BIO213- Introduction to Quantitative Biology

INDRAPRASTHA INSTITUTE *of*
INFORMATION TECHNOLOGY **DELHI**

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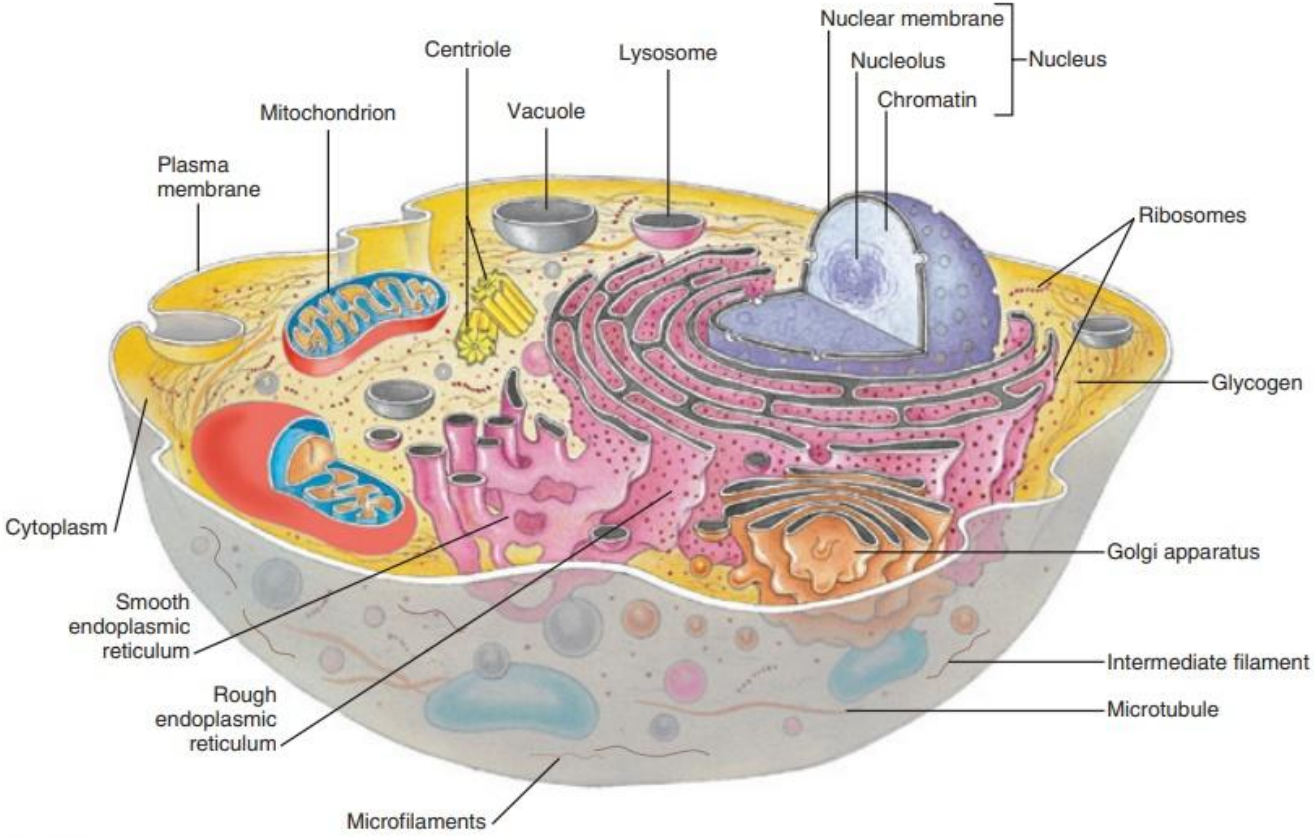
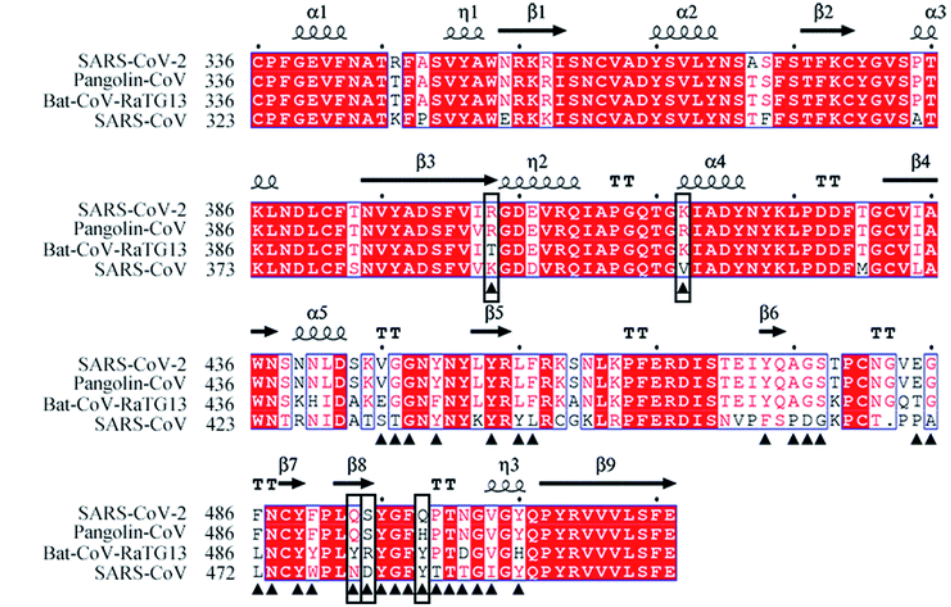
Course objectives

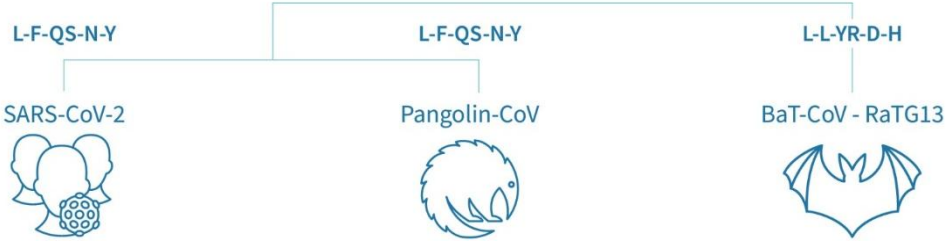
- This course will discuss some fundamental aspects of cellular and molecular biology as studied by quantitative approaches.
- In addition, you will be introduced to algorithms used for biomedical applications.
- Some simple mathematical/statistical and computational tools will be taken up to carry out quantitative analysis of biological systems.

