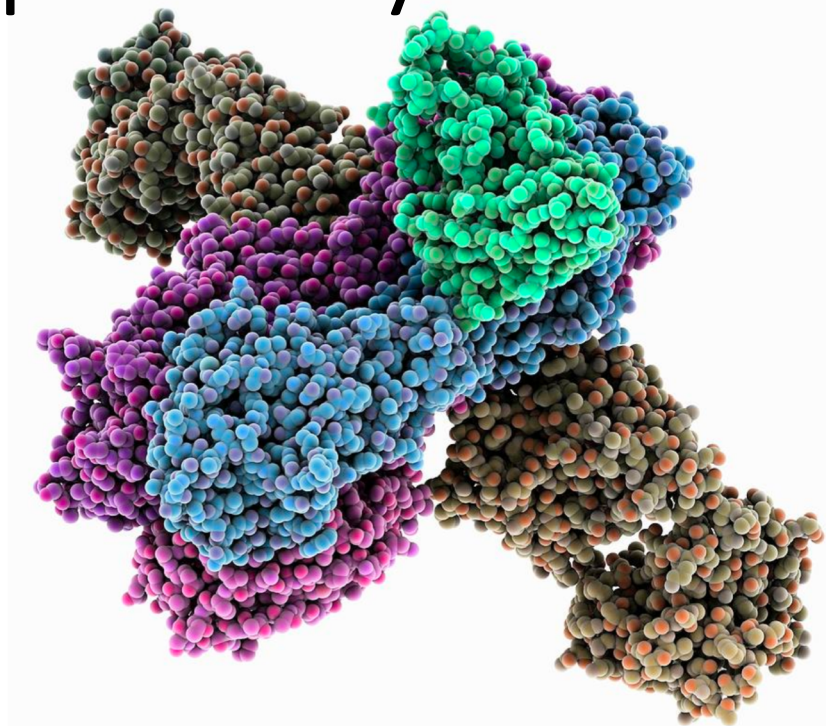


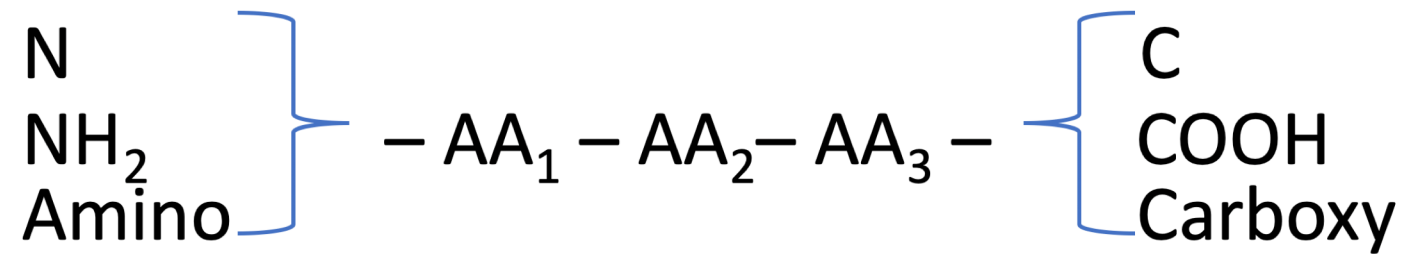
Lesson 3

Protein polarity and structure



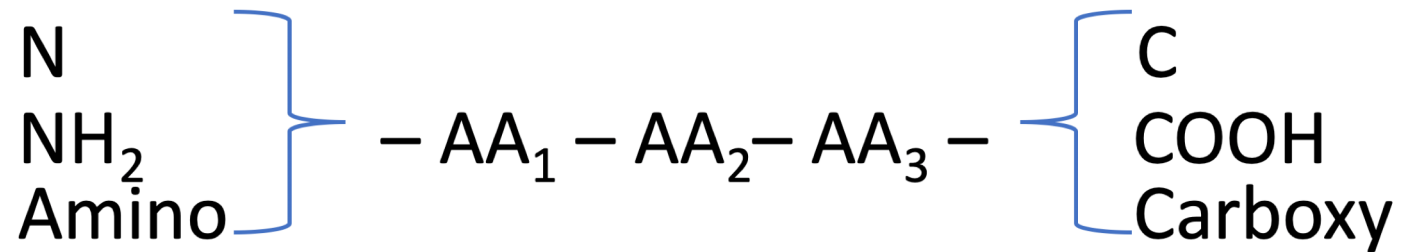
Protein polarity

- Protein = amino acid polymer

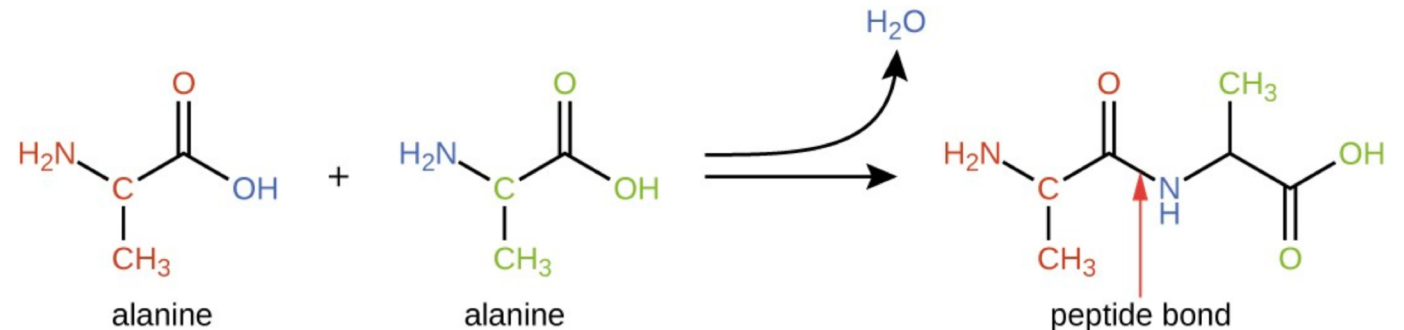


Protein polarity

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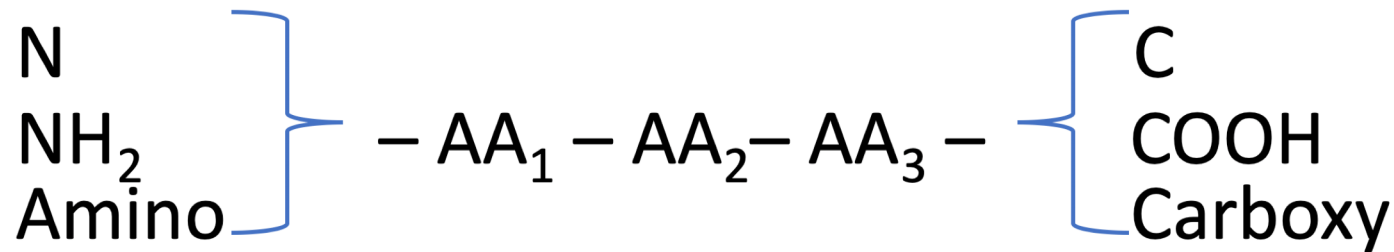


