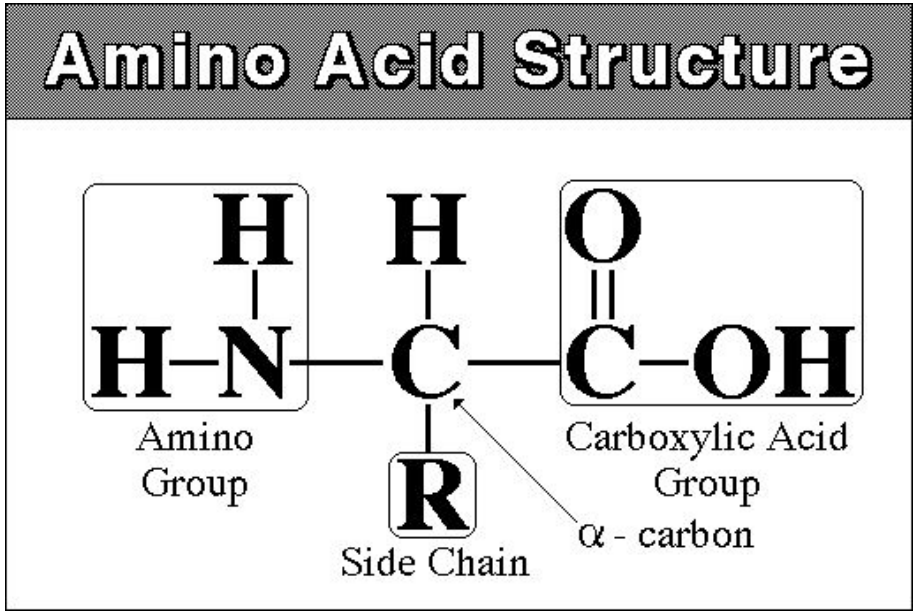
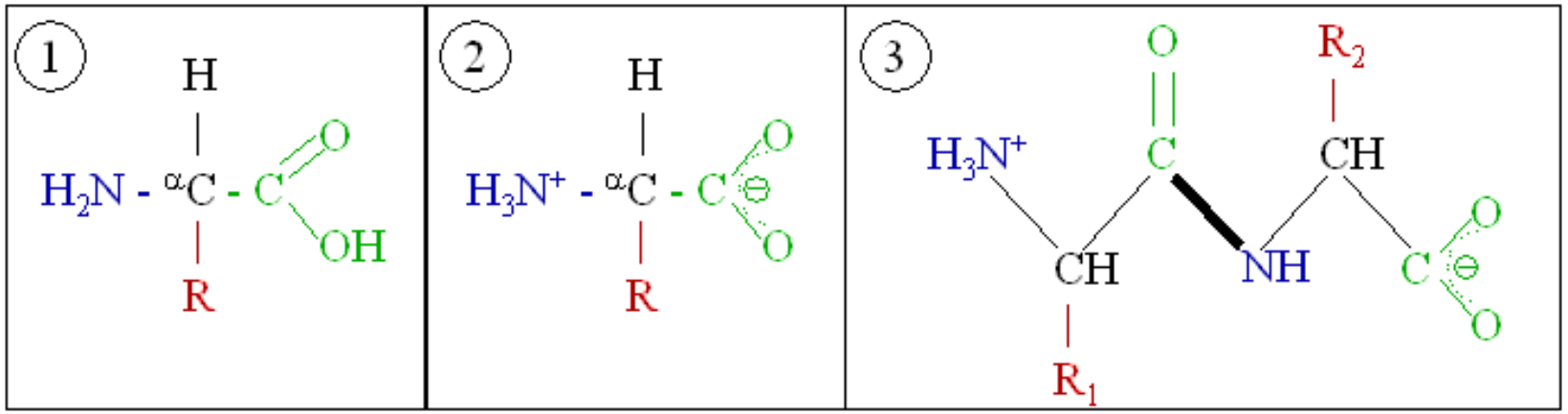
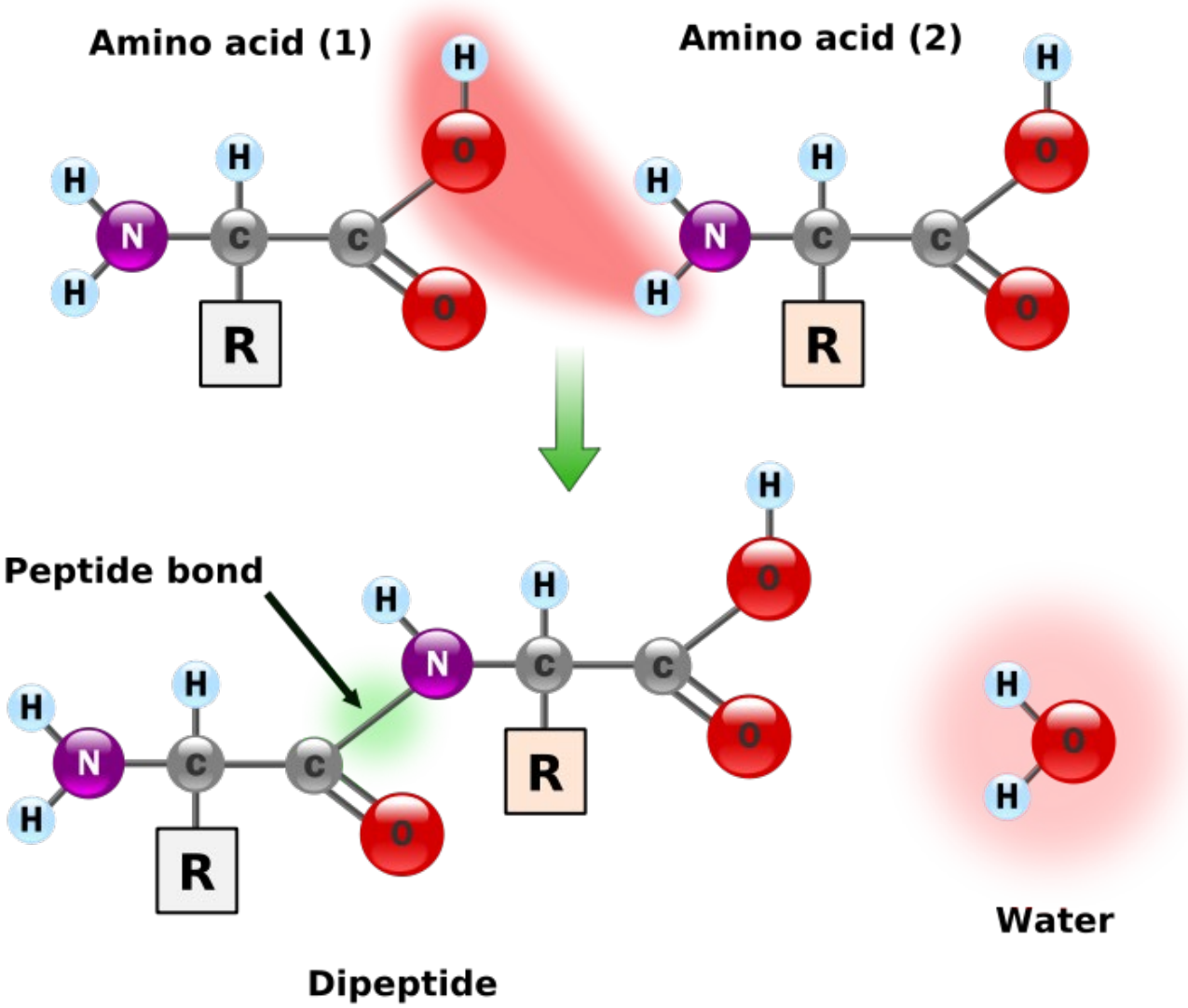
Amino Acid


Amino Acid Structure
H
H
O
H–N
C
C–OH
Amino Group
Carboxylic Acid Group
R
α - carbon
Side Chain

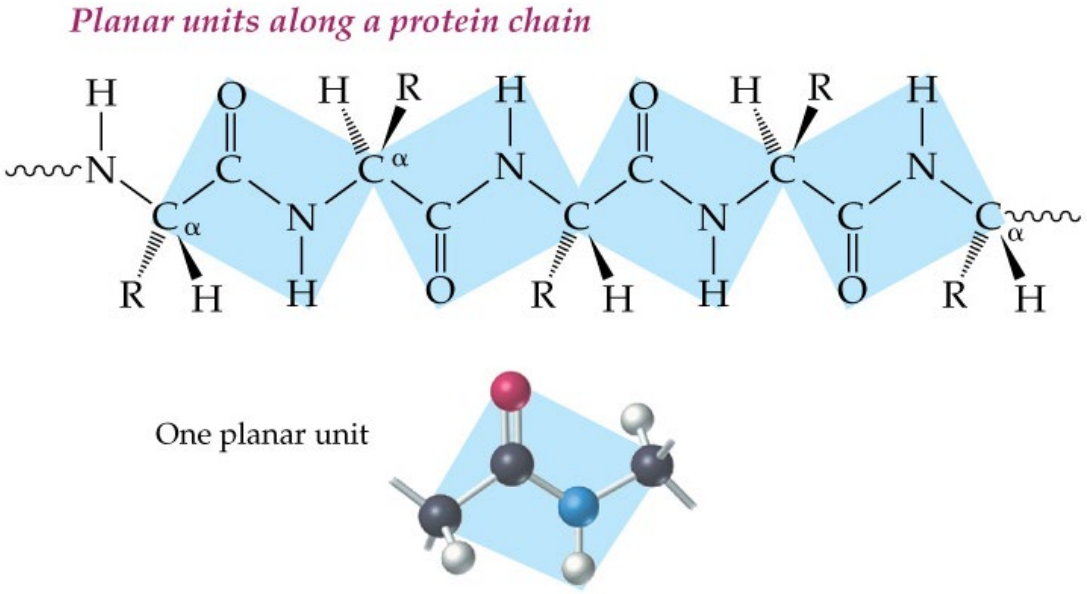

1
H
H2N - αC - C
O
OH
R
2
H
H3N+ - αC - C
O
O
R
3
O
R2
H3N+
C
CH
CH
NH
C
O
O
R1

Peptide bond



Primary Protein Structure

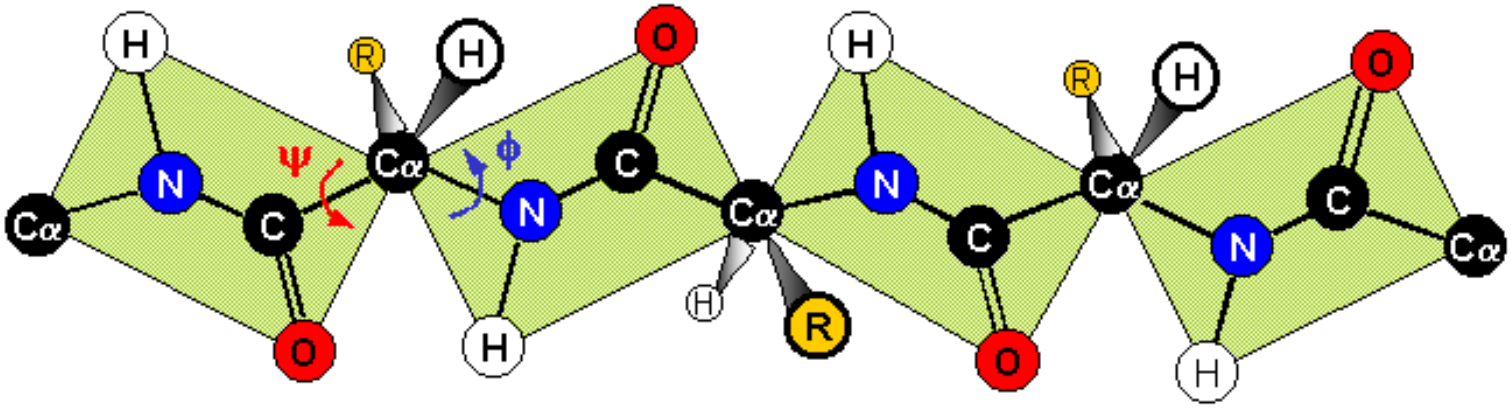
- Primary structure of a proteins is the sequence of amino acids connected by peptide bonds. Along the backbone of the proteins is a chain of alternating peptide bonds and α-carbons and the amino acid side chains are connected to these

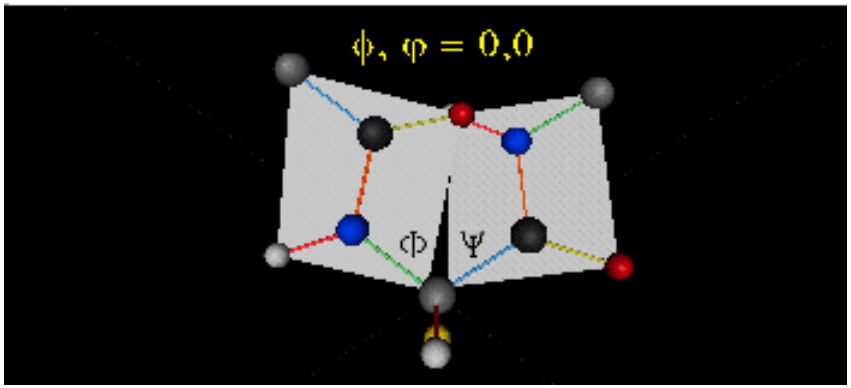


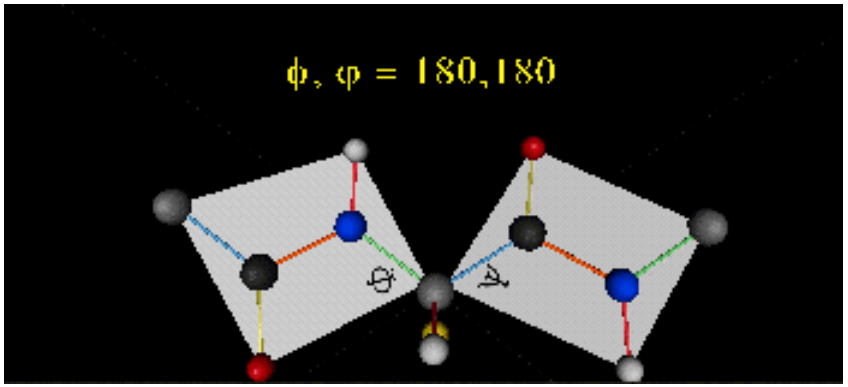
Secondary Protein Structure

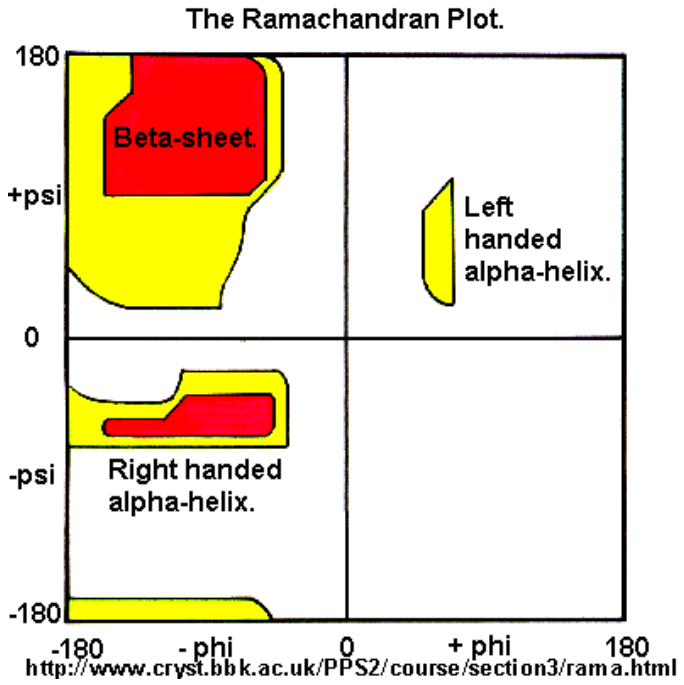
- Secondary structure of a protein is the arrangement of polypeptide backbone of the protein in space. The secondary structure includes two kinds of repeating pattern known as the *α-helix* and *β-sheet*.
- Hydrogen bonding between backbone atoms are responsible for both of these secondary structures.