Introduction to biology



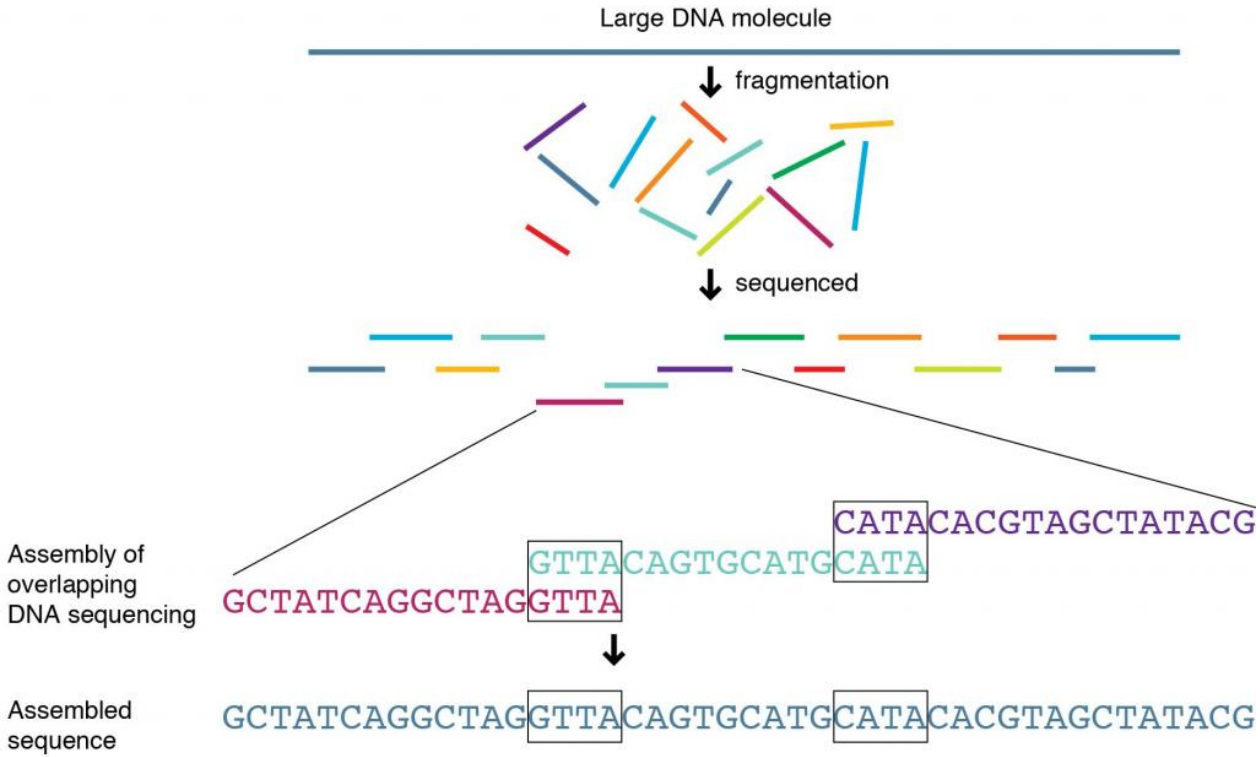
Sequence analysis



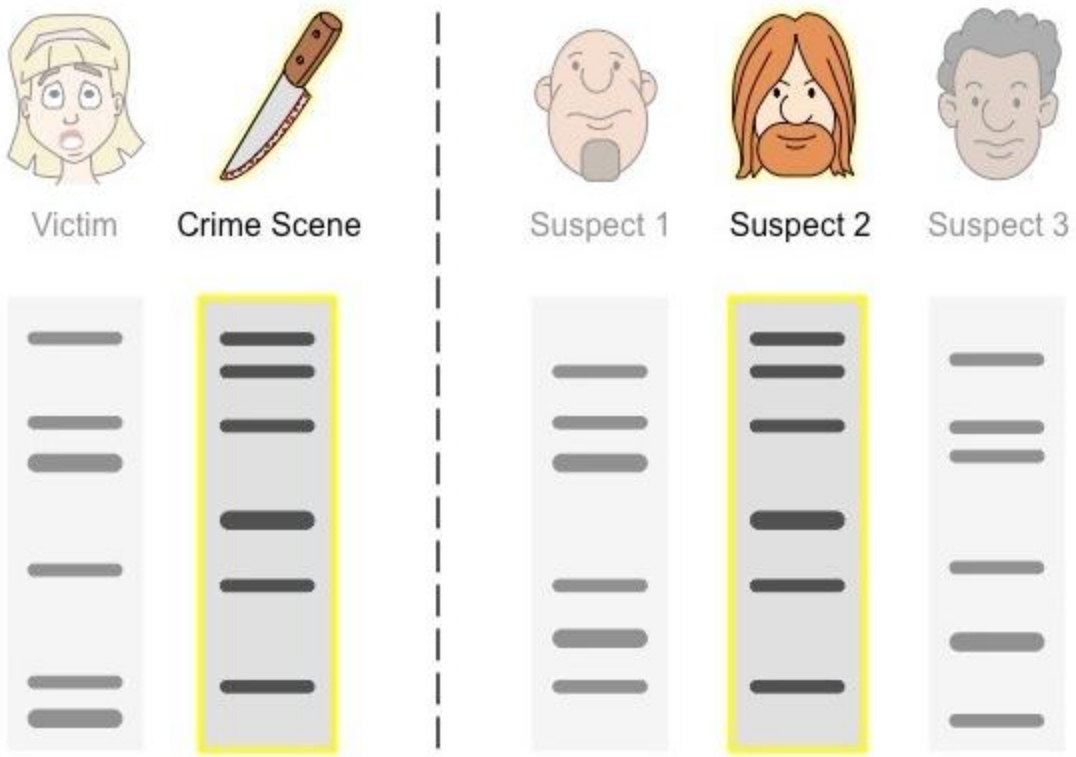


Evolution and phylogenetic analysis

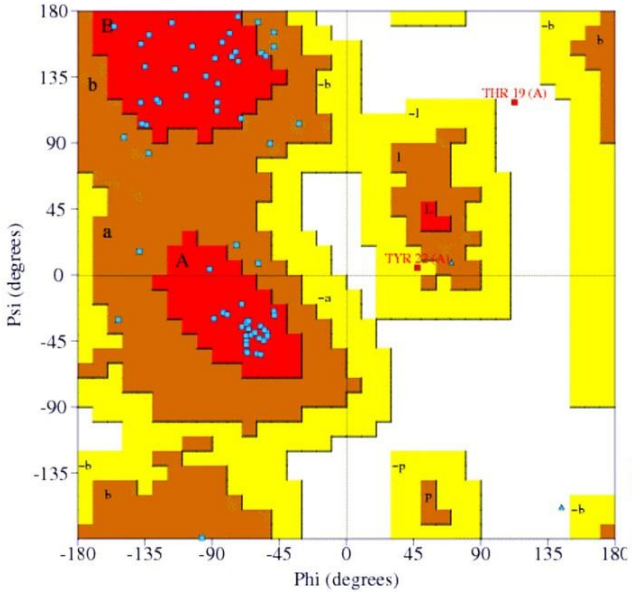
Genome sequencing and Fragment assembly

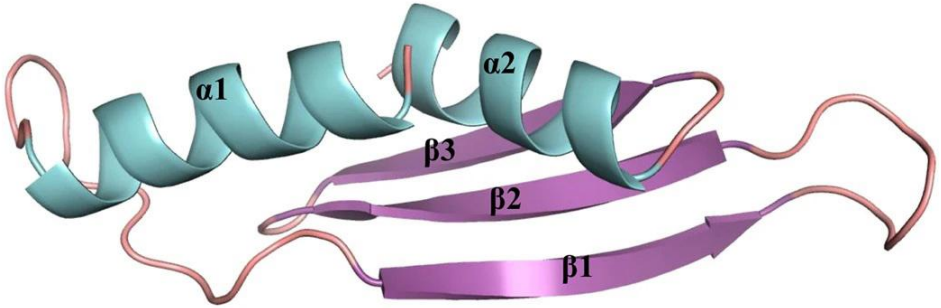


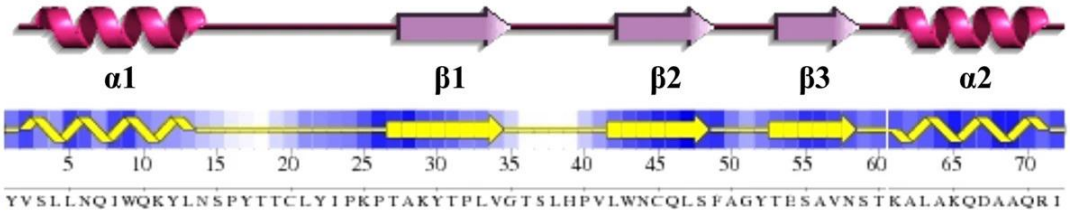
DNA fingerprinting



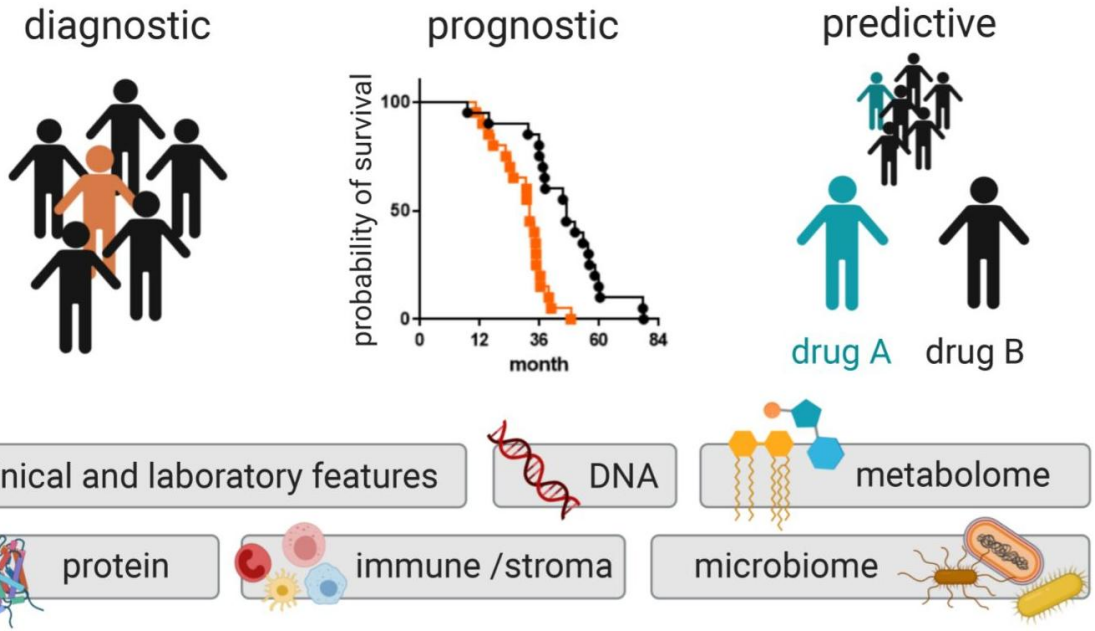
