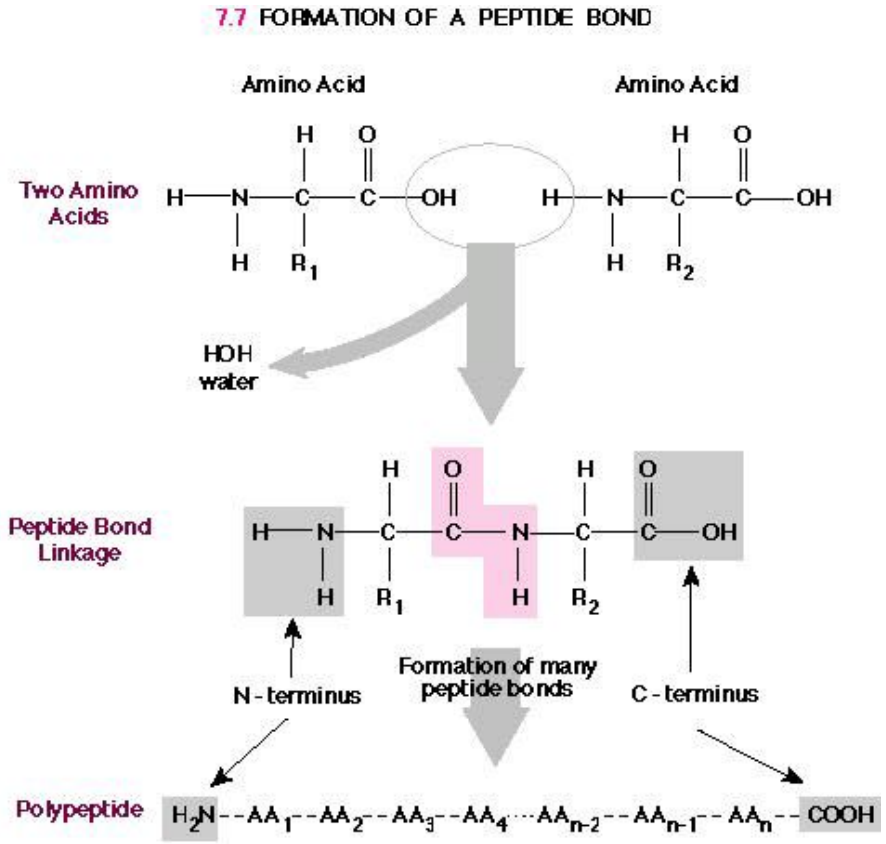
5



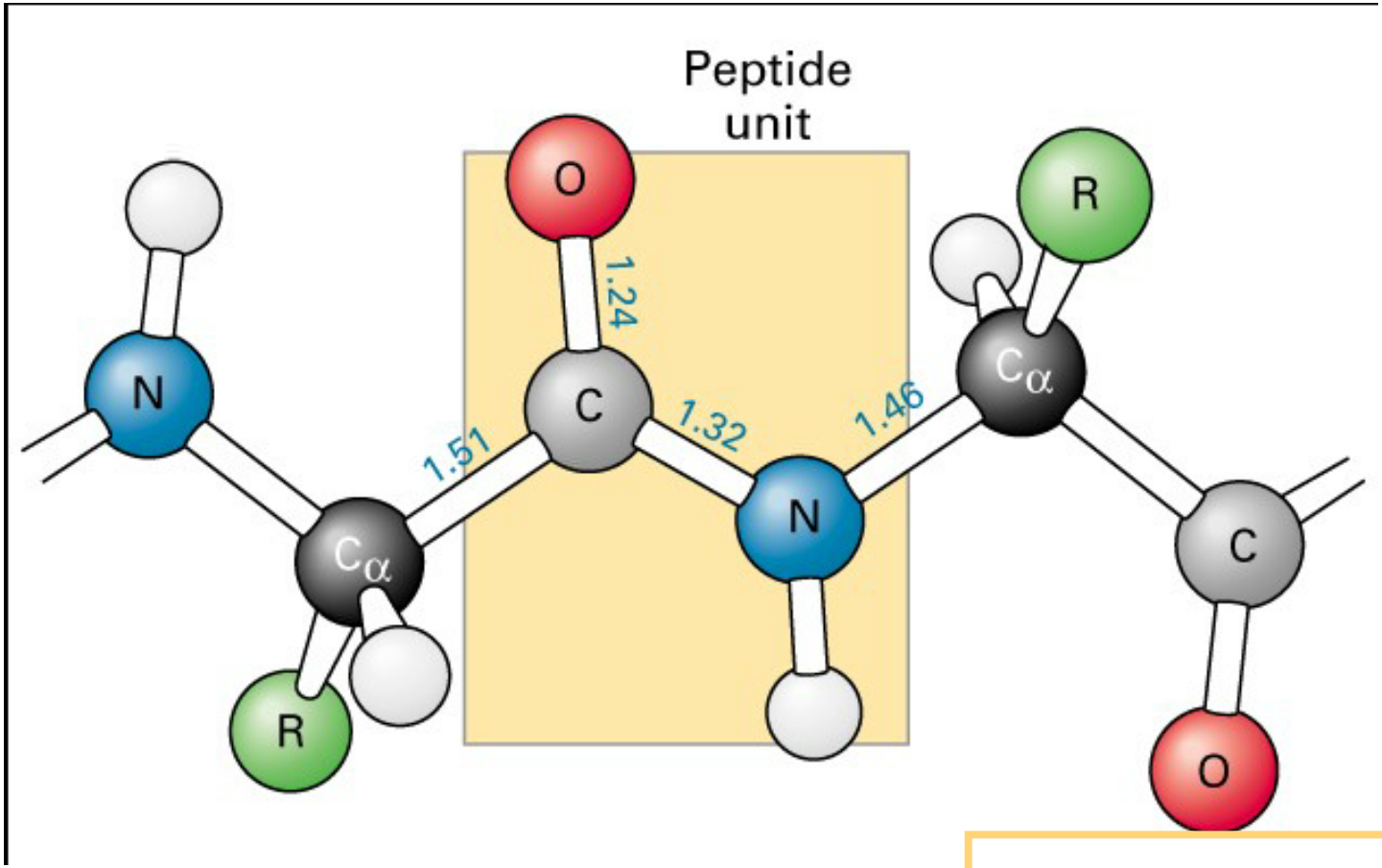
6

Amino Acids are joined together using Peptide Bonds to make Proteins

- Biologists calls this process translation, and it happens when a messenger RNA is "read" by a ribosome.
- Peptide bonds link amino acids together through -NH_2 on one amino acid and –COOH on another



Peptide Bond is Planar and rigid



* The peptide plane consists of six atoms, $C_{\alpha 1}$, C, O, N, H, $C_{\alpha 2}$

* H-N-Cα bond angle is 121°, not 109.5°.

Properties of Peptide Bond

- Barrier to Rotation about C-N bond is 20 kcal
- Peptide bond is planar with Cα groups typically trans to the peptide bond (better accommodate R groups)
- C and N are planar (2-D) and not able to rotate
- C_α groups are tetrahedral (3-D) and able to rotate though some angles are unfavorable due to steric repulsion with other atoms.
- C_α Naturally occurring amino acids are ALMOST exclusively the L stereoisomer.