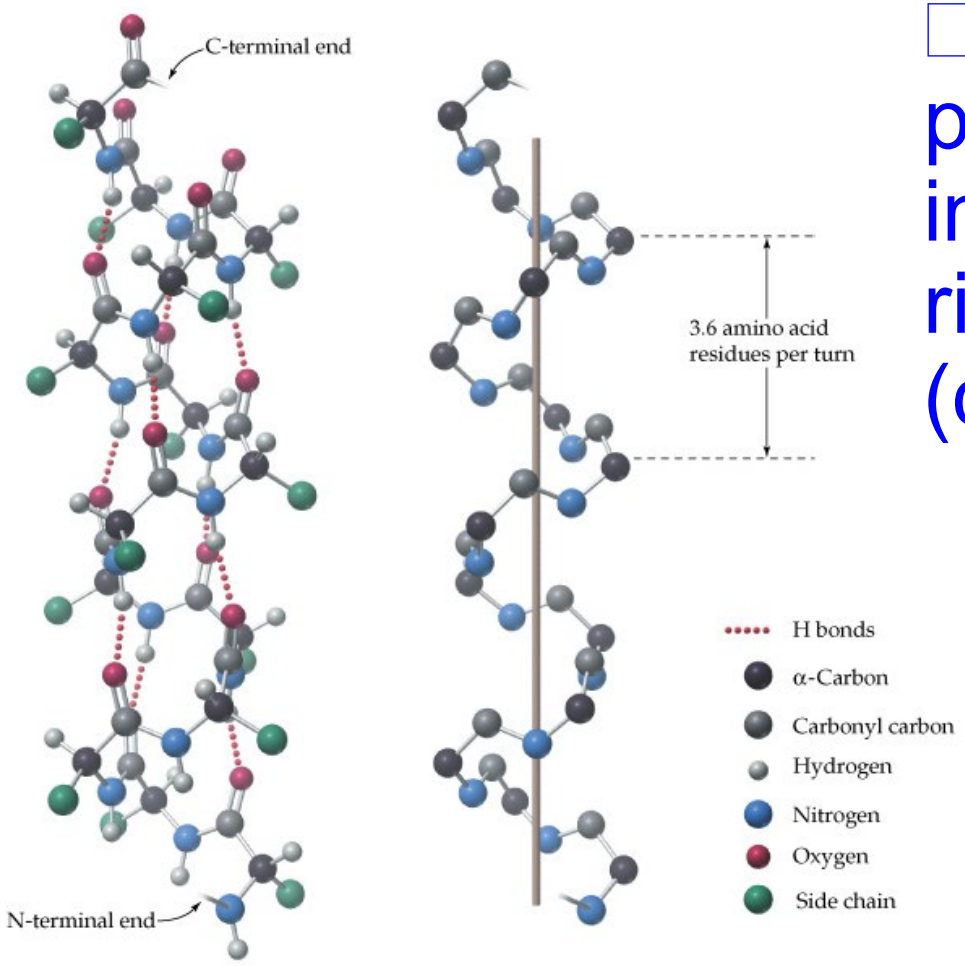
FULLY EXTENDED POLYPEPTIDE CHAIN





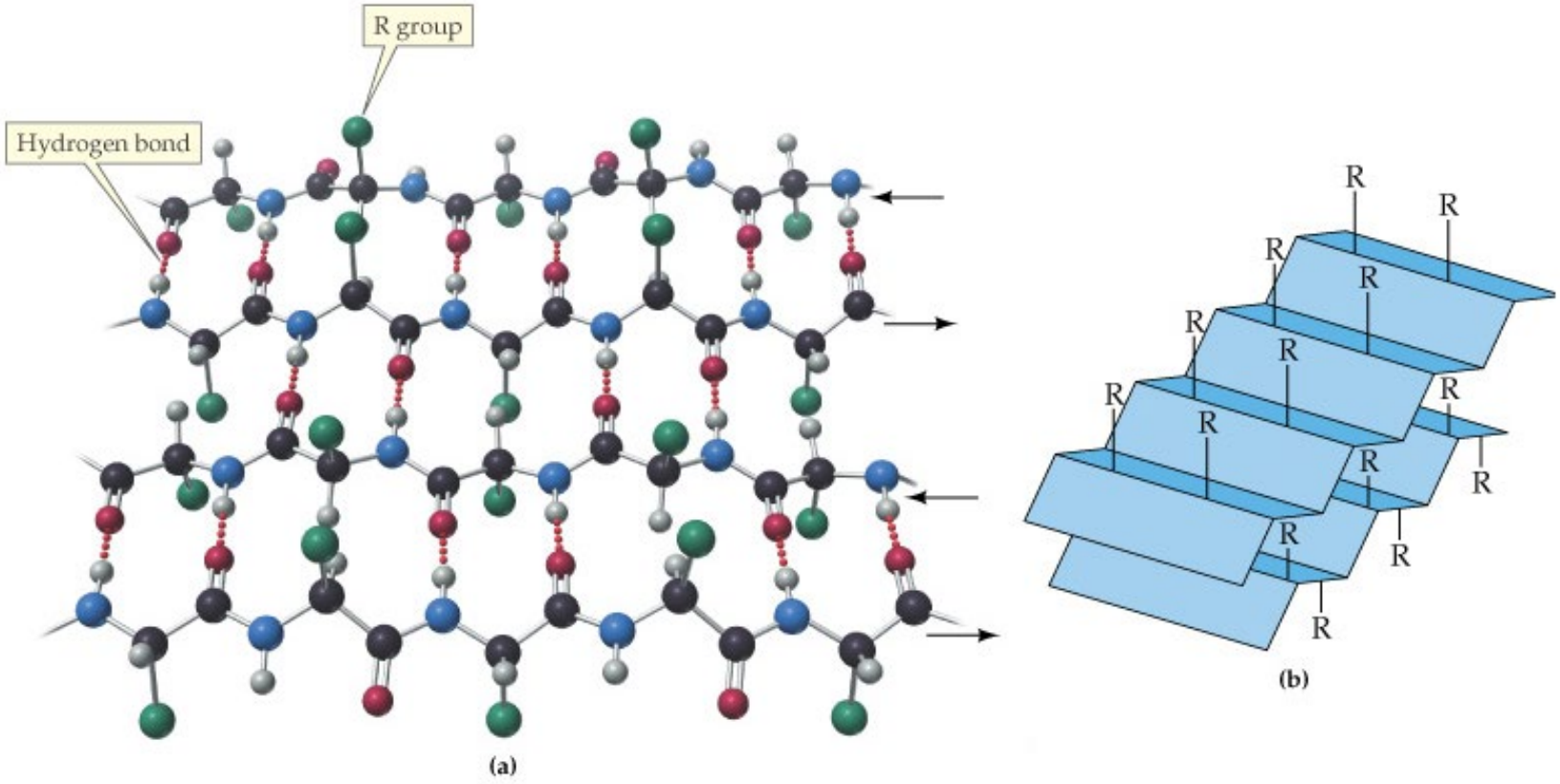


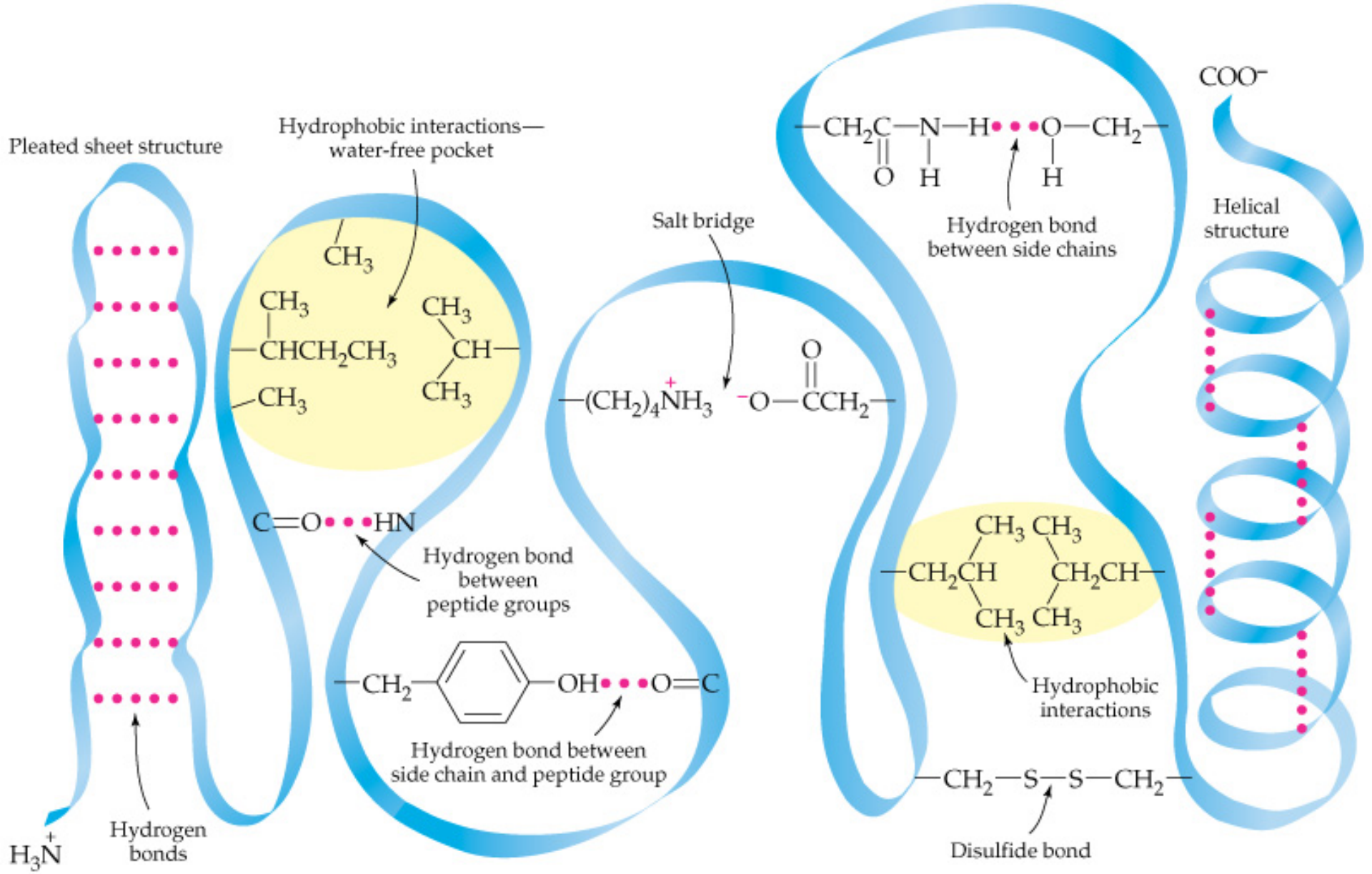




- ***α-Helix:*** A single protein chain coiled in a spiral with a right-handed (clockwise) twist.

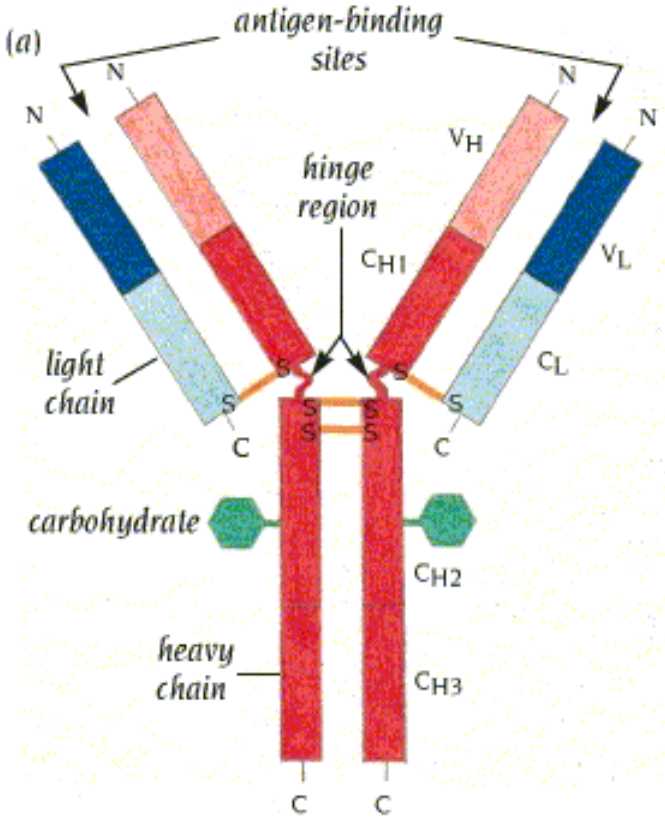
β-Sheet: The polypeptide chain is held in place by hydrogen bonds between pairs of peptide units along neighboring backbone segments.

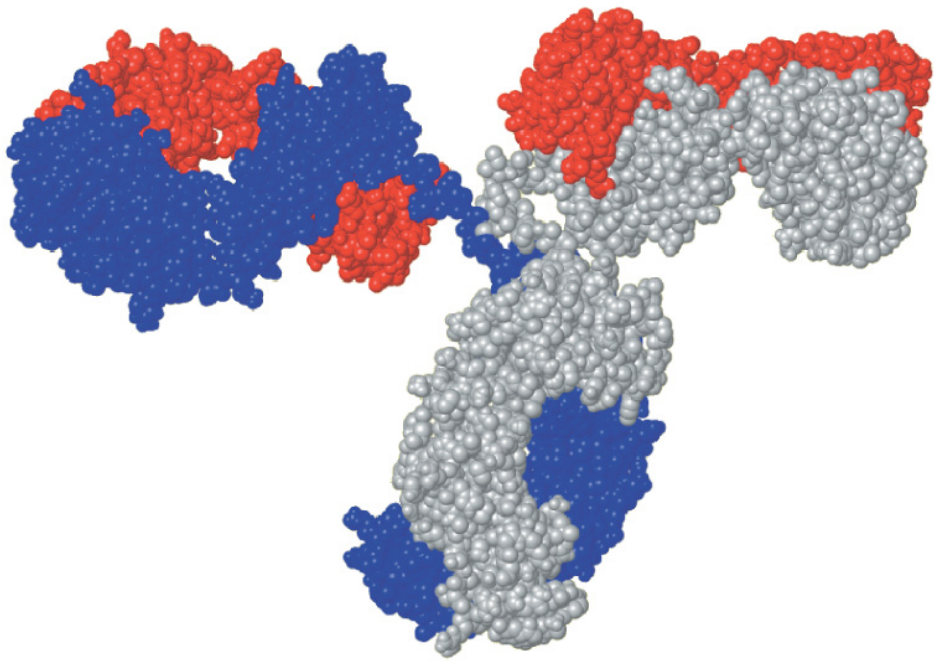



Pleated sheet structure
Hydrophobic interactions—
water-free pocket
Salt bridge
Hydrogen bond
between side chains
Helical
structure
Hydrogen bond
between
peptide groups
Hydrogen bond between
side chain and peptide group
Hydrophobic
interactions
Hydrogen
bonds
Disulfide bond

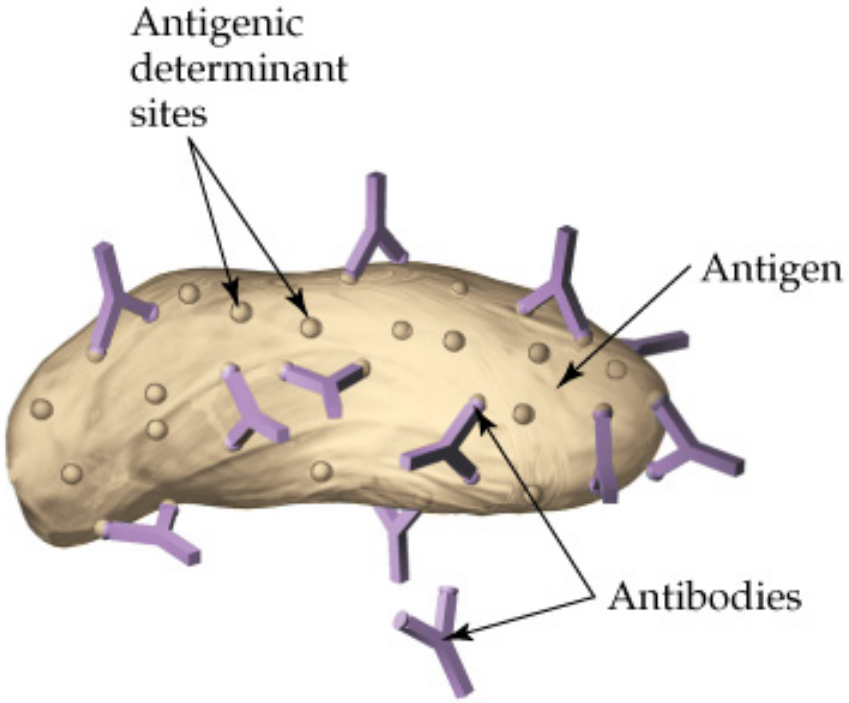
Shape-Determining Interactions in Proteins

- The essential structure-function relationship for each protein depends on the polypeptide chain being held in its necessary shape by the interactions of atoms in the side chains.