- Peptide bond = covalent bond between NH_2 of AA_n and COOH of AA_{n+1}

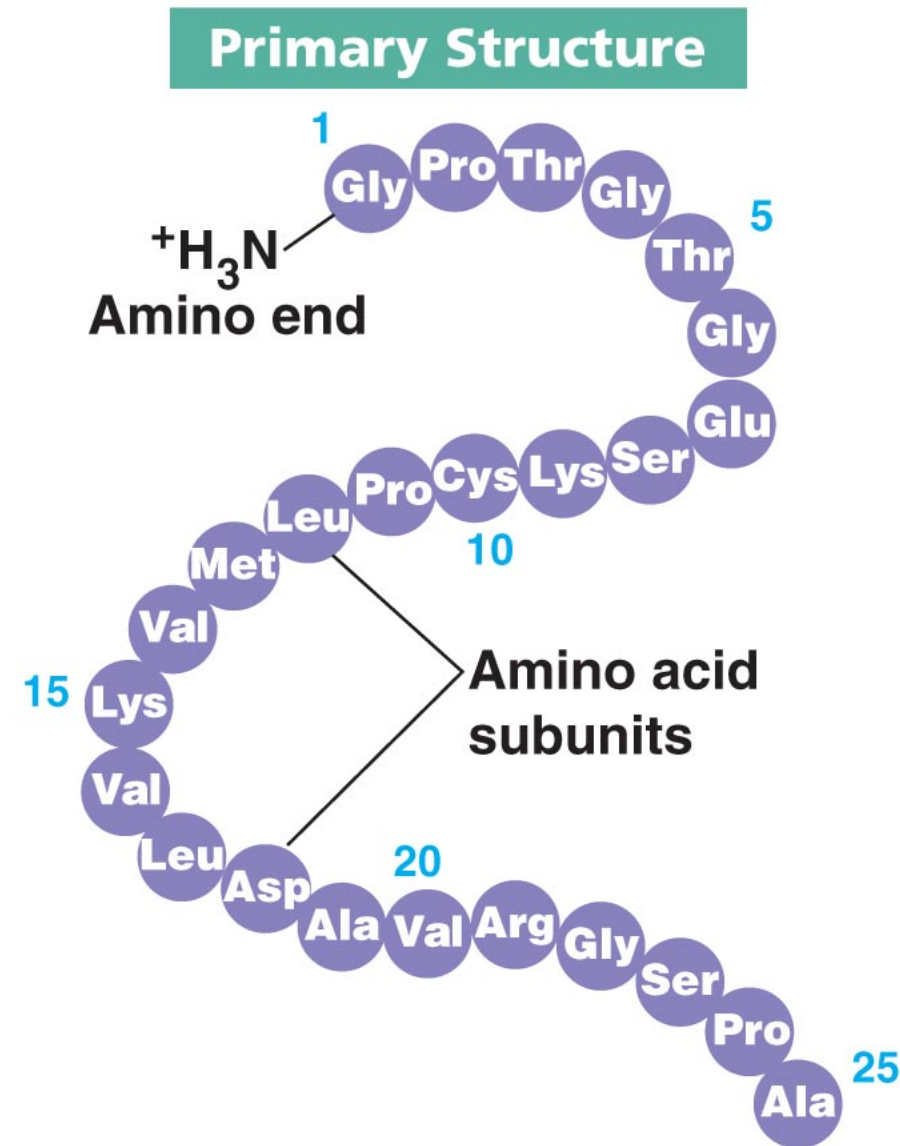


Protein polarity

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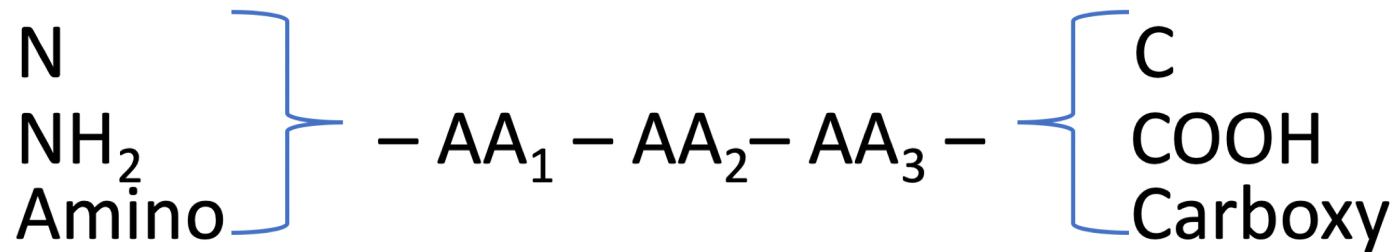


- Peptide bond = covalent bond between NH_2 of AA_n and COOH of AA_{n+1}
- **POLARITY** = amino (N) and carboxy (C) ends
- **INFORMATION** = amino acids order