Protein structure prediction





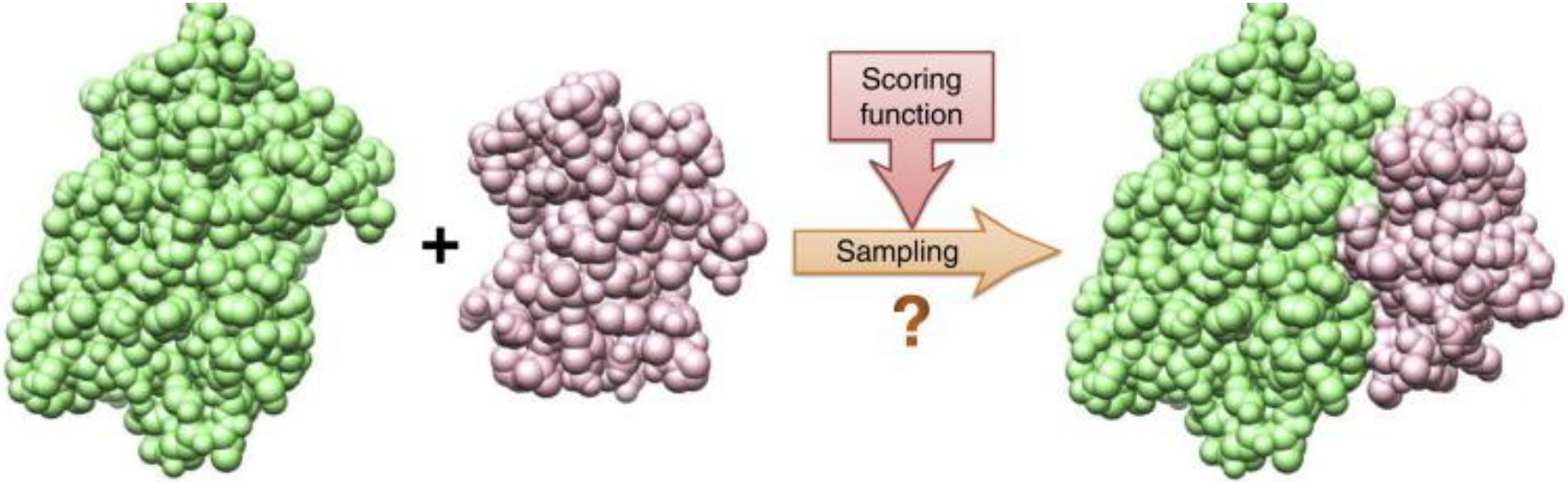


Disease diagnostics



Disease Forecasting

Interaction between biomolecules



Course structure

- Introduction to biology
- Sequence analysis
- Structural and functional annotation
- Genome sequencing
- DNA fingerprinting
- Evolution and phylogenetic analysis
- Motifs and pattern recognition
- Disease diagnostics
- Disease forecasting