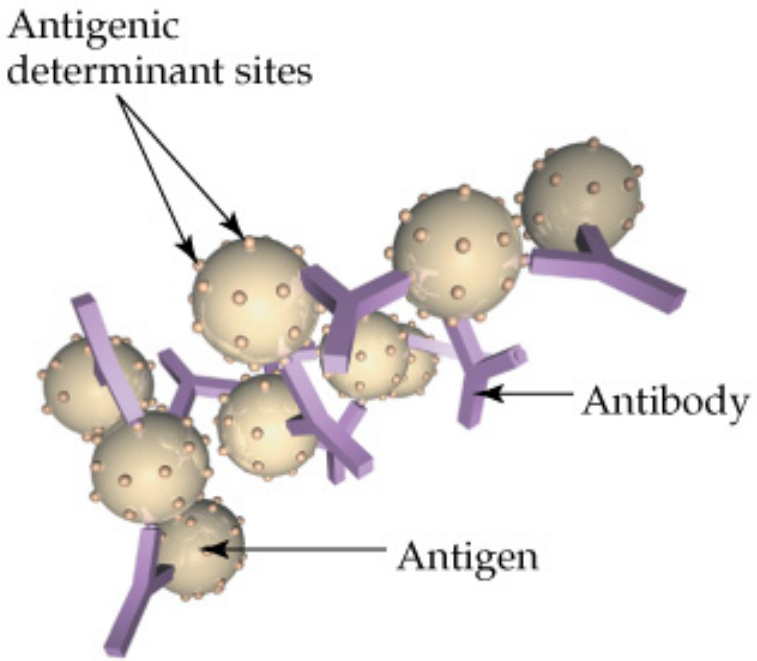

(a)
antigen-binding sites
N
N
N
N
VH
VL
hinge region
CH1
CL
light chain
S
S
S
S
S
S
S
S
C
C
carbohydrate
CH2
heavy chain
CH3
C
C



(b)

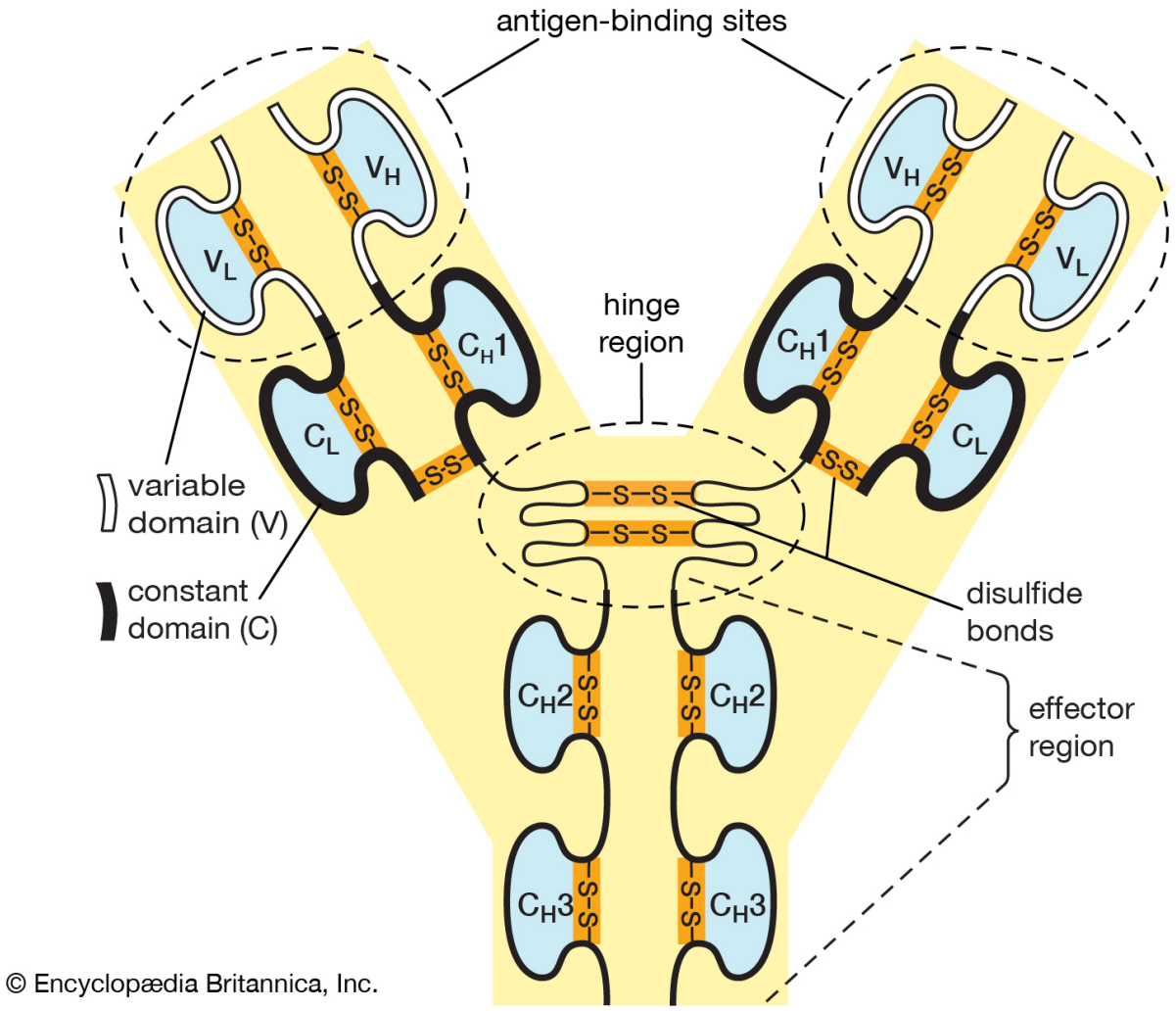

Antigenic determinant sites
Antigen
Antibodies

(a)

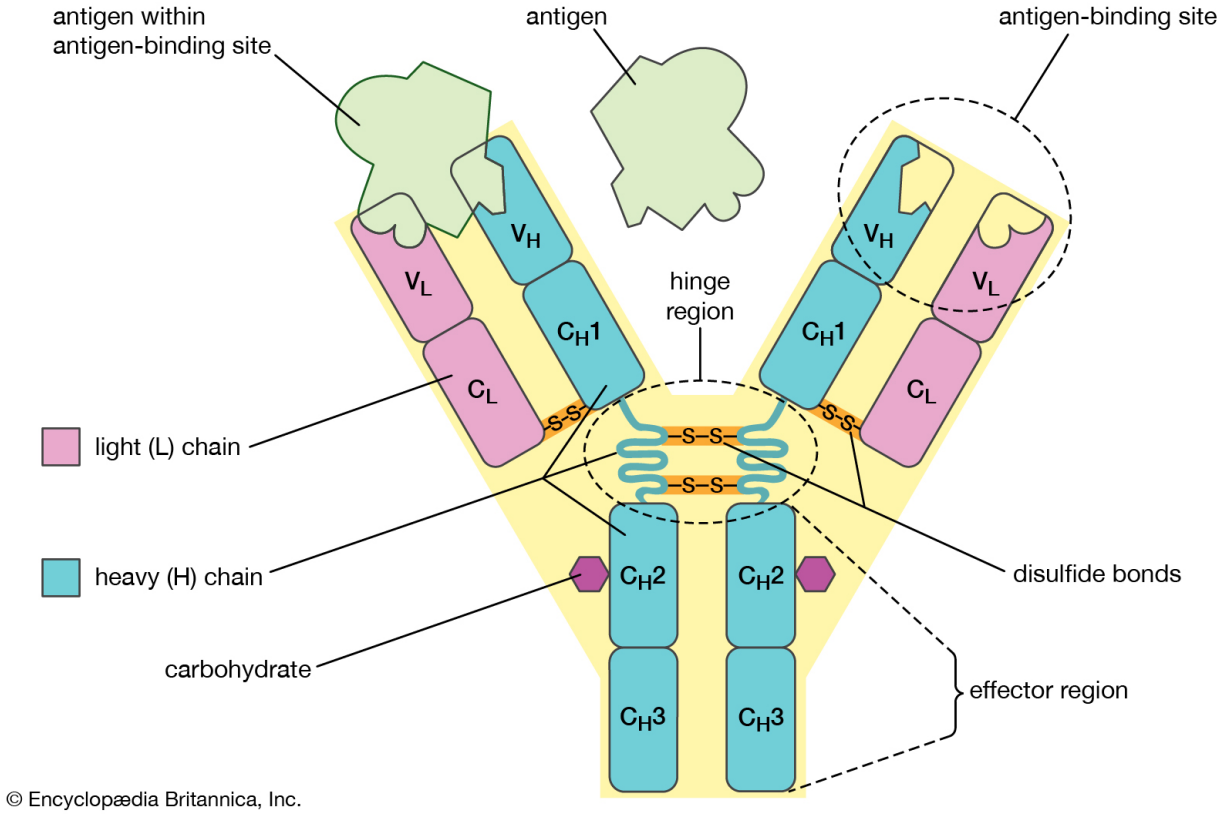

Antigenic determinant sites
Antibody
Antigen

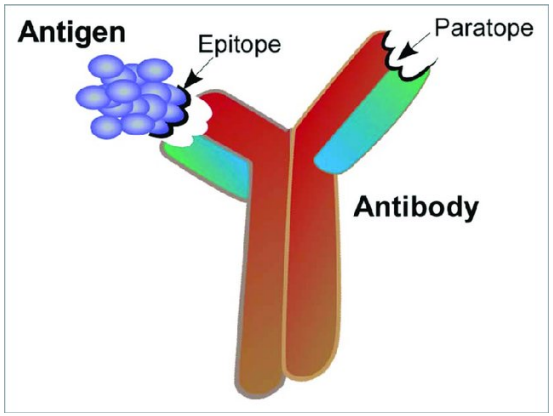
(b)

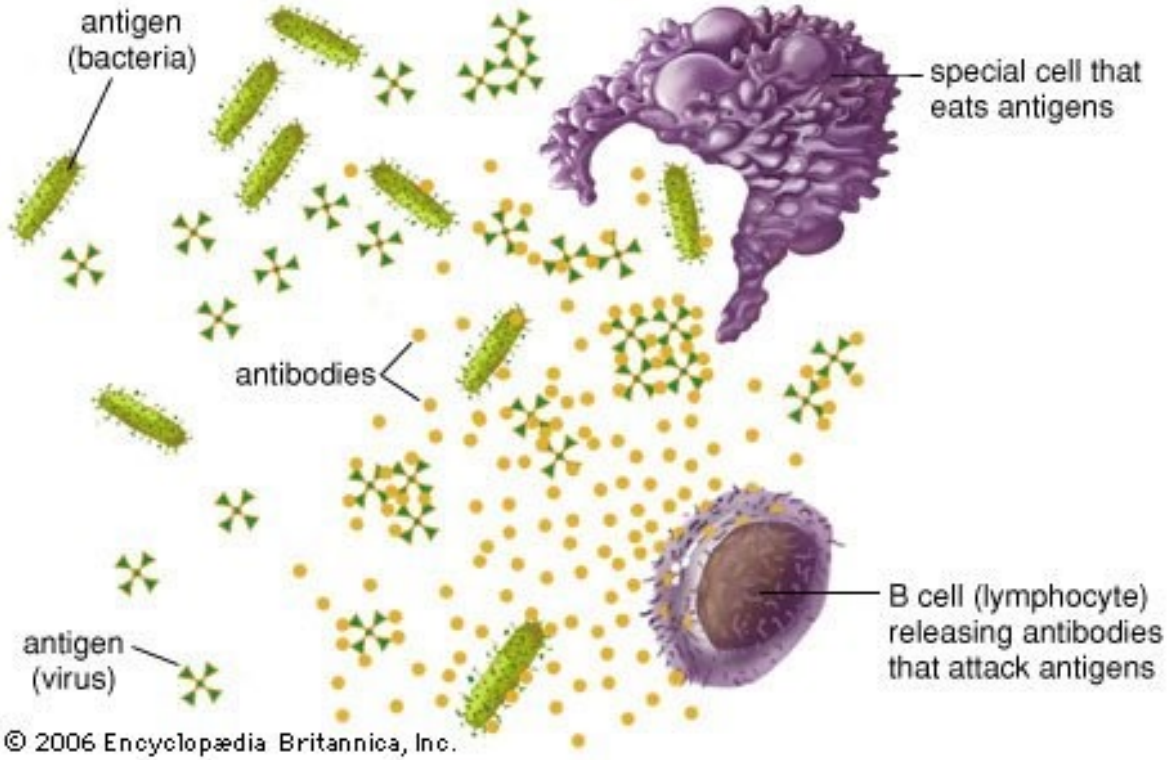
Antibody


antigen-binding sites
V_H
V_L
C_H1
C_L
hinge region
variable domain (V)
constant domain (C)
disulfide bonds
C_H2
C_H3
effector region
S-S
© Encyclopædia Britannica, Inc.