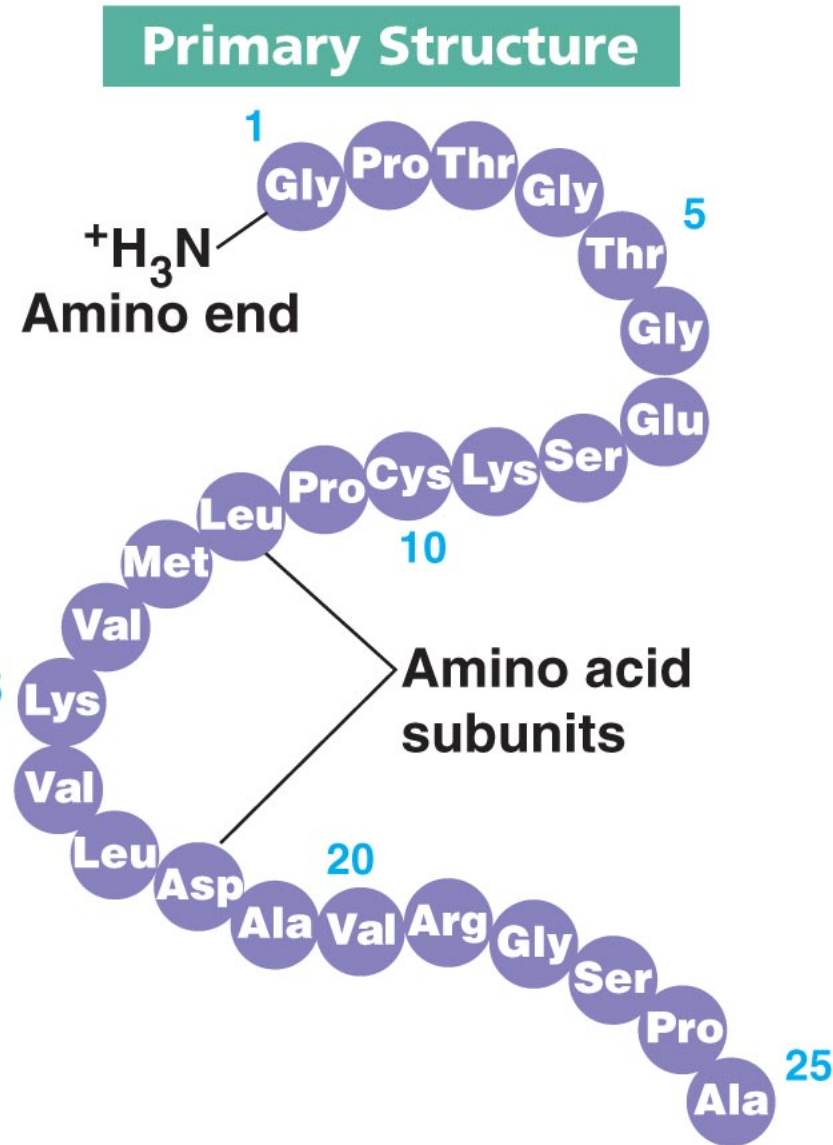


Protein polarity

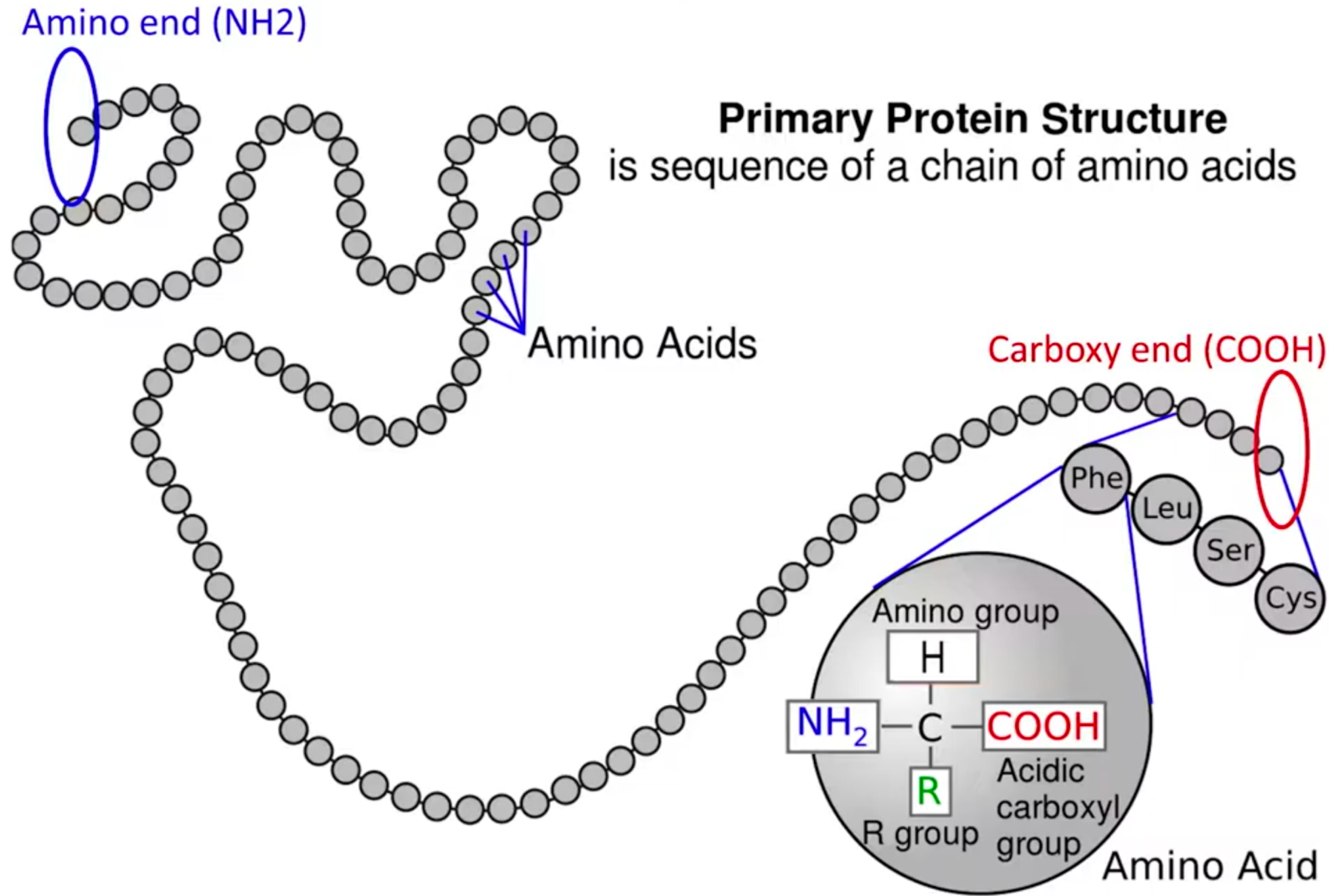
- Protein = amino acid polymer



- Peptide bond = covalent bond between NH_2 of AA_n and COOH of AA_{n+1}
- POLARITY = amino (N) and carboxy (C) ends
- INFORMATION = amino acids order
- AA_3 is the last amino acid added