- Interaction between biomolecules
- Implementation using case studies

Reference books

- *Introduction to Computational Molecular Biology (J. Setubal and J. Meidanis)*
- *Introduction to Bioinformatics Algorithms (Neil C. Jones and Pavel A. Pevzner)*

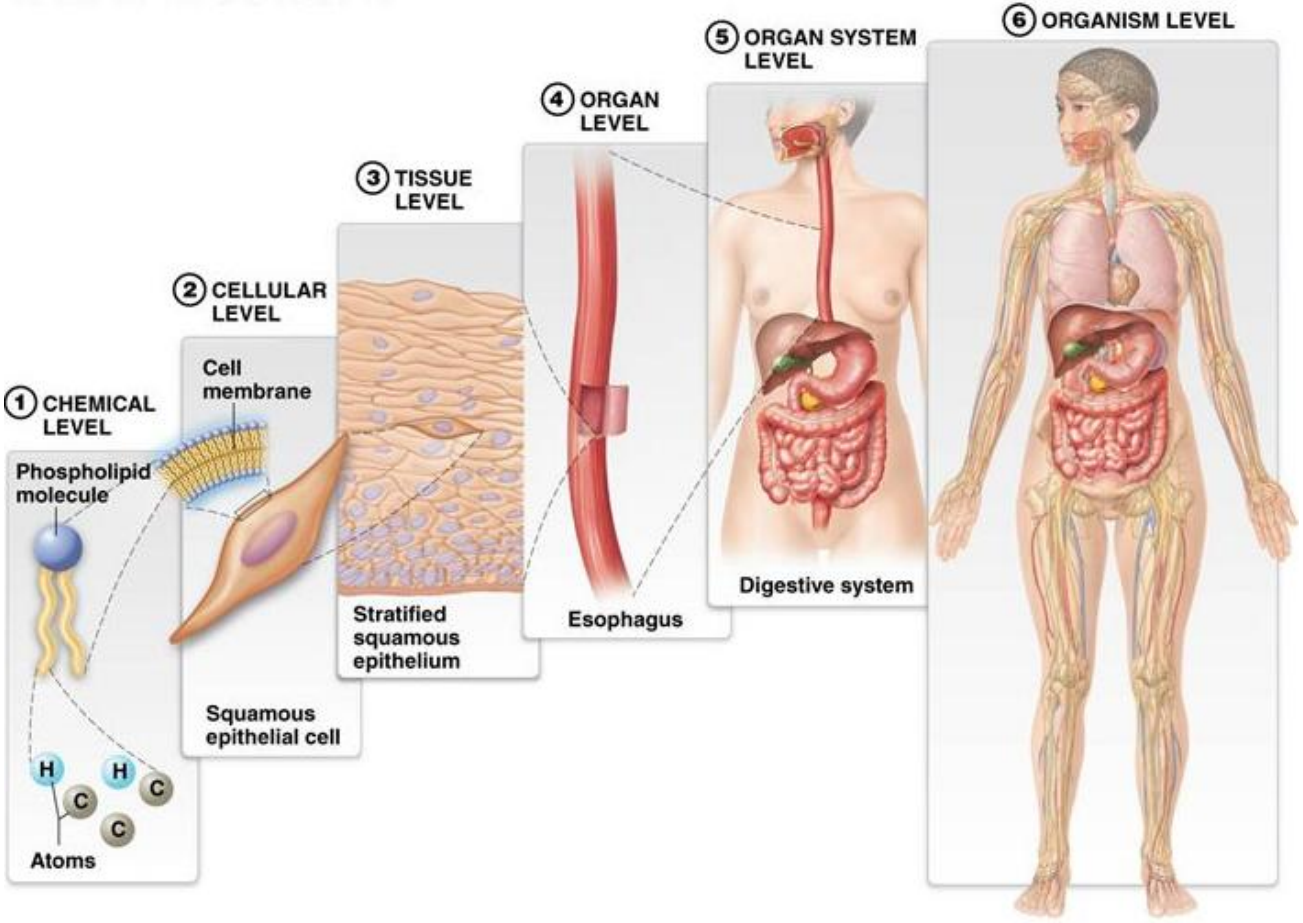
Evaluation scheme

Type of Evaluation	% Contribution in Grade
Mid-semester Exam	20
Quiz	30
Assignments	20
End-semester Exam	30