Antibody Binding Sites






antigen
(bacteria)
special cell that
eats antigens
antibodies
B cell (lymphocyte)
releasing antibodies
that attack antigens
antigen
(virus)
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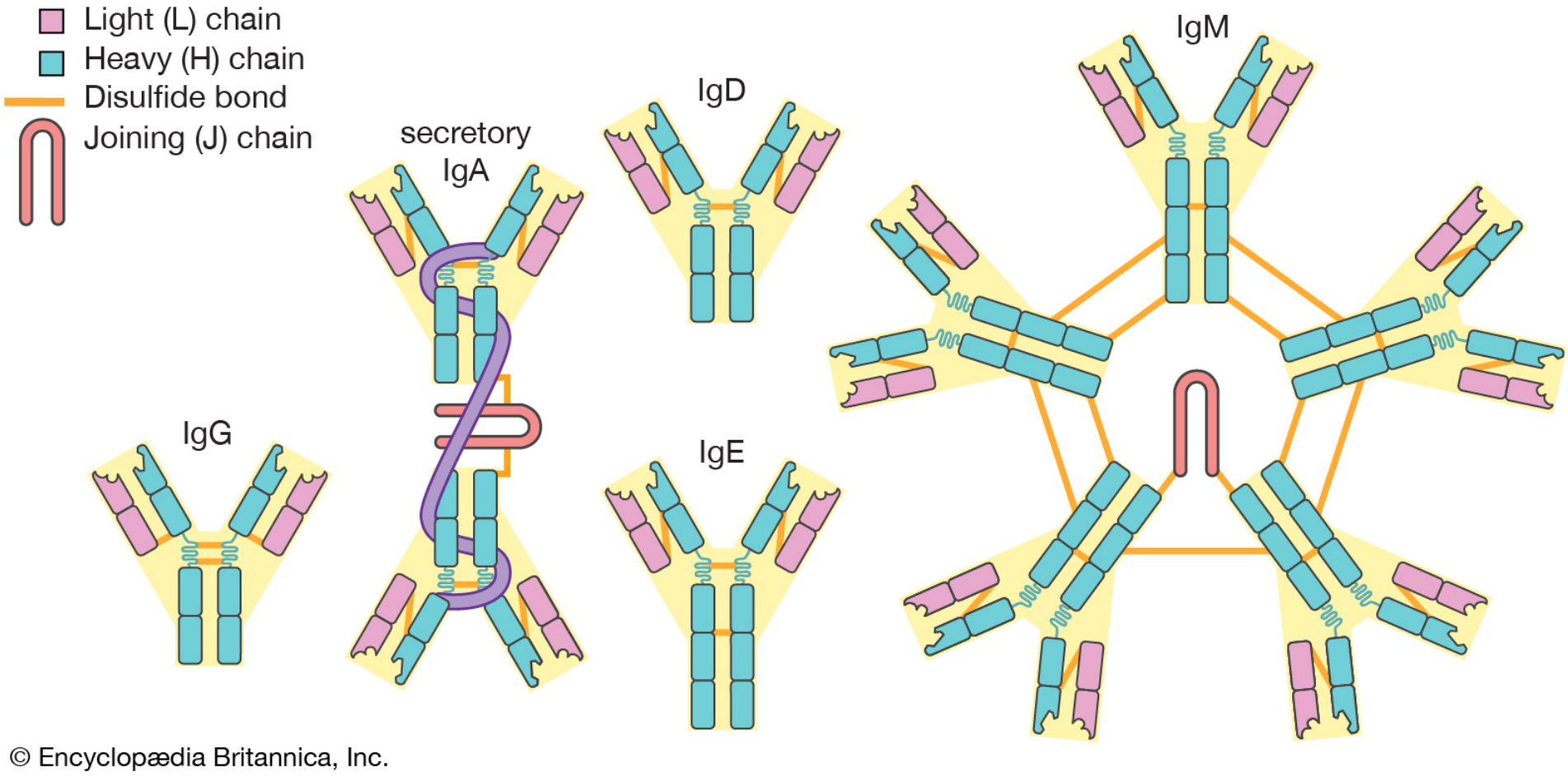
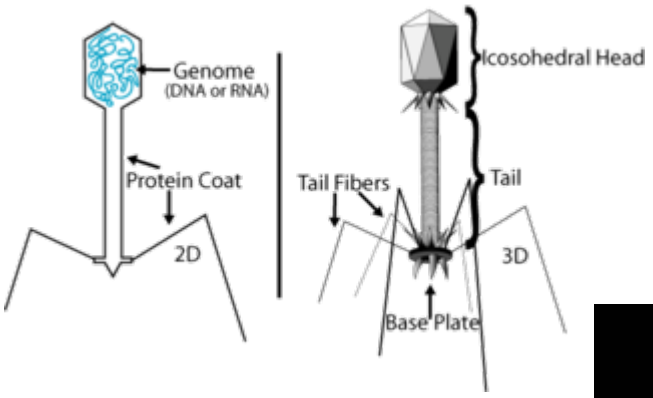
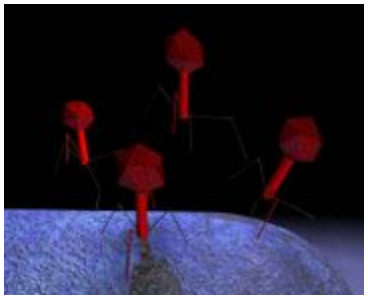
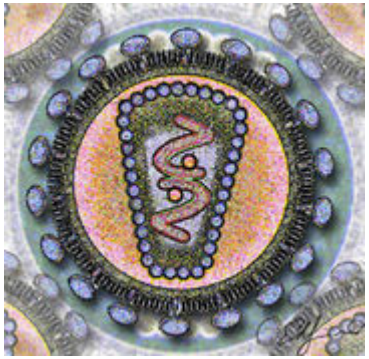
Different Types of Antibodies

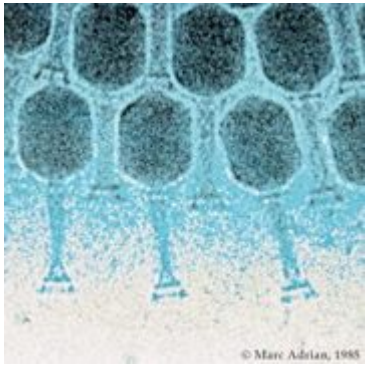


Virus

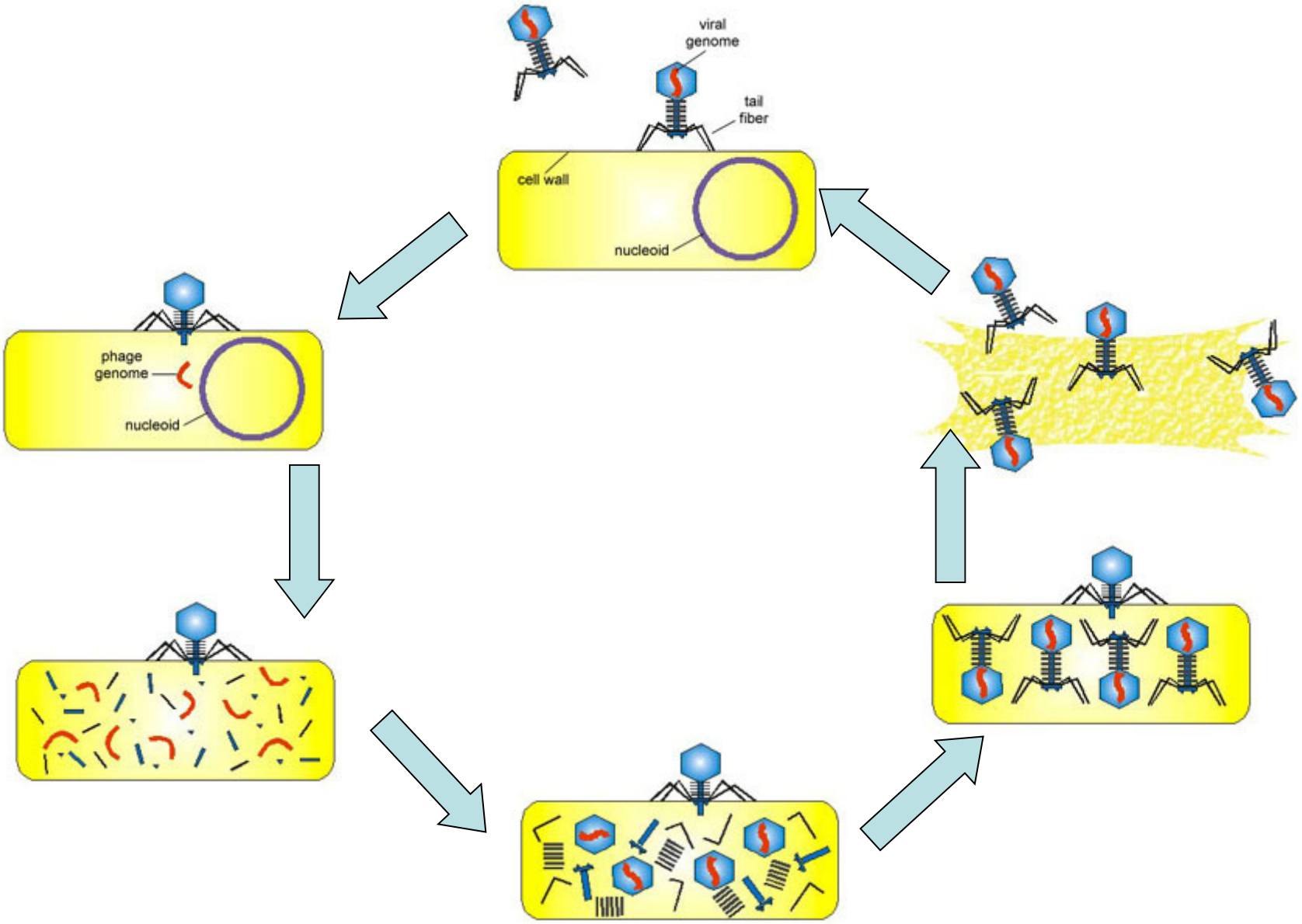

Genome
(DNA or RNA)
Protein Coat
2D
Icosohedral Head
Tail Fibers
Tail
3D
Base Plate



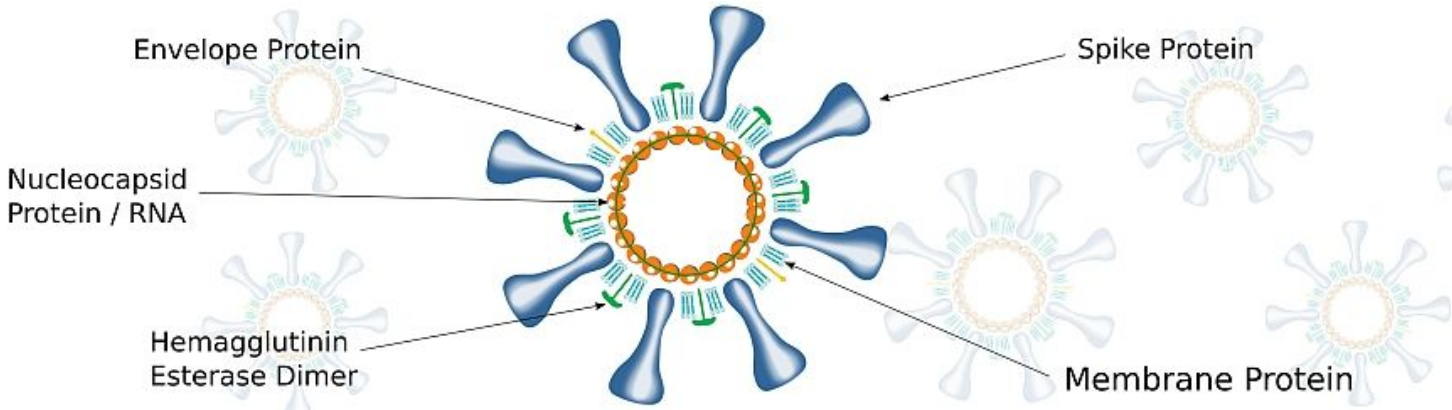


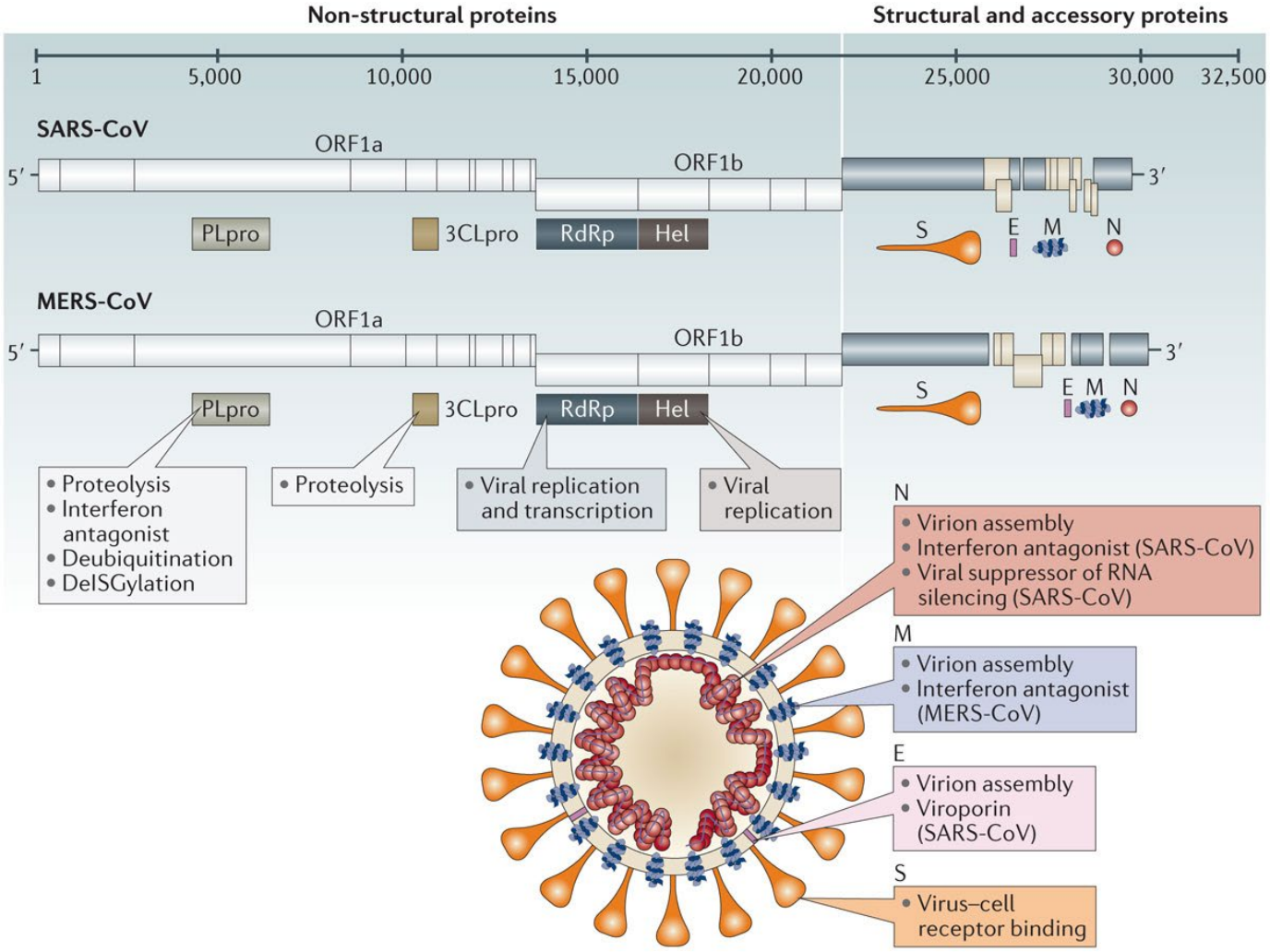

© Marc Adelan, 1985

Virus Reproduction



SARS-CoV-2

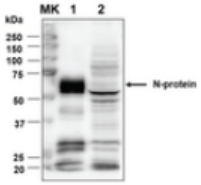

Envelope Protein
Spike Protein
Nucleocapsid
Protein / RNA
Hemagglutinin
Esterase Dimer
Membrane Protein


Non-structural proteins
Structural and accessory proteins
1
5,000
10,000
15,000
20,000
25,000
30,000
32,500
SARS-CoV
ORF1a
ORF1b
5′
3′
PLpro
3CLpro
RdRp
Hel
S
E
M
N
MERS-CoV
ORF1a
ORF1b
5′
3′
PLpro
3CLpro
RdRp
Hel
S
E M N
• Proteolysis
• Interferon antagonist
• Deubiquitination
• DelSGylation
• Proteolysis
• Viral replication and transcription
• Viral replication
N
• Virion assembly
• Interferon antagonist (SARS-CoV)
• Viral suppressor of RNA silencing (SARS-CoV)
M
• Virion assembly
• Interferon antagonist (MERS-CoV)
E
• Virion assembly
• Viroporin (SARS-CoV)
S
• Virus–cell receptor binding

COVID-19 Antibodies

Monoclonal & Polyclonal Antibodies to SARS-CoV-2

The antibodies available below have been validated to bind to proteins from SARS-CoV-2 (COVID-19), but were developed originally to target proteins from SARS-CoV-1, the virus responsible for the 2003 outbreak. We are currently developing monoclonal mouse and polyclonal rabbit antibodies specific to SARS-CoV-2 spike and nucleocapsid proteins. The polyclonal antibodies will be available in May. The monoclonal antibodies will be available sometime between July - August.