- Next AA adds to COOH

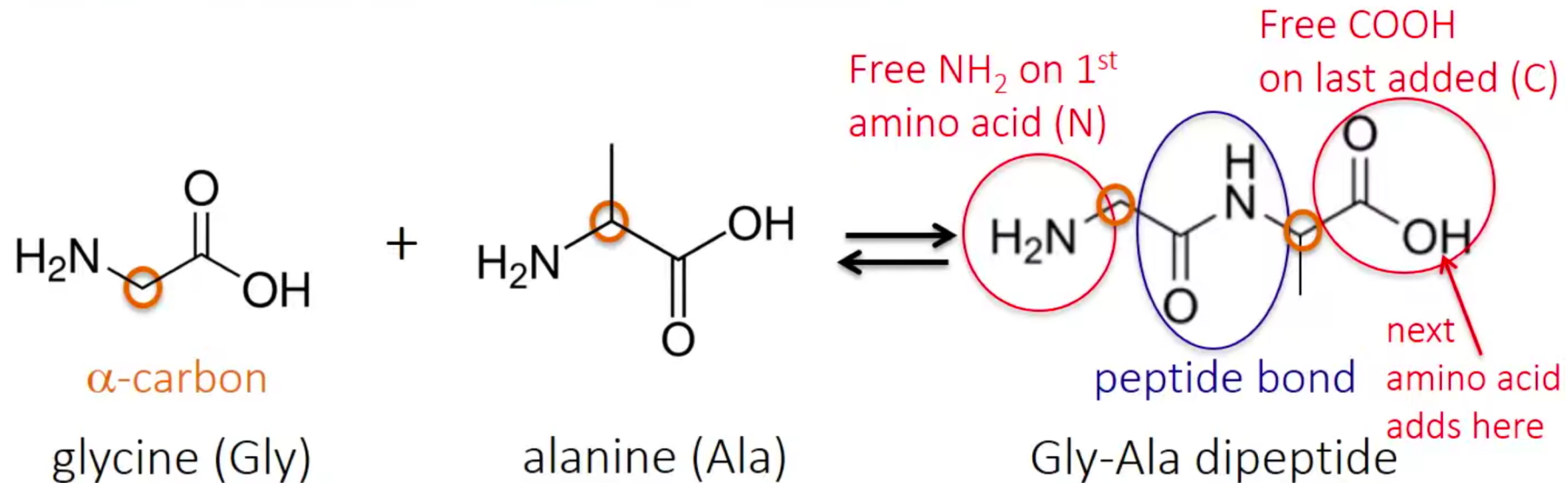


Protein polarity



Protein polarity

Protein polymer: direction and information



- Proteins are written with three or 1 letter amino acid code (e.g., VAL or V)
- **ALWAYS write N and C at the beginning and at the end of a protein sequence**