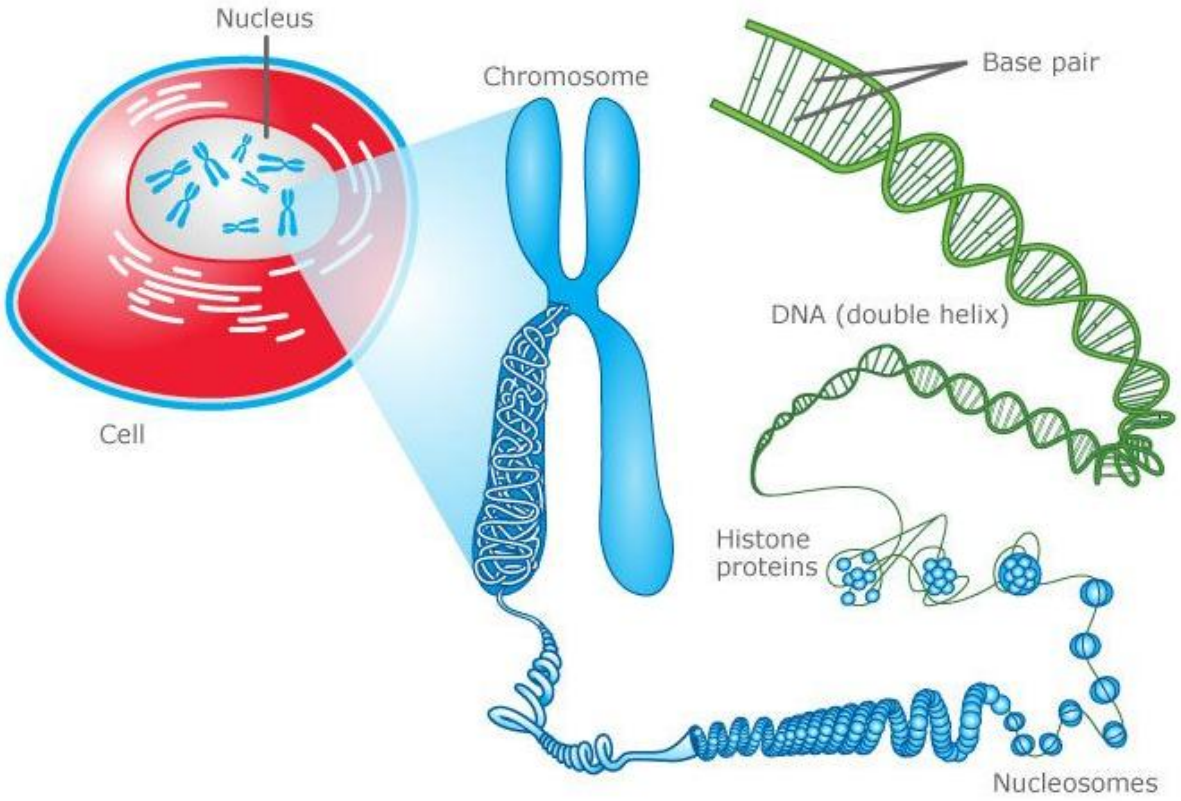
Class code: rpoveydx

Introduction to Biology

Structural organization of human body



The genome is our Genetic Blueprint

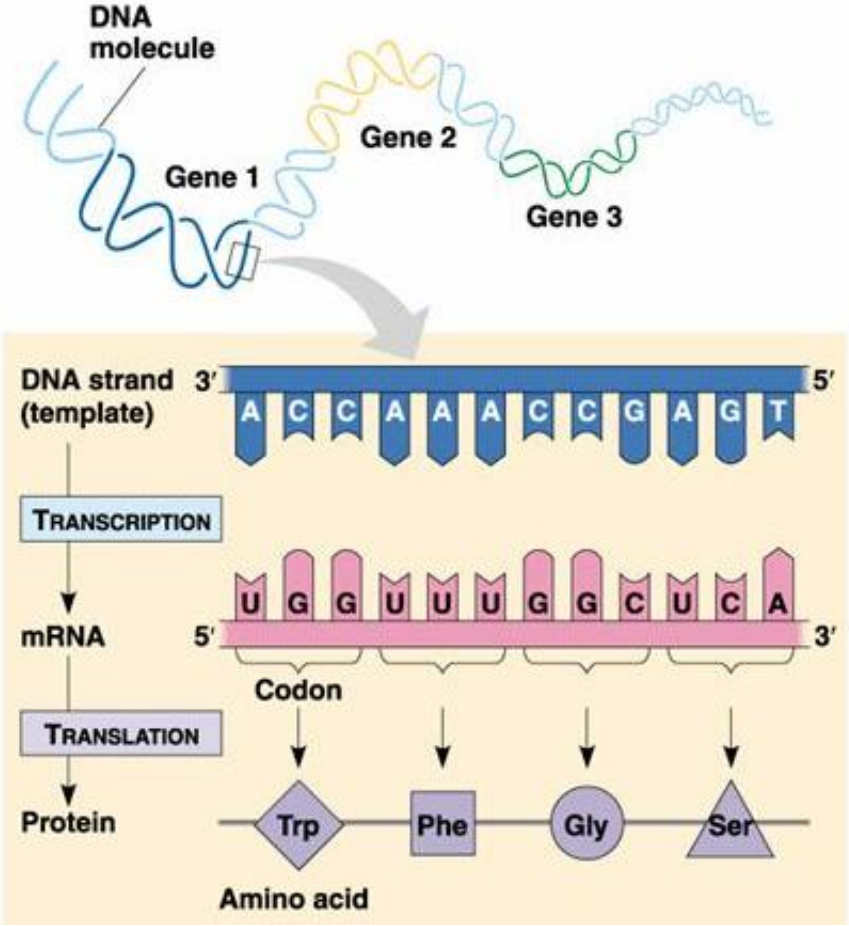


Nearly every human cell contains 23 pairs of chromosomes

- 1 - 22 and XY or XX
- XY = Male
- XX = Female

Length of chr 1-22, X, Y together is ~3.2 billion bases (about 2 meters diploid)