Rabbit Anti-SARS-CoV-2 Nucleocapsid Protein

Rabbit Anti-SARS-CoV-2 Coronavirus Nucleocapsid Protein

CODE: 128-10165-1

$1,450.00

SELECT SIZE ADD TO COMPARISON LIST

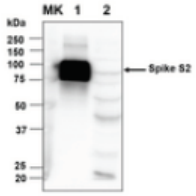
Mouse Anti-SARS-CoV-2 Nucleocapsid Protein

Mouse Anti-SARS-CoV-2 Coronavirus Nucleocapsid protein

CODE: 128-10166-1

$1,450.00

SELECT SIZE ADD TO COMPARISON LIST



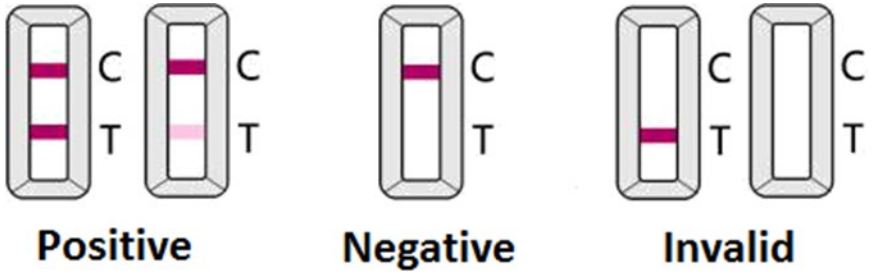
Rabbit Anti-SARS-CoV-2 Spike Protein

Rabbit Anti-SARS-Associated Coronavirus (COVID-19) Spike Protein

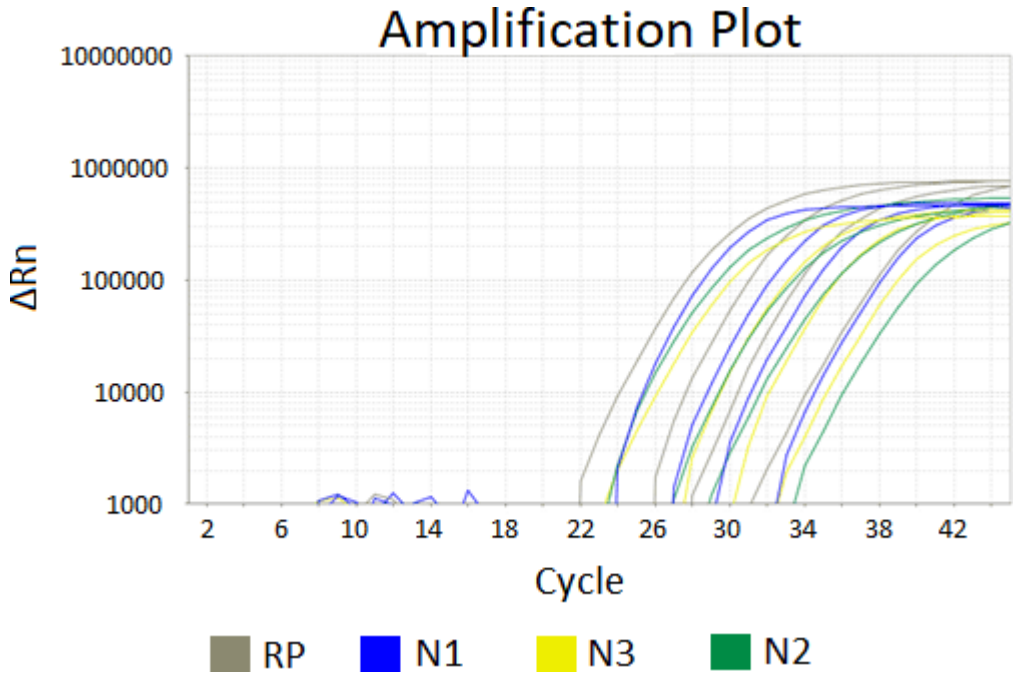
CODE: 128-10168-1

$1,450.00

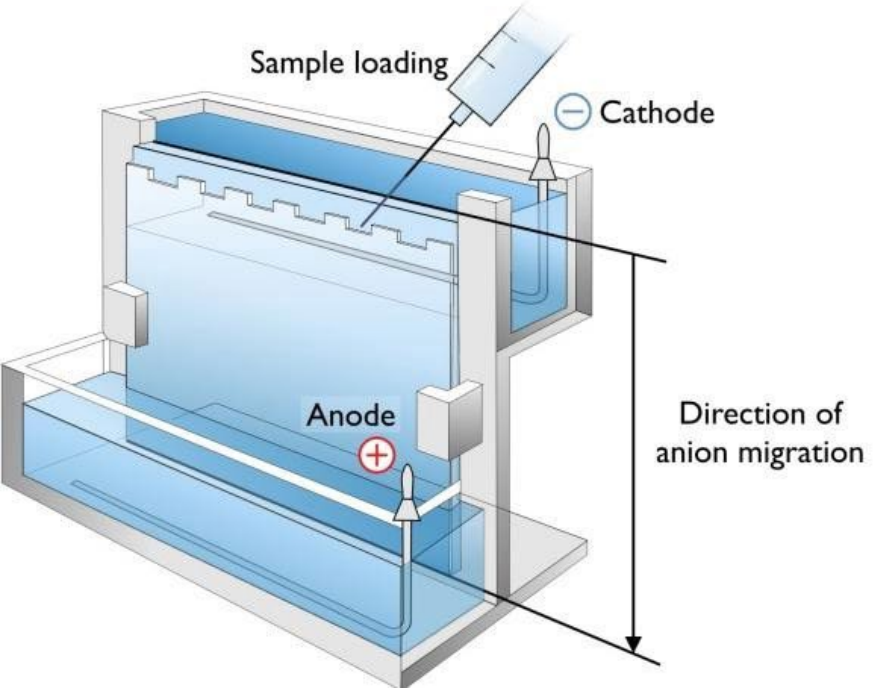
Fast Screening Kit

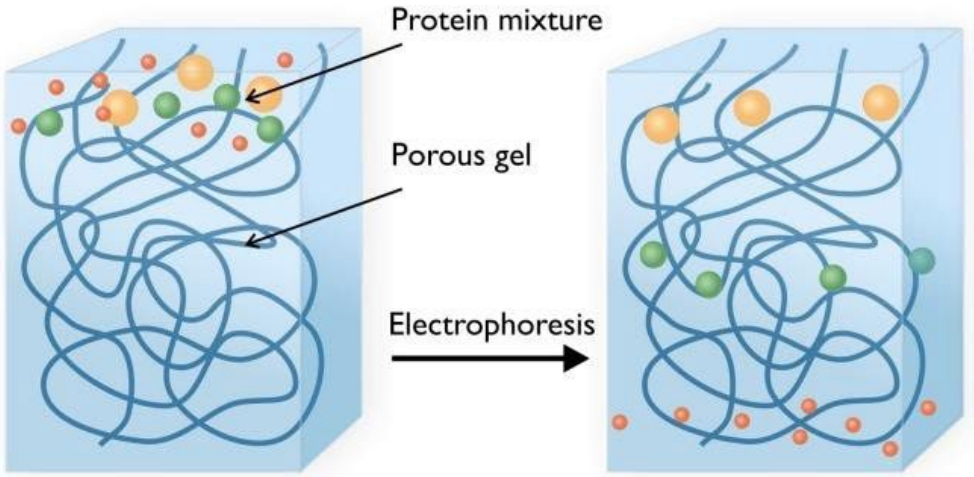


Real-time RT PCR

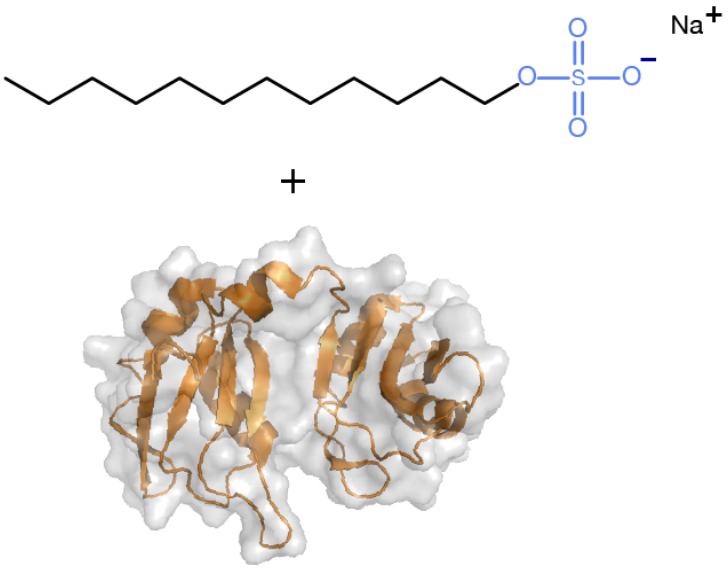


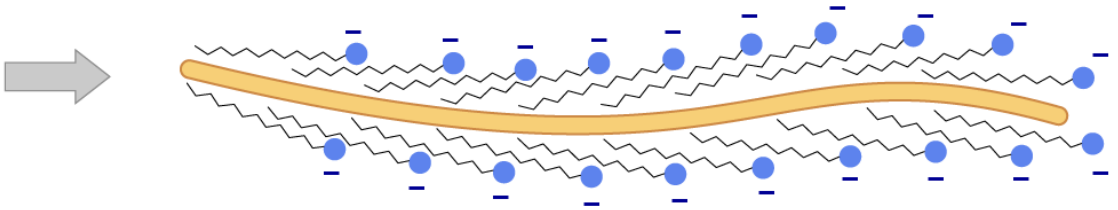
Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE)