N-Gly-Ala-Val-Ser-C or NH₂-G-A-V-S-COOH

1st → last, next adds here
Polymerization direction

Protein polarity vs nucleic acid polarity

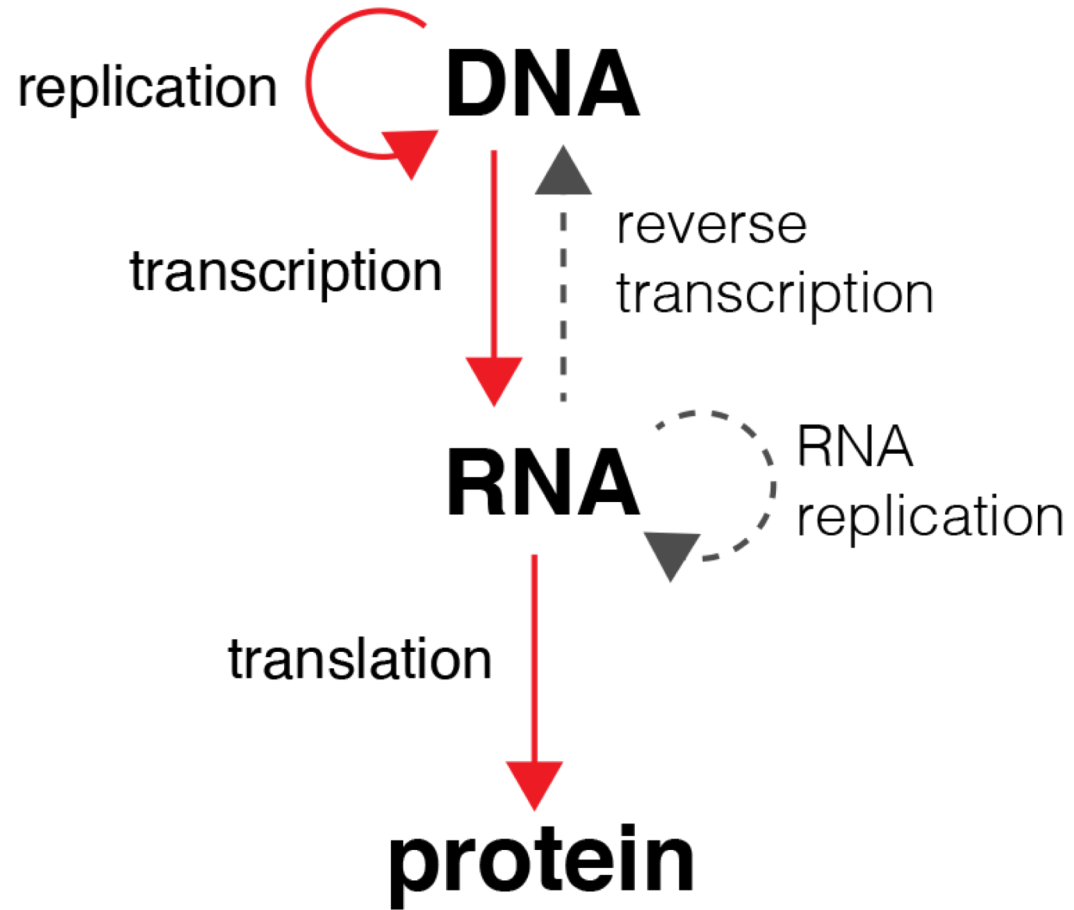
PROTEINS

- Amino acid order = INFORMATION
- Polarity = N and C ends: shows
 - First to last amino acid added
 - Direction to read information

NUCLEIC ACIDS

- Base order = INFORMATION
- Polarity = 5' and 3' ends: shows
 - First to last nucleotide added
 - Direction to read information