Major molecules: DNA, RNA, Proteins

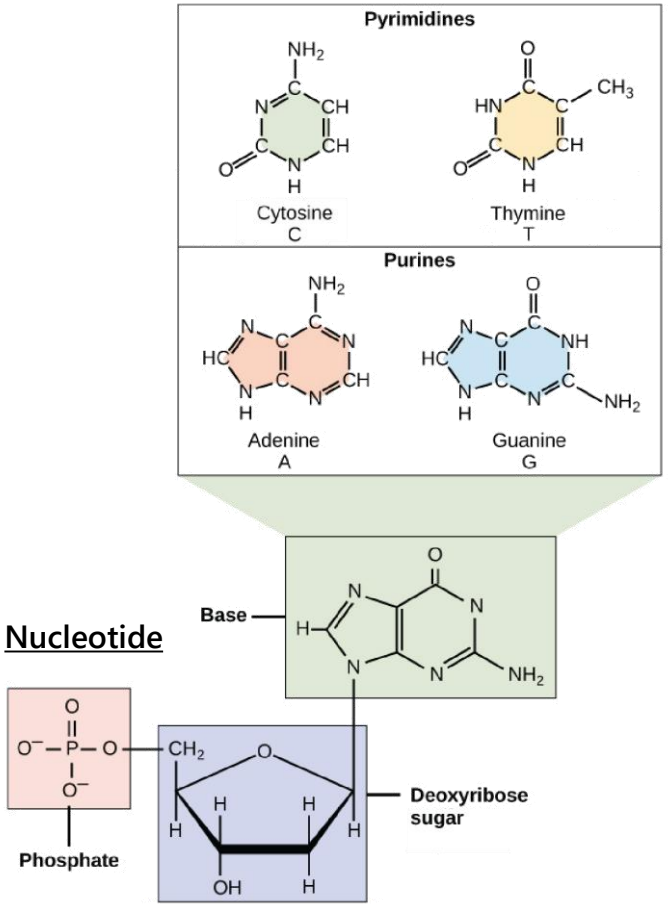


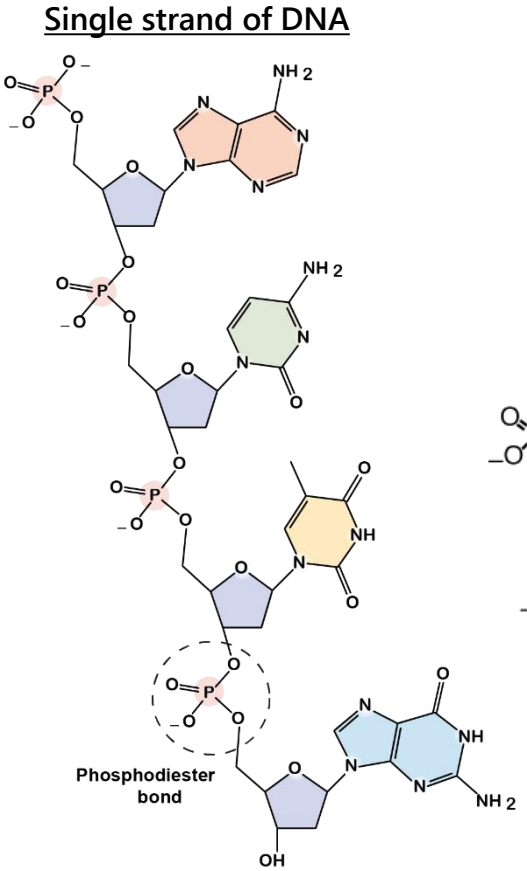
Central Dogma

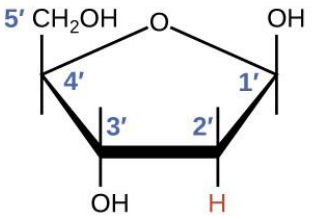
DNA → RNA → Protein

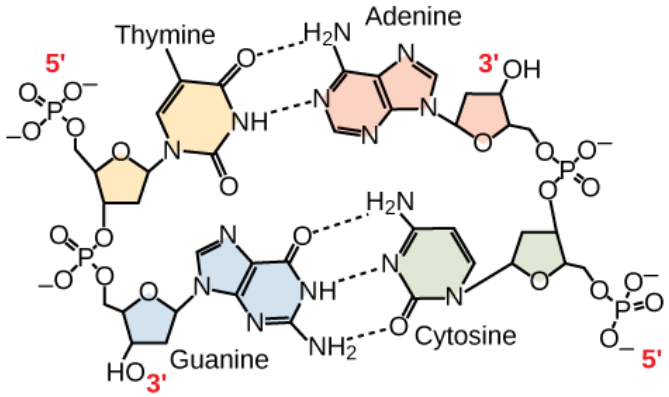
- Every cell contains the same DNA
- Cells differ in the DNA (gene) which is active at any one time
- Genes - DNA sequences that encode proteins or RNA