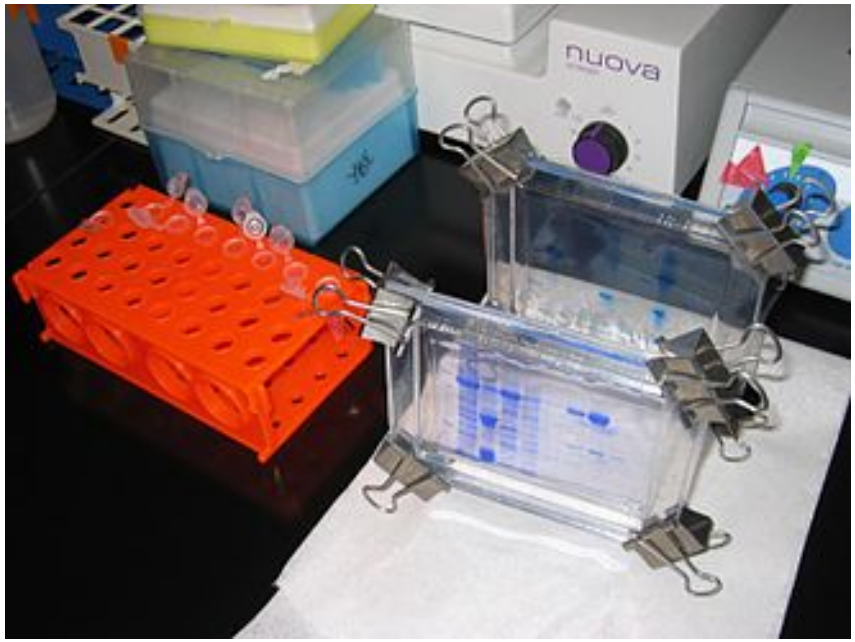


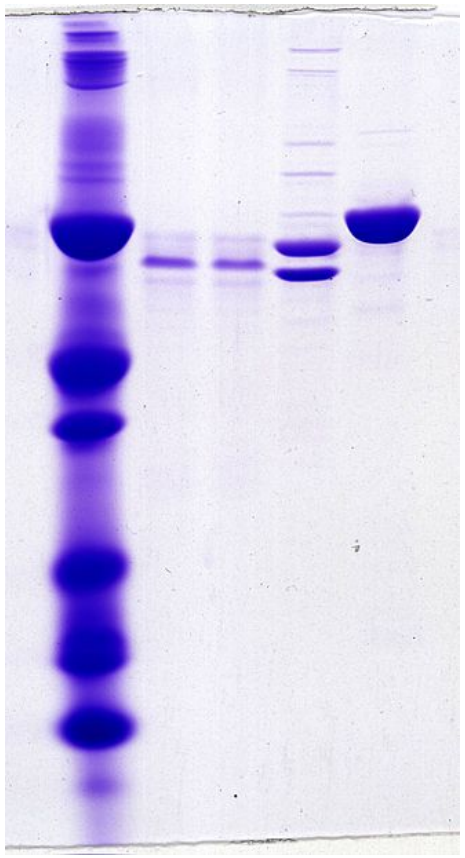
Protein Denature



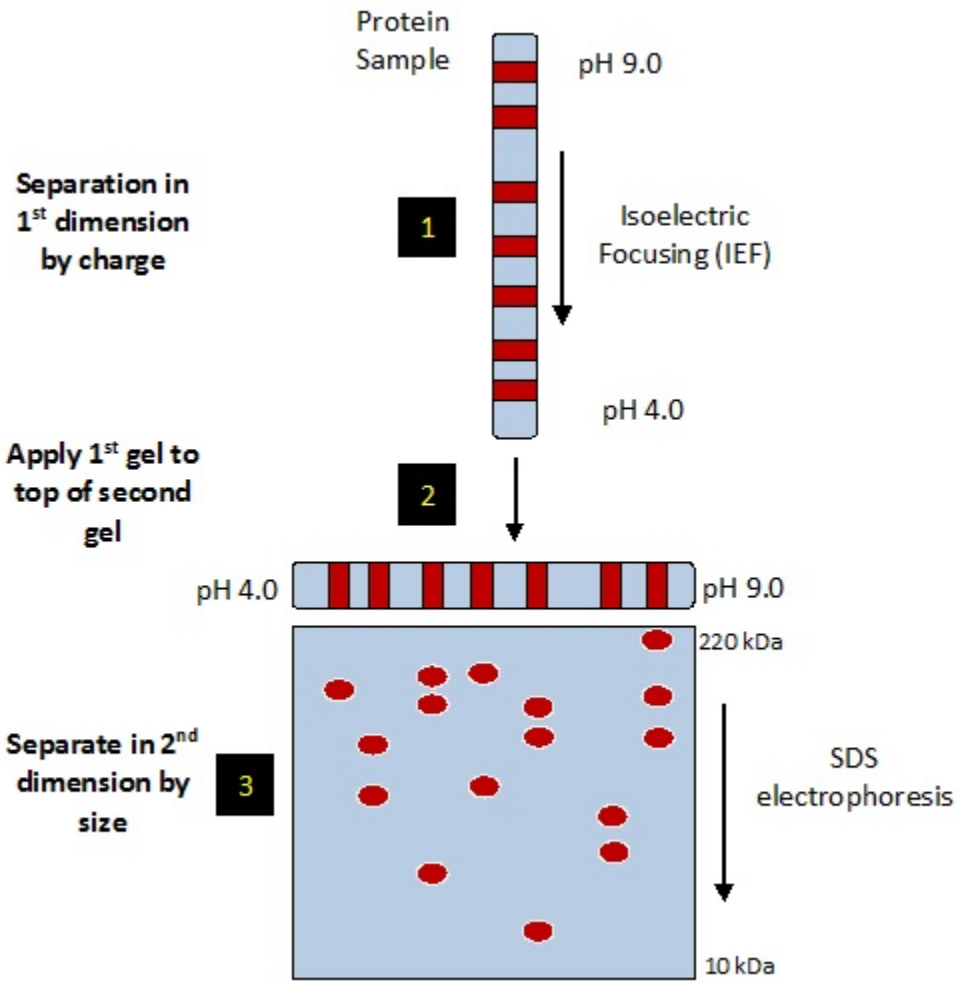


SDS-PAGE

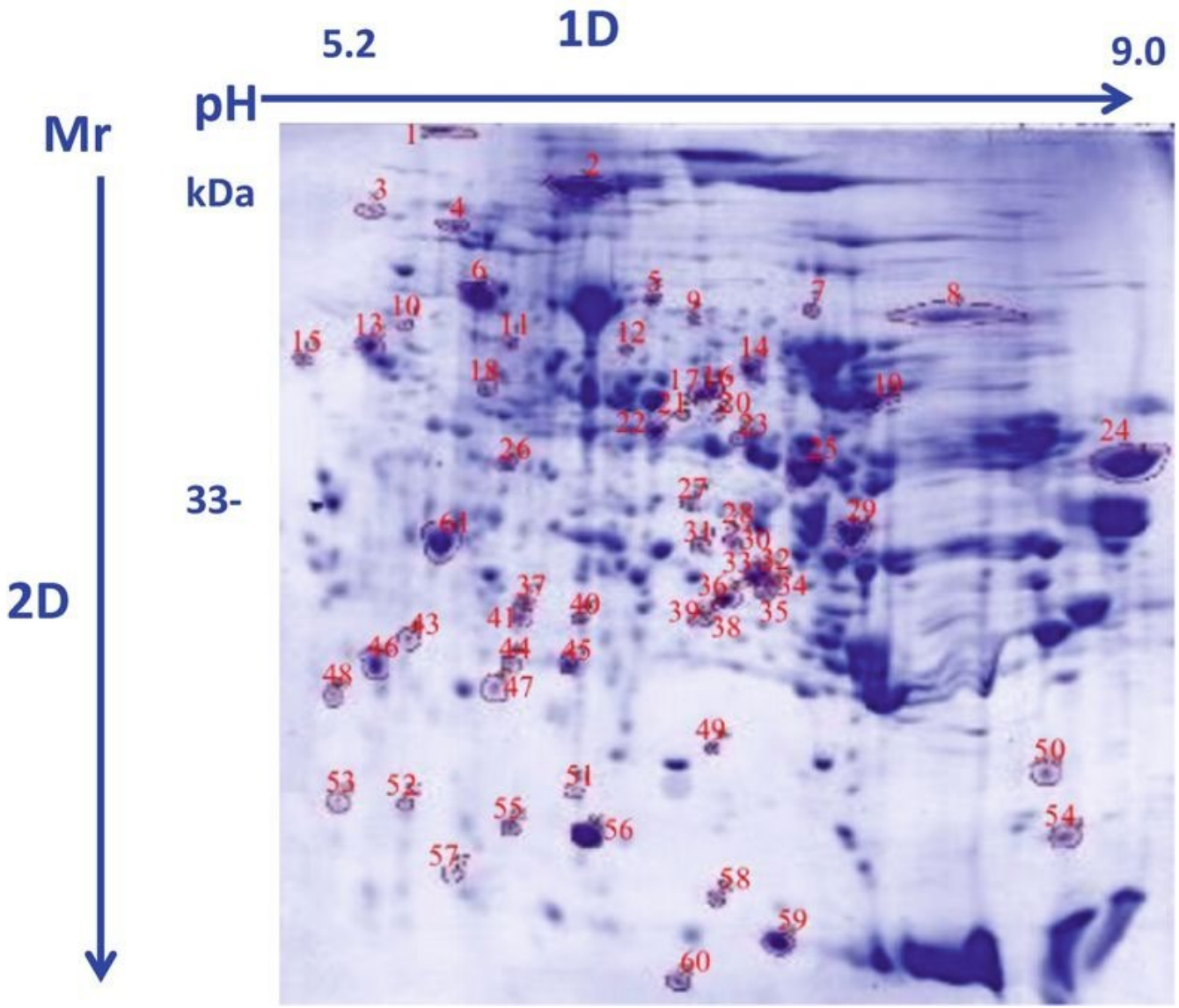


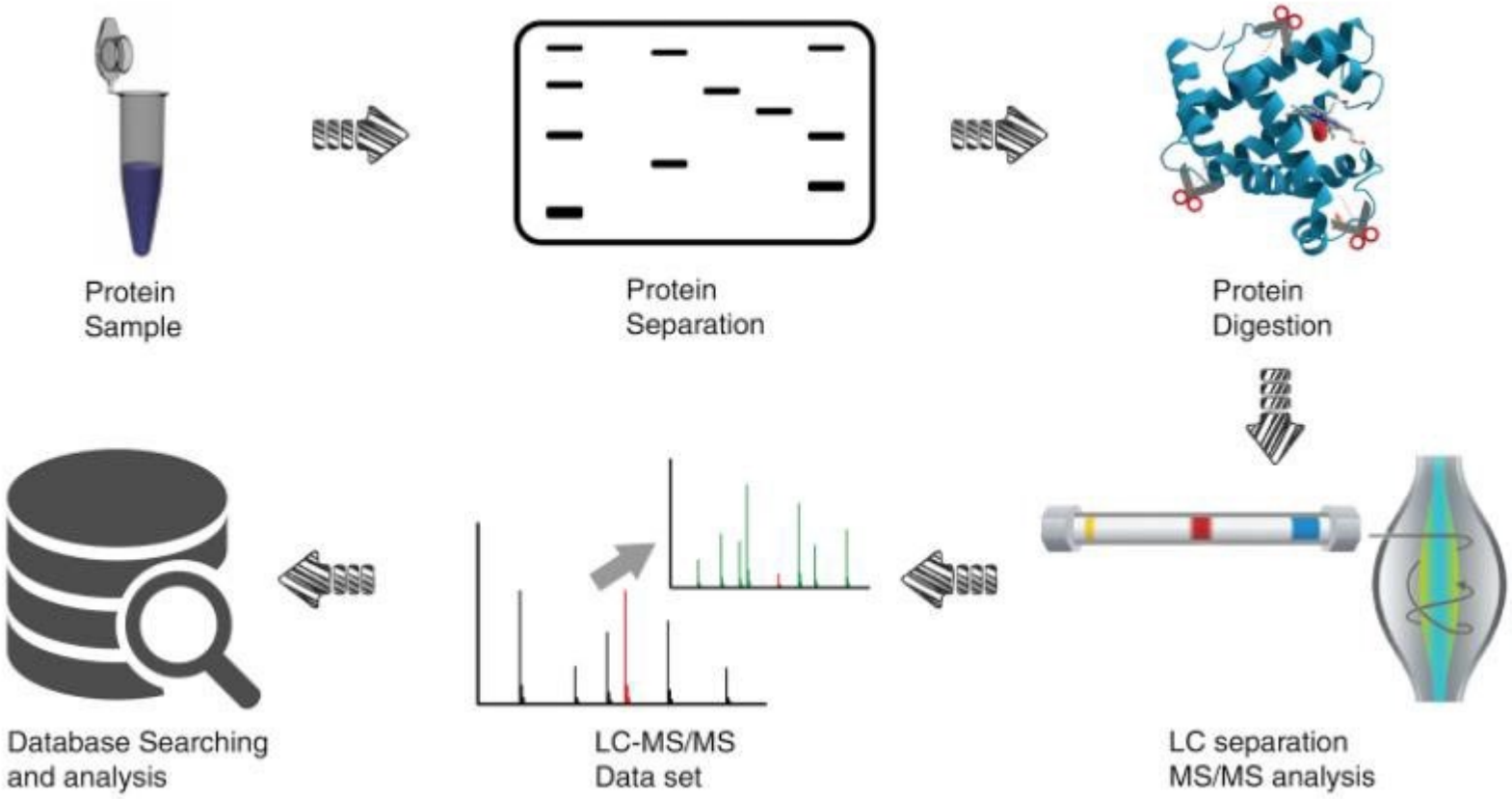


2D PAGE


Protein Sample
pH 9.0
Separation in 1st dimension by charge
1
Isoelectric Focusing (IEF)
pH 4.0
Apply 1st gel to top of second gel
2
pH 4.0
pH 9.0
220 kDa
Separate in 2nd dimension by size
3
SDS electrophoresis
10 kDa

2D PAGE

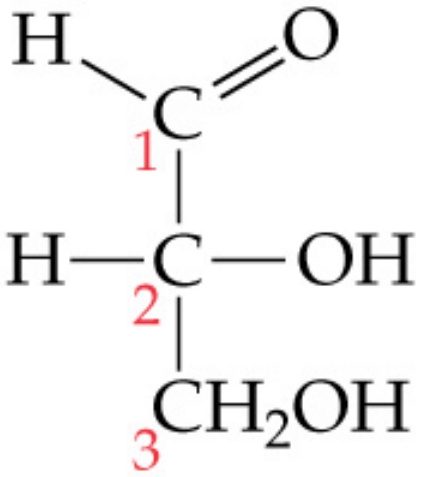


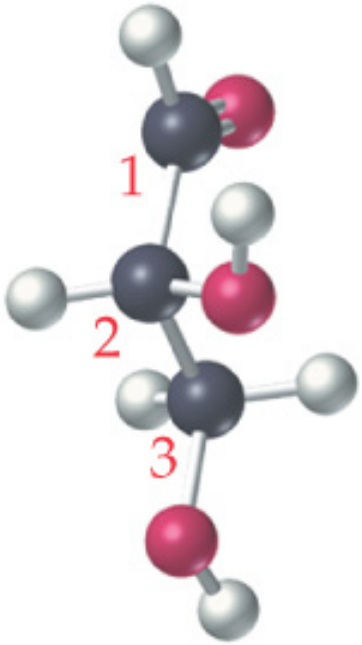

Protein
Sample
Protein
Separation
Protein
Digestion
Database Searching
and analysis
LC-MS/MS
Data set
LC separation
MS/MS analysis

An Introduction to Carbohydrates

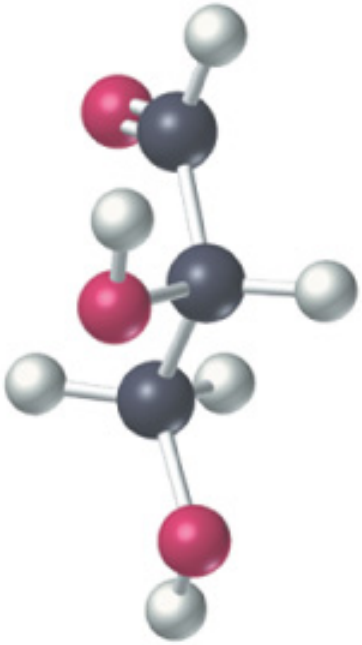
- *Carbohydrates* are a large class of naturally occurring polyhydroxy aldehydes and ketones.
- Monosaccharides also known as simple sugars, are the simplest carbohydrates containing 3-7 carbon atoms.
- sugar containing an aldehydes is known as an aldose.
- sugar containing a ketones is known as a ketose.

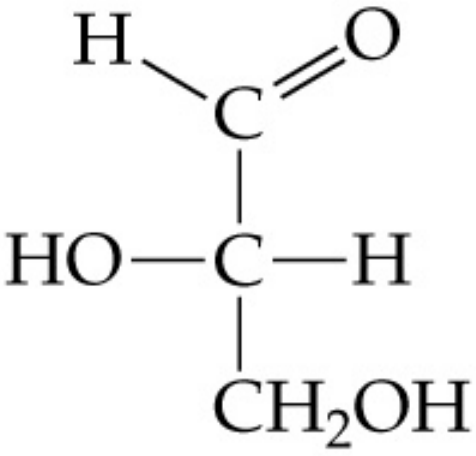
- The number of carbon atoms in an aldose or ketose may be specified as by tri, tetr, pent, hex, or hept. For example, glucose is aldohexose and fructose is ketohexose.
- Monosaccharides react with each other to form disaccharides and polysaccharides.
- Monosaccharides are chiral molecules and exist mainly in cyclic forms rather than the straight chain.



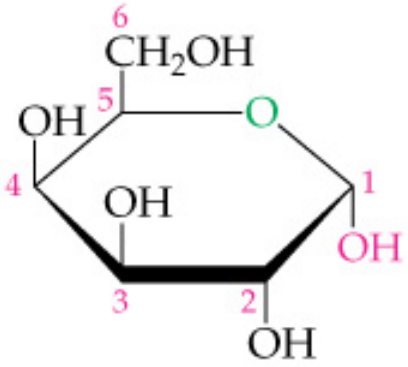


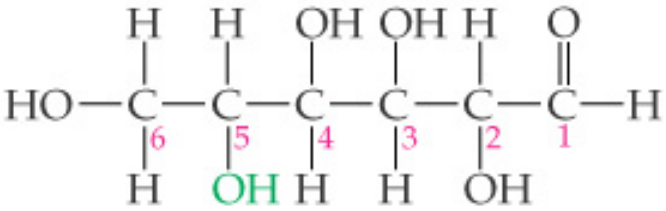
D-Glyceraldehyde
Right-handed

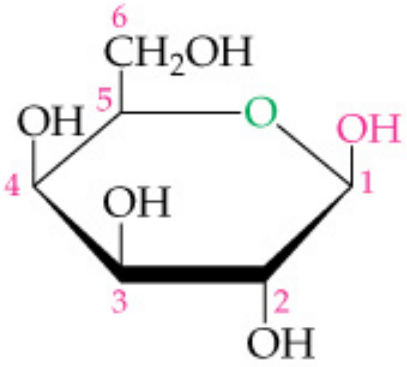


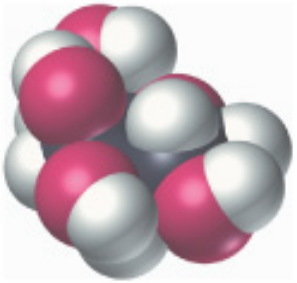


L-Glyceraldehyde
Left-handed

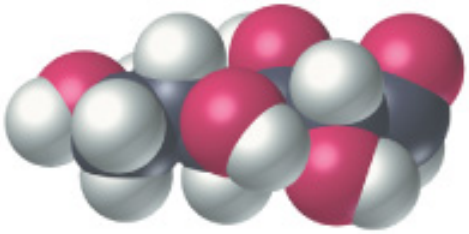




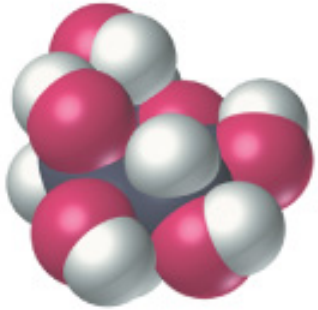




α-D-Galactose

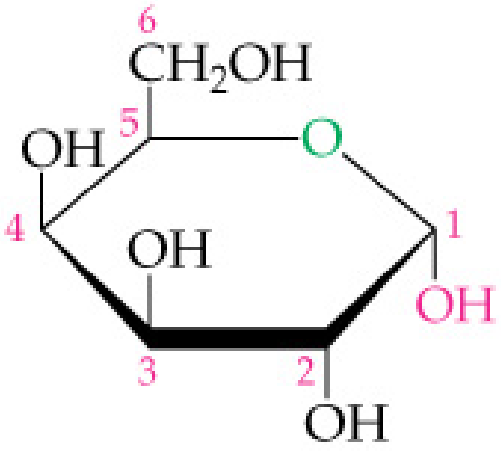


Open-chain galactose

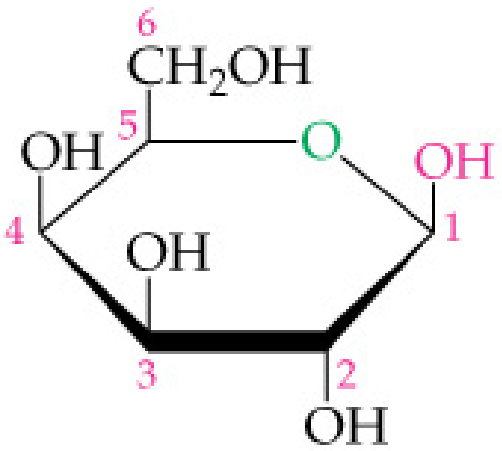


β-D-Galactose

- *Anomers:* Cyclic sugars that differs only in positions of substituents at the hemiacetal carbon; the α-form has the –OH group on the opposite side from the $–CH_2OH$; the β-form the –OH group on the same side as the $–CH_2OH$ group.