The central dogma of molecular biology

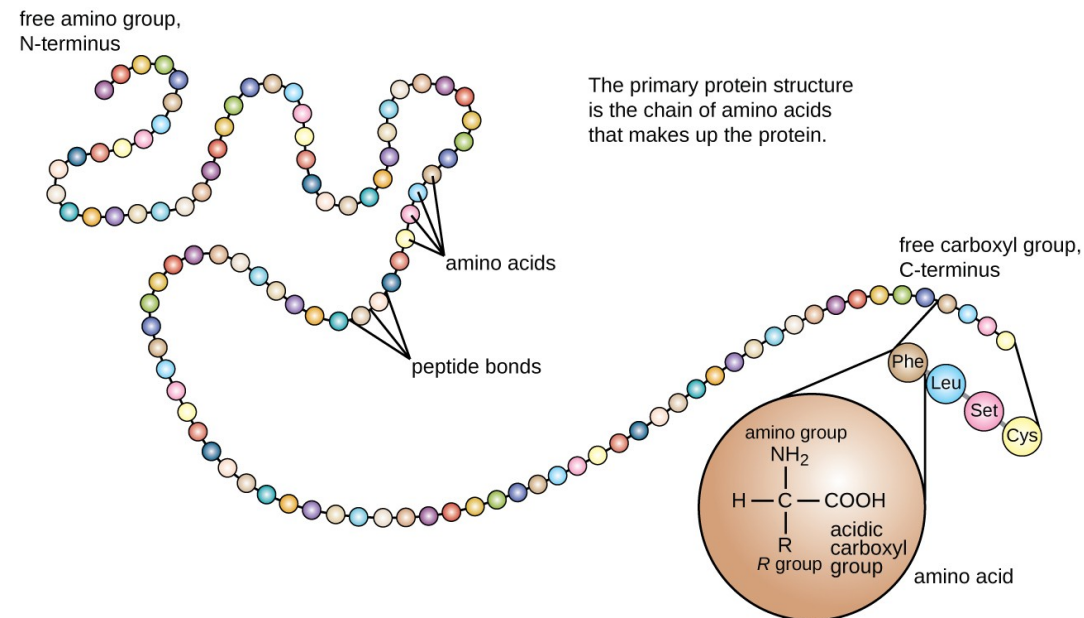


Protein structure

- Protein structure is categorized in four levels: primary, secondary, tertiary, and quaternary

Protein structure

- Protein structure is categorized in four levels: primary, secondary, tertiary, and quaternary
- The **primary structure** is simply the sequence of amino acids that make up the polypeptide chain

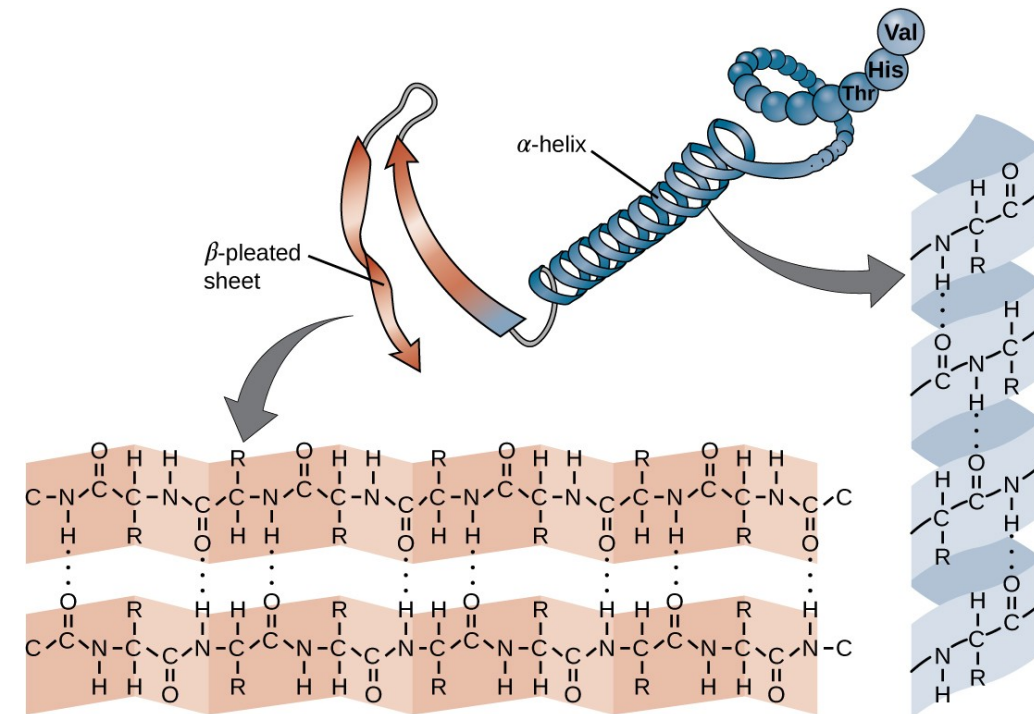


Protein structure

- The chain of amino acids that defines a protein's primary structure is flexible

Protein structure

- The chain of amino acids that defines a protein's primary structure is flexible
- When the chain is sufficiently long, H-bonds may occur between NH_2 and COOH groups along the backbone \rightarrow localized folding of chain into **helices** and **sheets**
- These shapes constitute a protein's **secondary structure**
 - the most common secondary structures are the **α -helix** and **β -pleated sheets**