Nucleotides, the building blocks of DNA





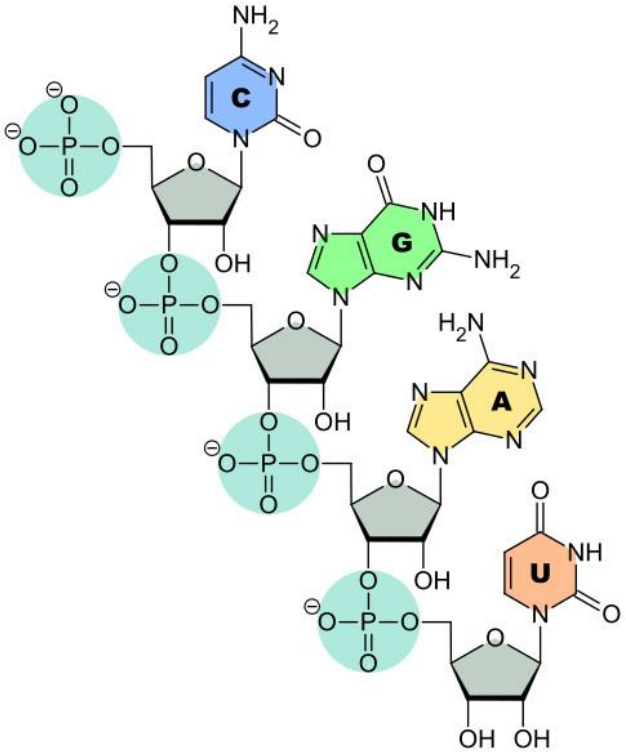




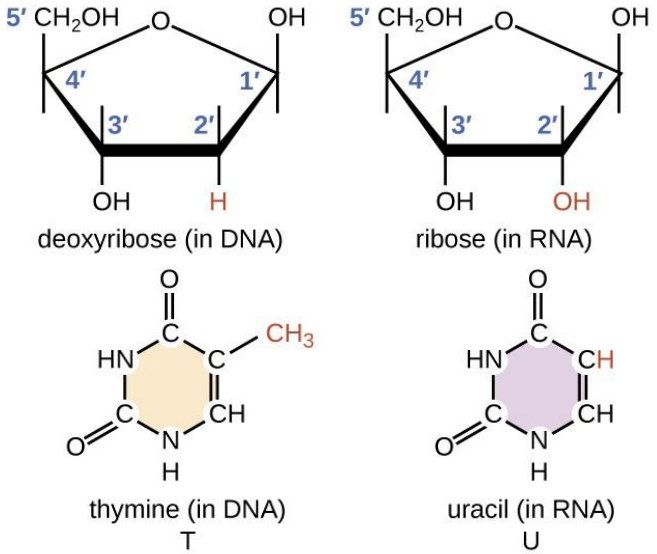
Double stranded DNA

Nucleotides, the building blocks of RNA

Structure of RNA



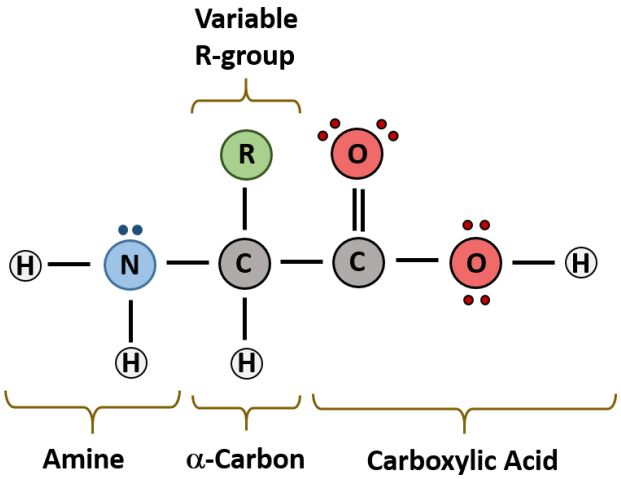
Differences between DNA and RNA



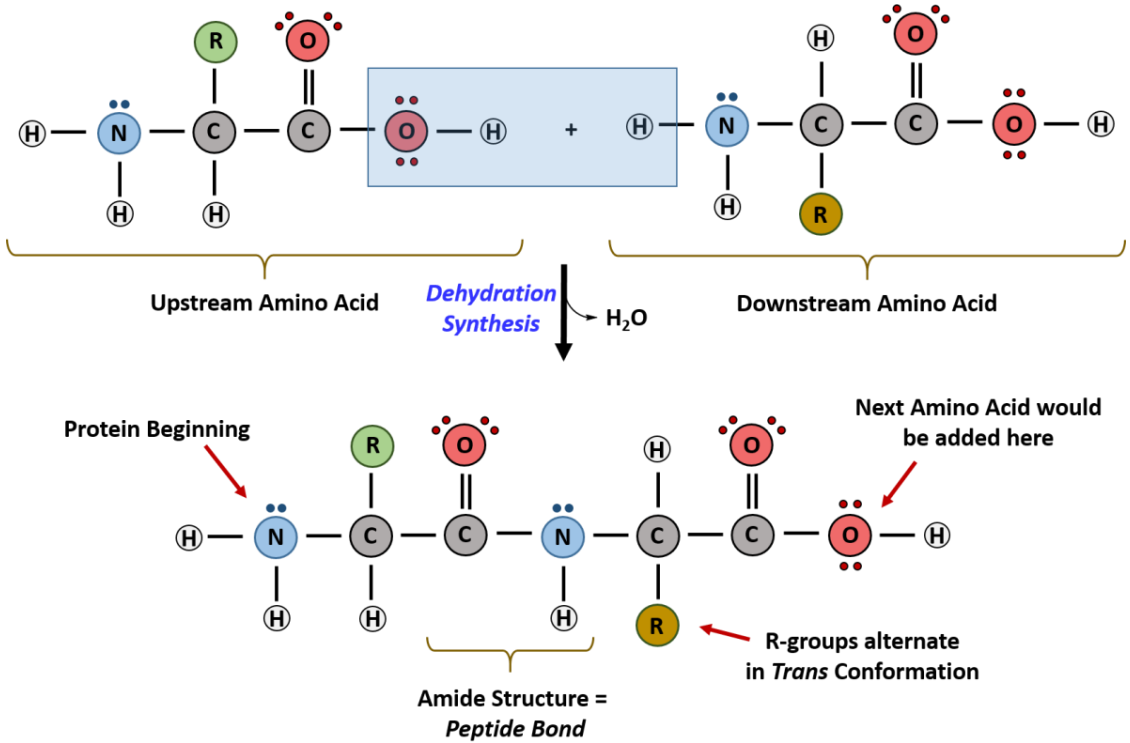
Major types of RNA:
messenger RNA (mRNA),
ribosomal RNA (rRNA), transfer RNA (tRNA),
regulatory RNAs (miRNA, siRNA)