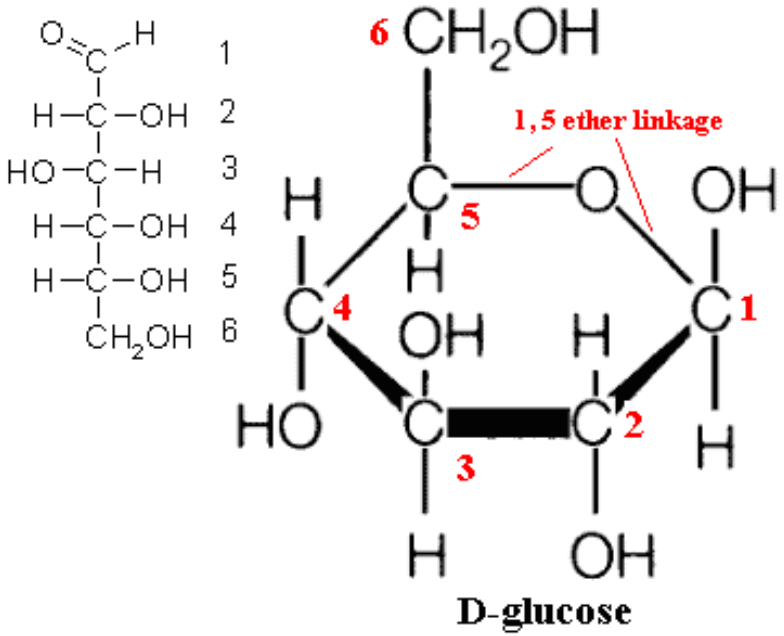
α-D-Galactose

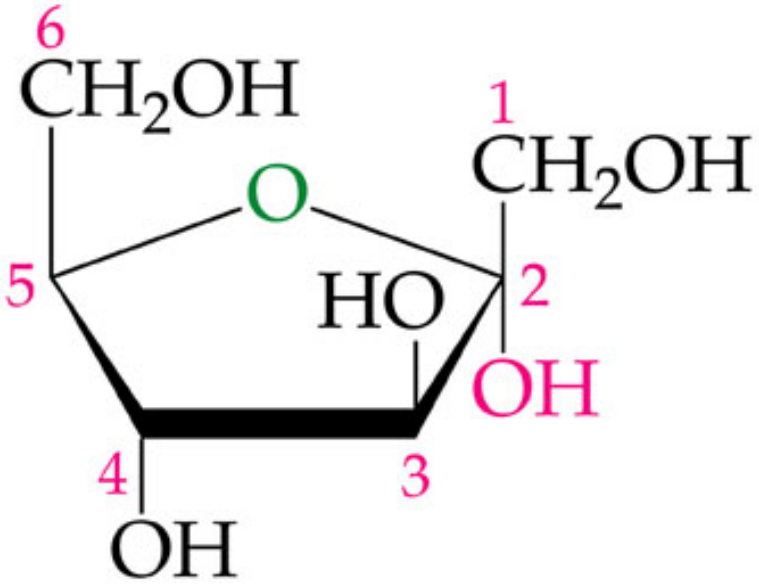


β-D-Galactose

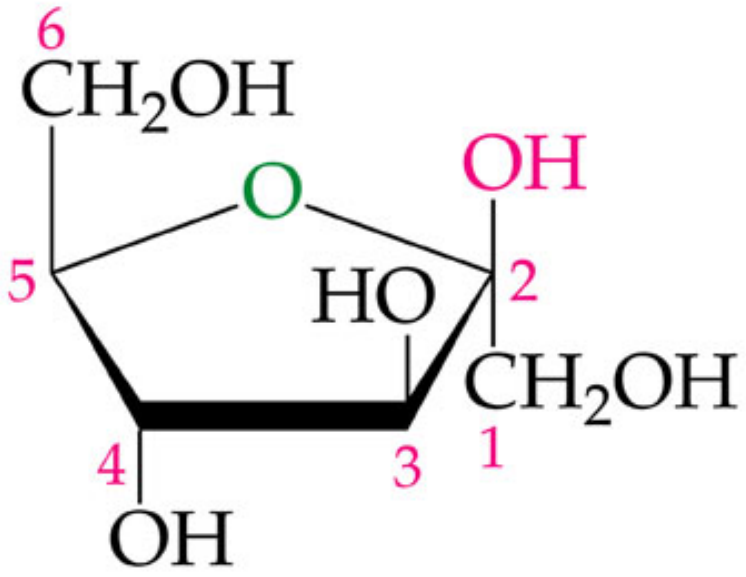
Some Important Monosaccharides

Monosaccharides are generally high-melting, white, crystalline solids that are soluble in water and insoluble in nonpolar solvents. Most monosaccharides are sweet tasting, digestible, and nontoxic.