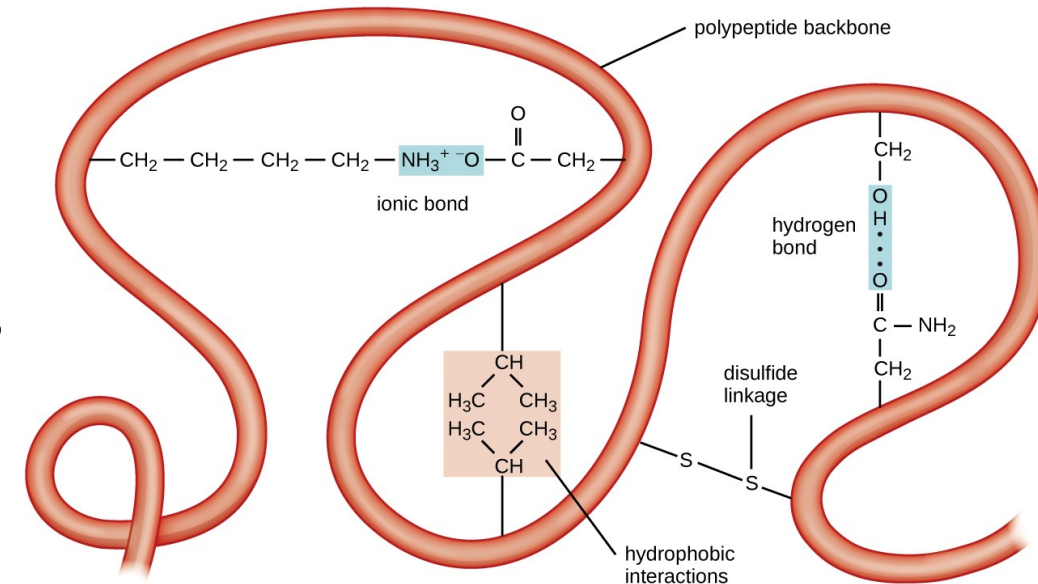


Protein structure

- The next level of protein organization is the **tertiary structure** or the large-scale three-dimensional shape of a single polypeptide chain

Protein structure

- The next level of protein organization is the **tertiary structure** or the large-scale three-dimensional shape of a single polypeptide chain
- Tertiary structure is determined by interactions between amino acid residues that are far apart in the chain:
 - disulfide bridges, which are bonds between the sulfhydryl (–SH) functional groups on amino acid side groups
 - hydrogen bonds
 - ionic bonds
 - and hydrophobic interactions between nonpolar side chains

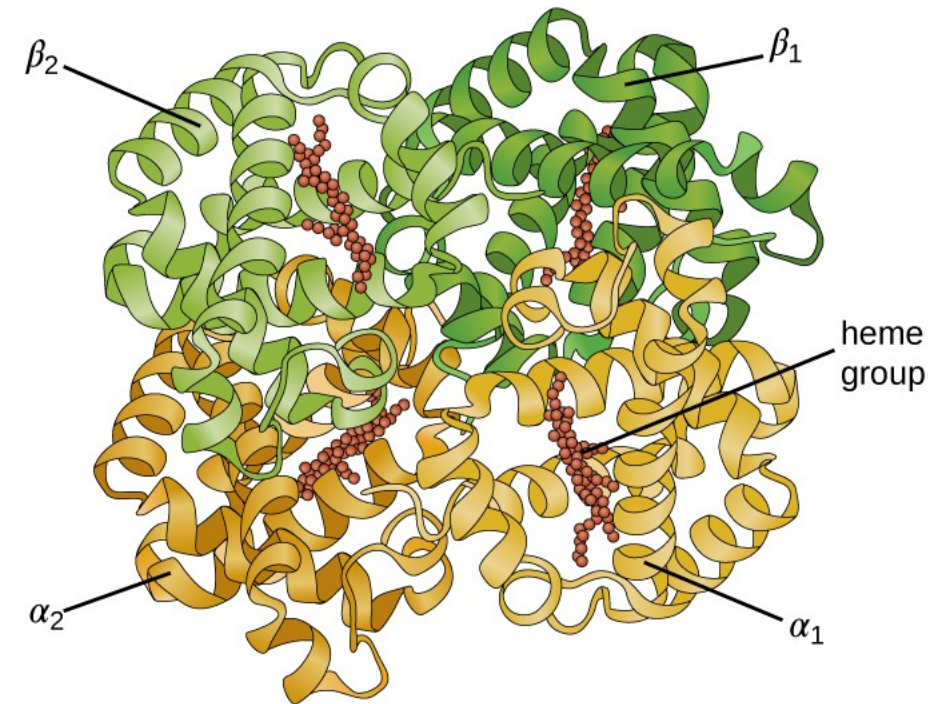


Protein structure

- Some proteins are assemblies of protein subunits
 - These proteins function adequately only when all subunits are present and appropriately configured