Amino acids, the building blocks of protein

Basic structure of an amino acid

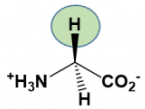


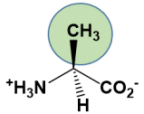
Formation of peptide bond

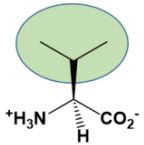


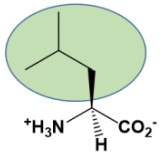
Different types of Amino acids

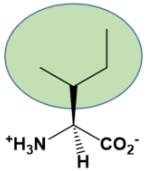
Nonpolar (Hydrophobic) Amino Acids

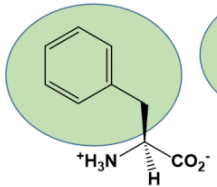

Glycine
Gly, G

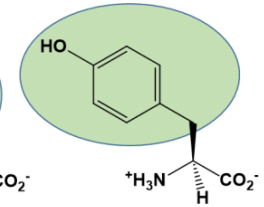

Alanine
Ala, A

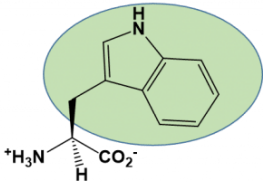

Valine
Val, V

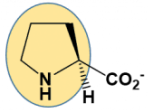

Leucine
Leu, L

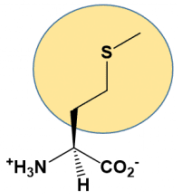

Isoleucine
Ile, I


Phenylalanine
Phe, F

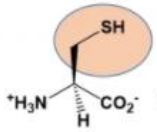

Tyrosine
Tyr, Y

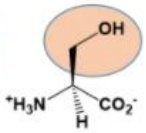

Tryptophan
Trp, W

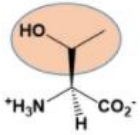

Proline
Pro, P

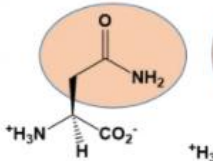

Methionine
Met, M

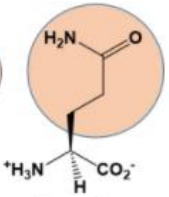
Polar (Hydrophilic) Amino Acids


Cysteine
Cys, C

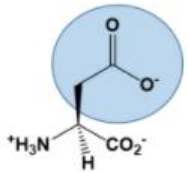

Serine
Ser, S

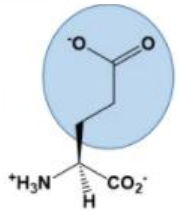

Threonine
Thr, T


Asparagine
Asn, N

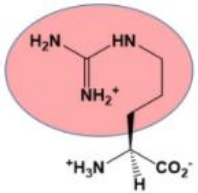

Glutamine
Gln, Q

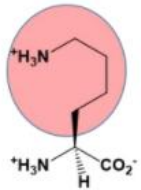
Acidic Amino Acids

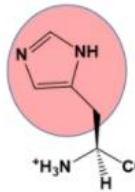

Aspartic Acid
Asp, D


Glutamic Acid
Glu, E

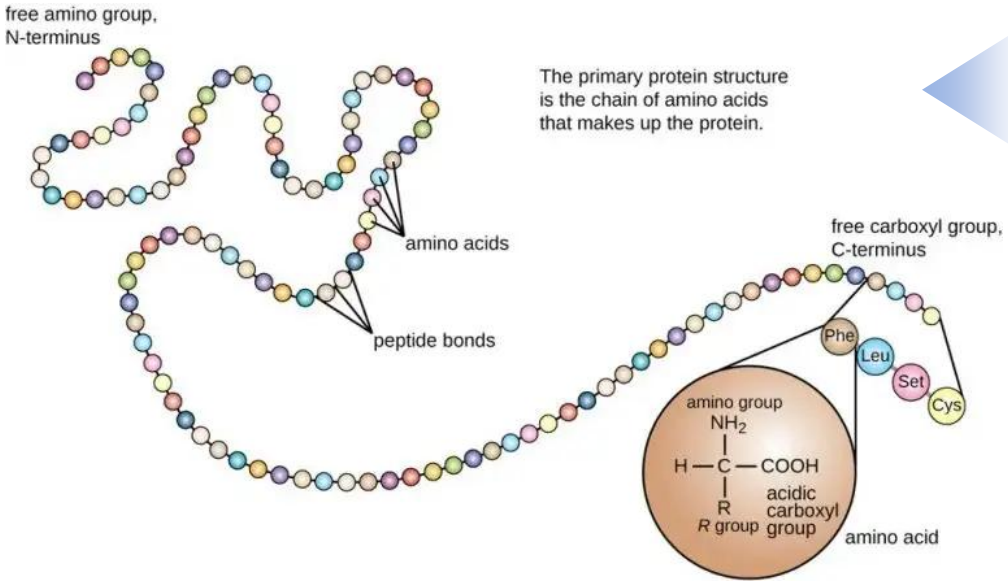
Basic Amino Acids


Arginine
Arg, R


Lysine
Lys, K

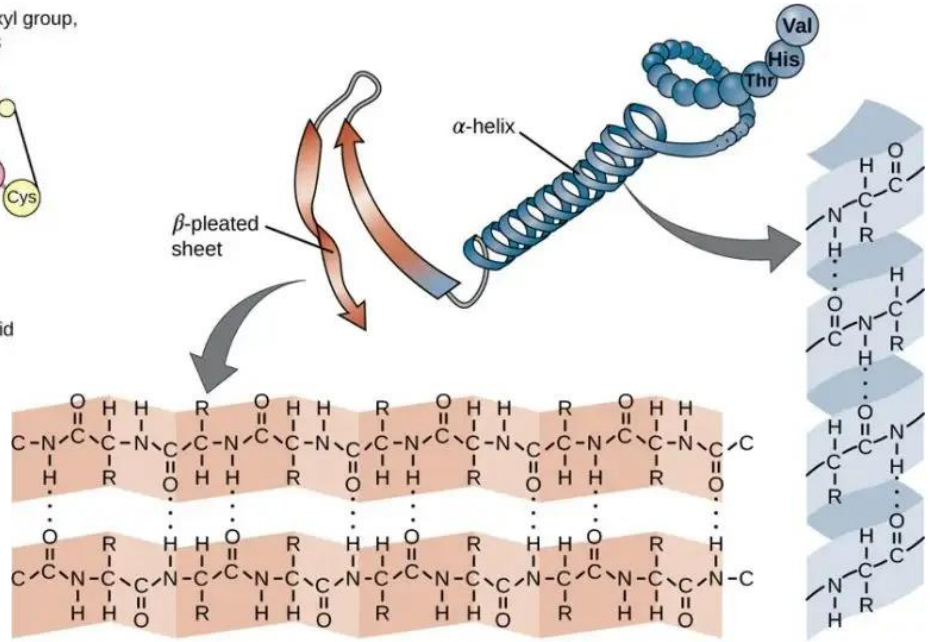

Histidine
His, H

Structure of protein



Primary structure of protein

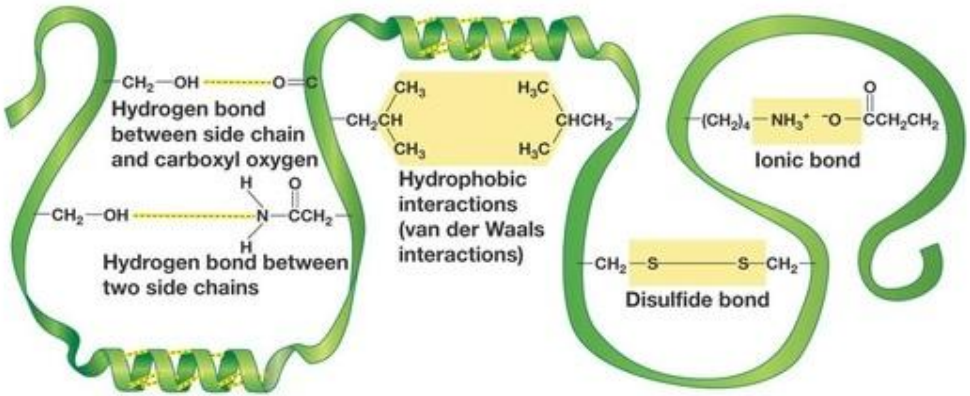
This level of structure is determined by the sequence of amino acids that join to form a polypeptide.



Secondary structure of protein

Hydrogen bonding between amino acids cause the polypeptide to form an alpha helix or a pleated sheet.

Structure of protein



Tertiary structure of protein

This level of structure is determined by the sequence of amino acids that join to form a polypeptide.

Quaternary structure of protein

This level of structure forms when two or more tertiary structures combine to form a single protein