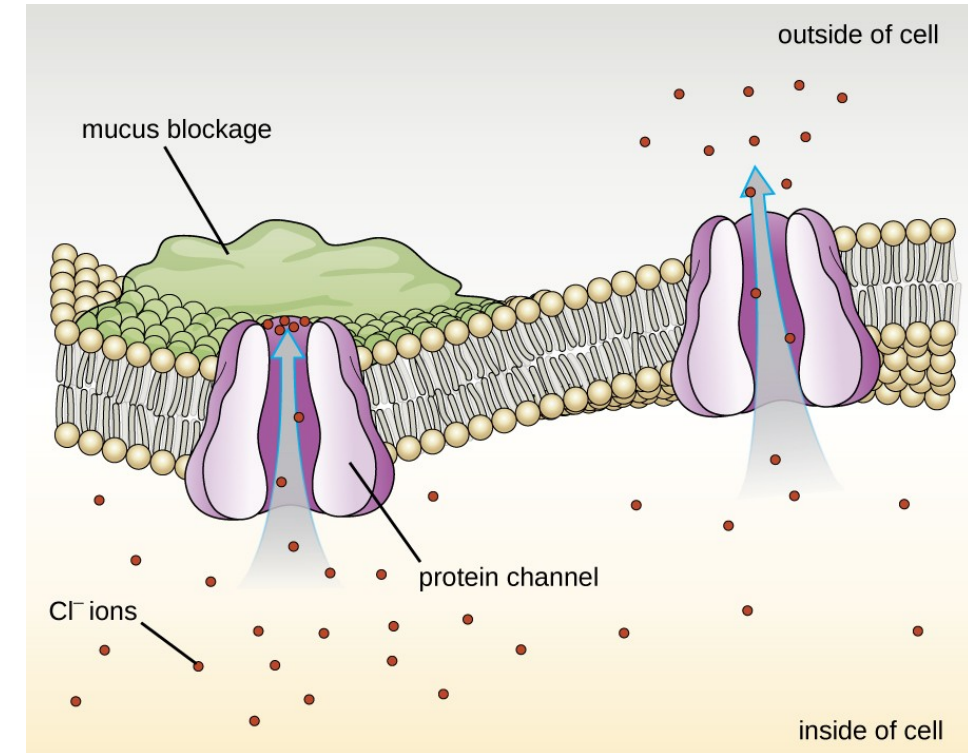
Protein structure

- Some proteins are assemblies of protein subunits
 - These proteins function adequately only when all subunits are present and appropriately configured
- The interactions that hold these subunits together constitute the **quaternary structure** of the protein
 - The overall quaternary structure is stabilized by relatively weak interactions
 - Hemoglobin is a prototypical example



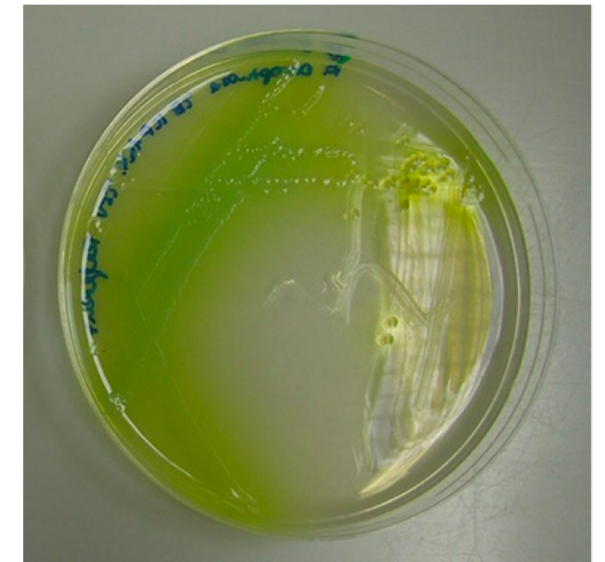
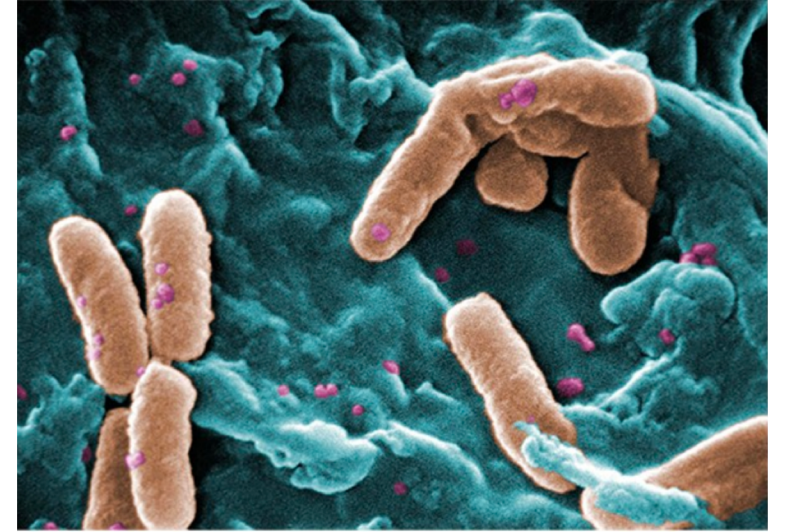
Protein structure and diseases: the CF example

- Cystic fibrosis (CF) is a human **genetic disease**
- CF affects mostly the lungs but may also pancreas, liver, kidneys, and intestine
- CF is caused by **the loss** of the amino acid **phenylalanine** in the primary sequence of the **cystic fibrosis transmembrane protein (CFTR)**
- This **MUTATION** changes the **primary structure** of **CFTR** that normally helps transport salt and water in and out of cells
- The change in the primary structure prevents the protein from functioning properly
 - the body produces unusually thick mucus that clogs
 - clog the lungs
 - obstructs the pancreas and stops natural enzymes from helping the body break down food and absorb vital nutrients



Protein structure and diseases: the CF example

- The altered CF mucus provides an environment where bacteria can thrive
- This colonization leads to the formation of **biofilms** in the small airways of the lungs
- The most common pathogens found in the lungs of patients with cystic fibrosis are *Pseudomonas aeruginosa* and *Burkholderia cepaci*
- *Pseudomonas* differentiates within the biofilm in the lung and forms large colonies, called “mucoid” *Pseudomonas*.
 - The colonies have a unique pigmentation that shows up in laboratory tests
 - provides physicians with the first clue that the patient has CF (such colonies are rare in healthy individuals)



Protein polarity and structure

- Take assignment 3: **Protein polarity and structure**