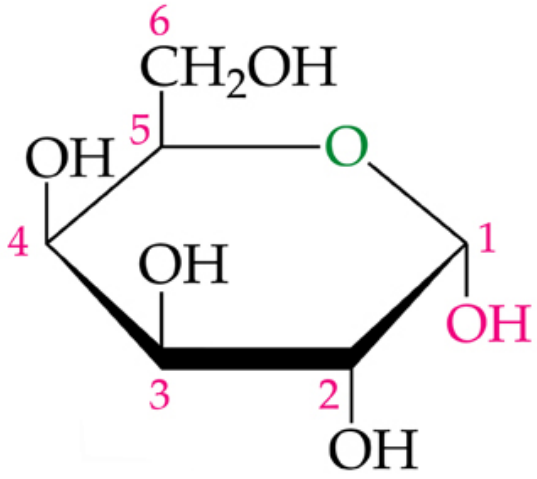




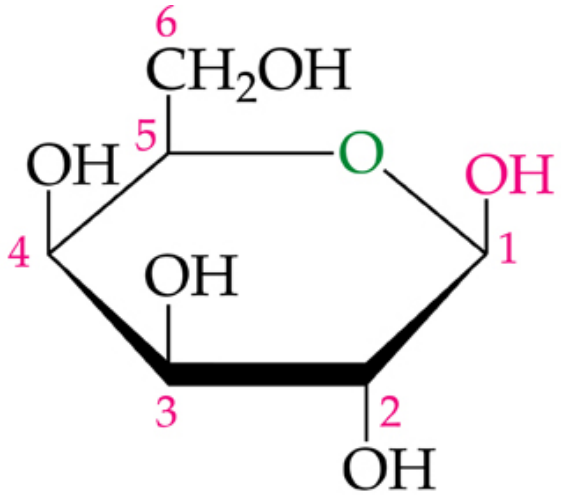
α-D-Fructose



β-D-Fructose

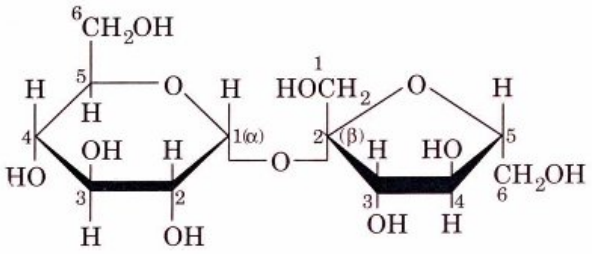


α-D-Galactose

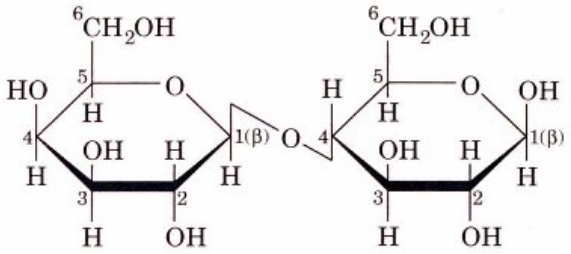


β-D-Galactose

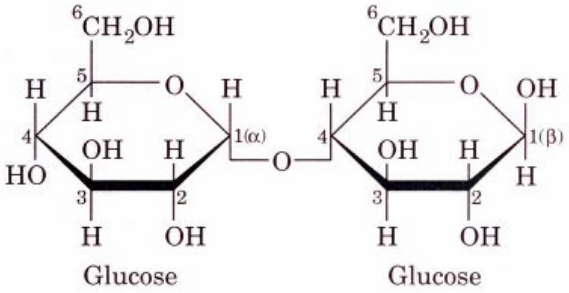
Some Common Disaccharides



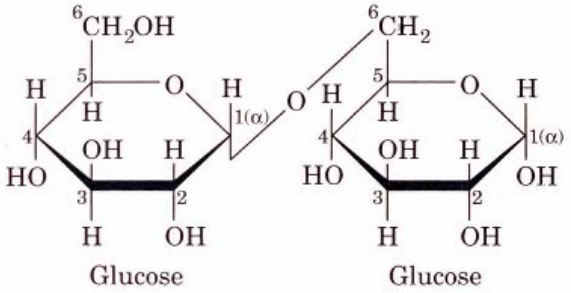
Sucrose



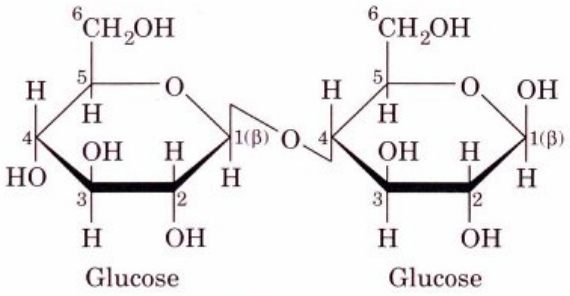
Lactose



Maltose

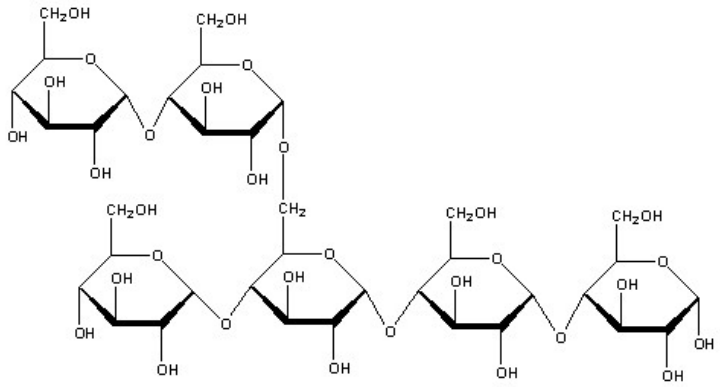


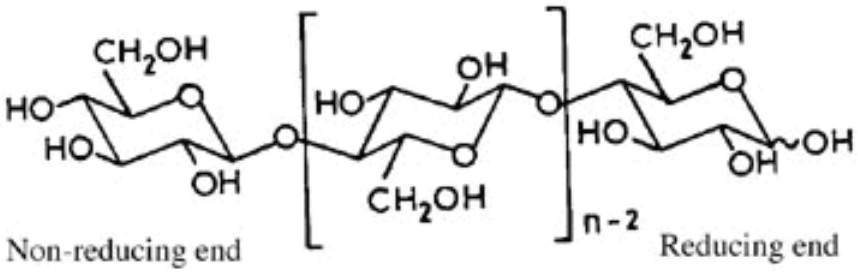
Isomaltose



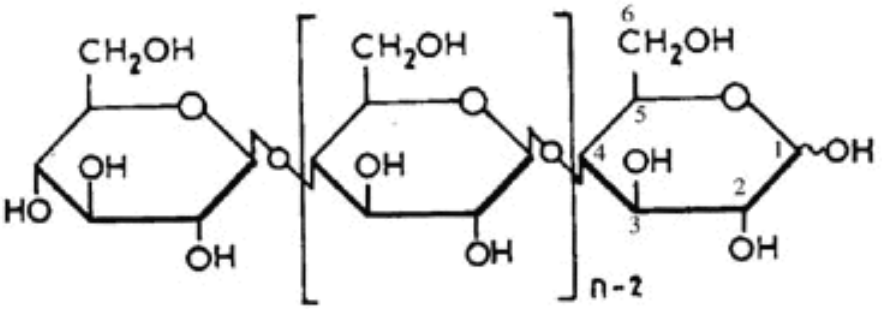
Cellobiose

Polysaccharides

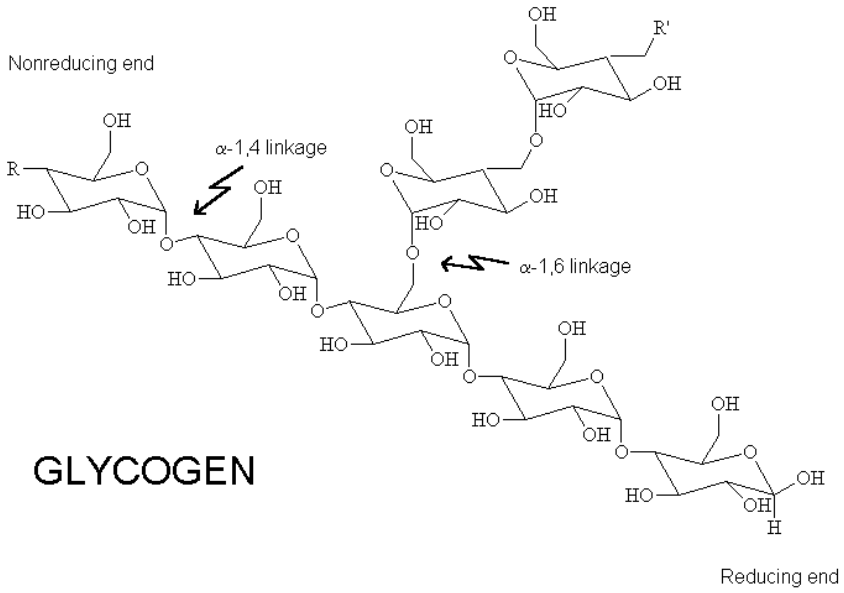




Sometimes shown as

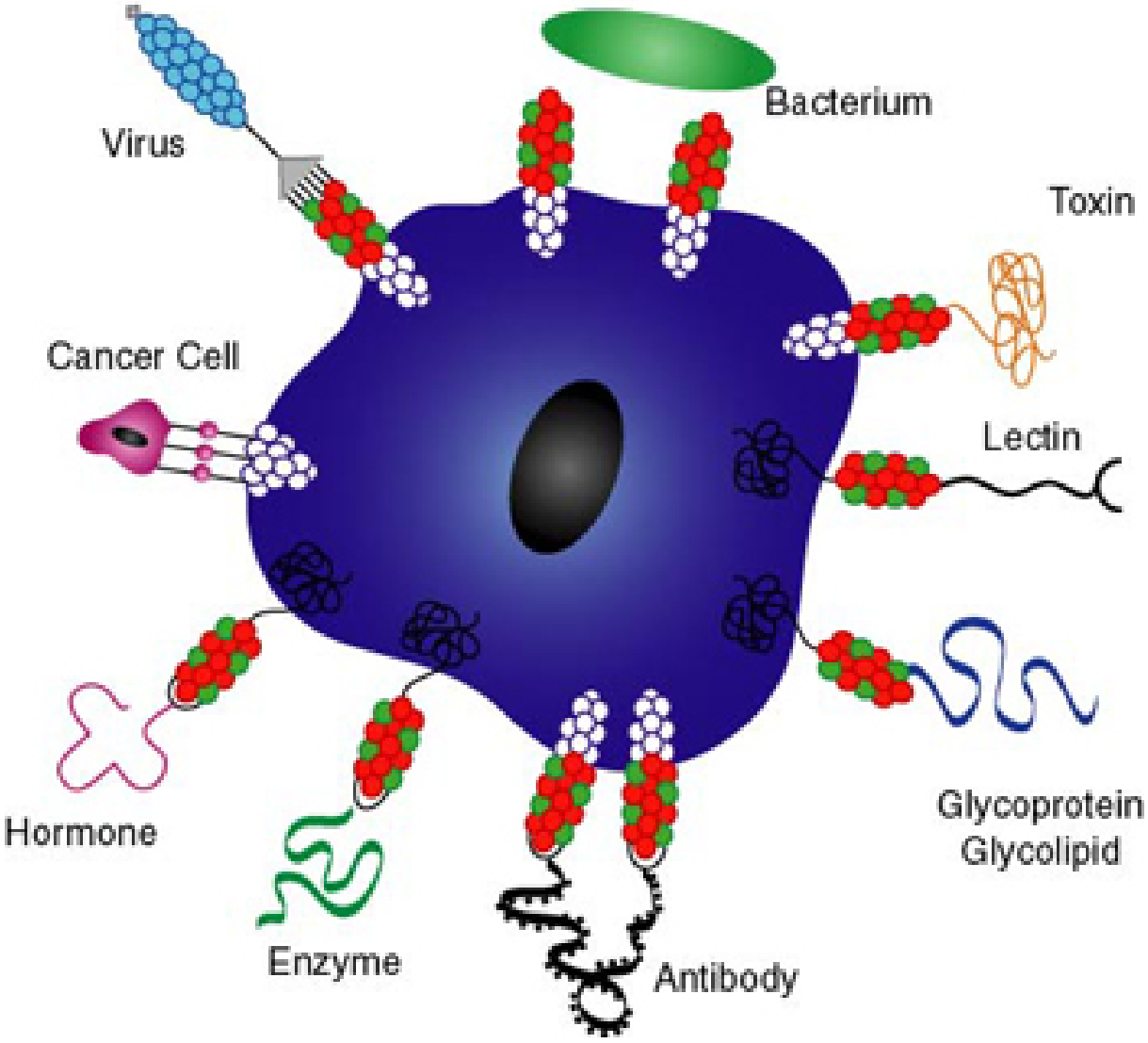


Cellulose



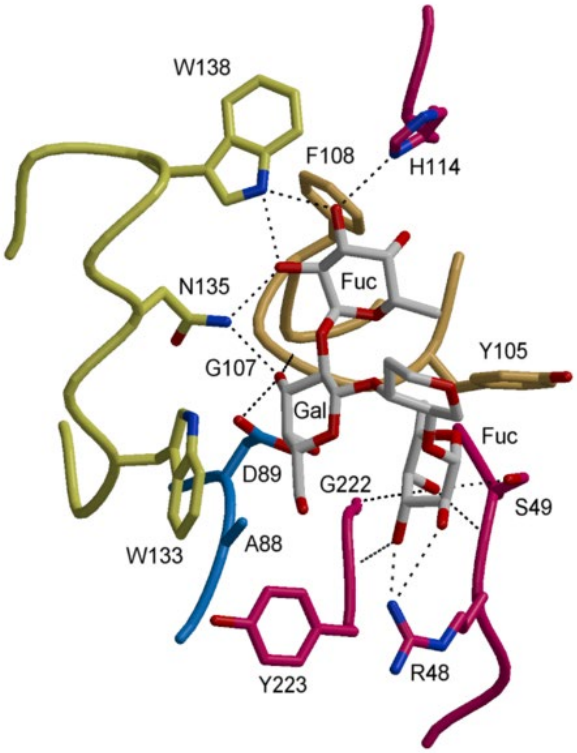
GLYCOGEN

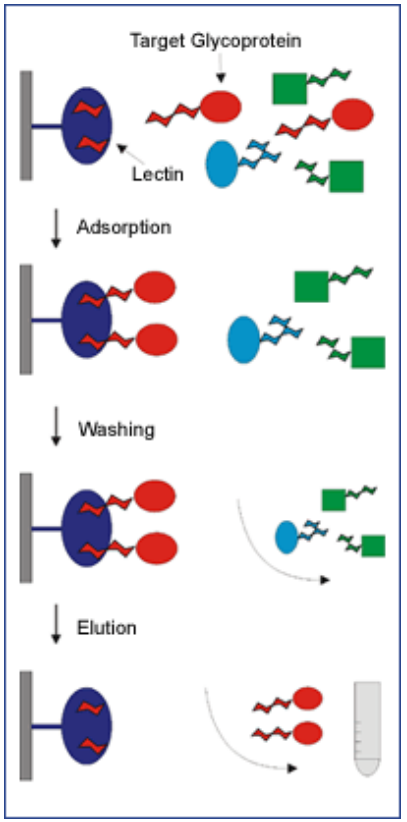
Cell-Surface Carbohydrates Involved in Molecular Recognition



Lectin

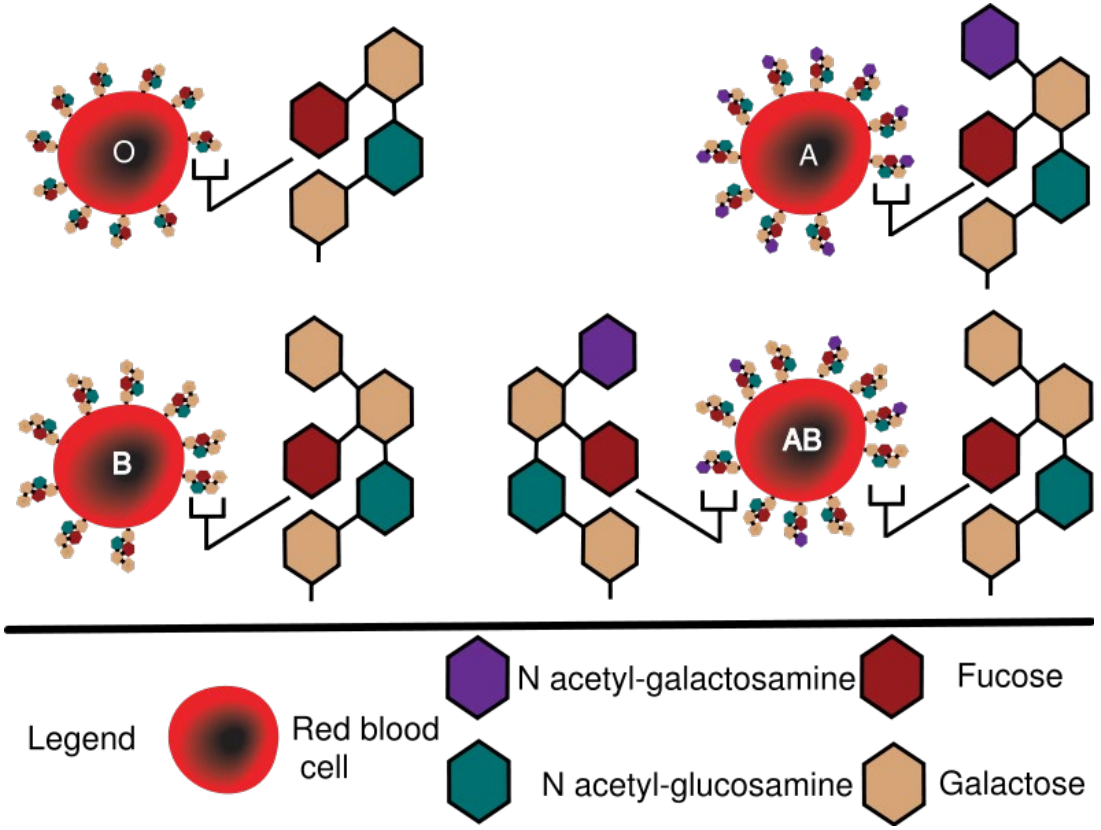
Lectins are sugar-binding proteins which are highly specific for their sugar moieties. They typically play a role in biological recognition phenomena involving cells and proteins. For example, some bacteria use lectins to attach themselves to the cells of the host organism during infection.





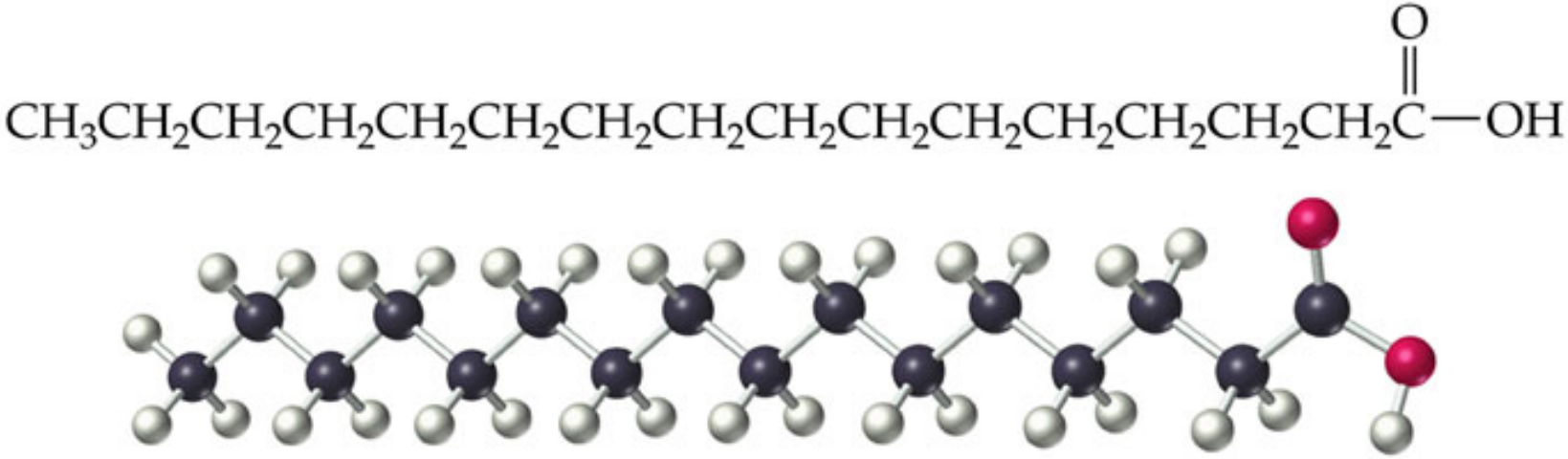
Blood Type

	Group A	Group B	Group AB	Group O
Red blood cell type	A	B	AB	O
Antibodies present	Anti-B	Anti-A	None	Anti-A and Anti-B
Antigens present	A antigen	B antigen	A and B antigens	No antigens

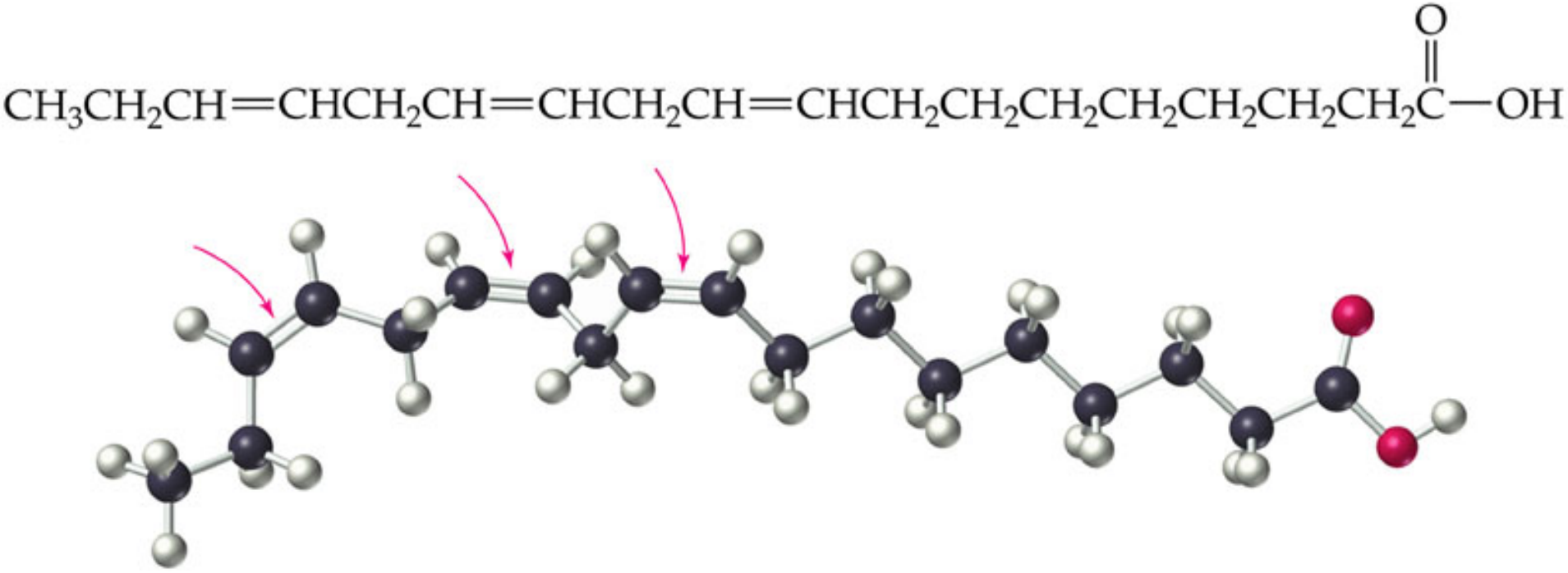


Lipid

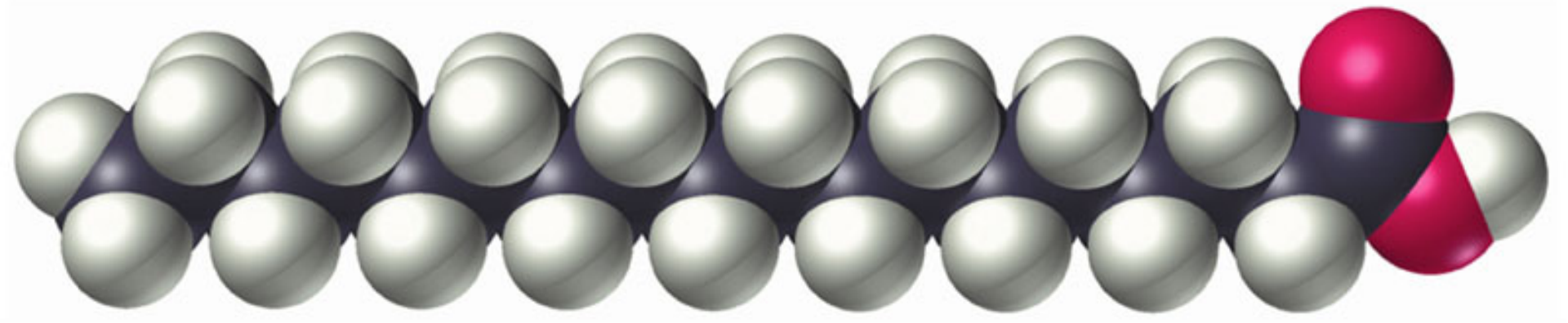
- ***Lipids*** are naturally occurring molecules from plants or animals that are soluble in nonpolar organic solvents.
- Lipid molecules contain large hydrocarbon portion and not many polar functional group, which accounts for their solubility behavior.



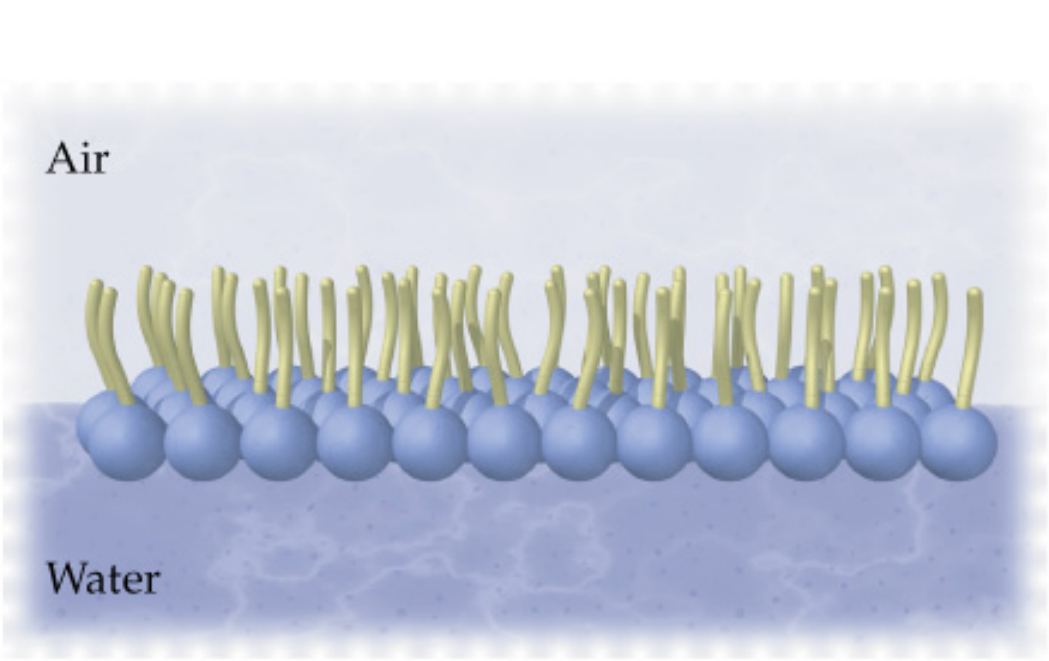
A saturated fatty acid
(palmitic acid)

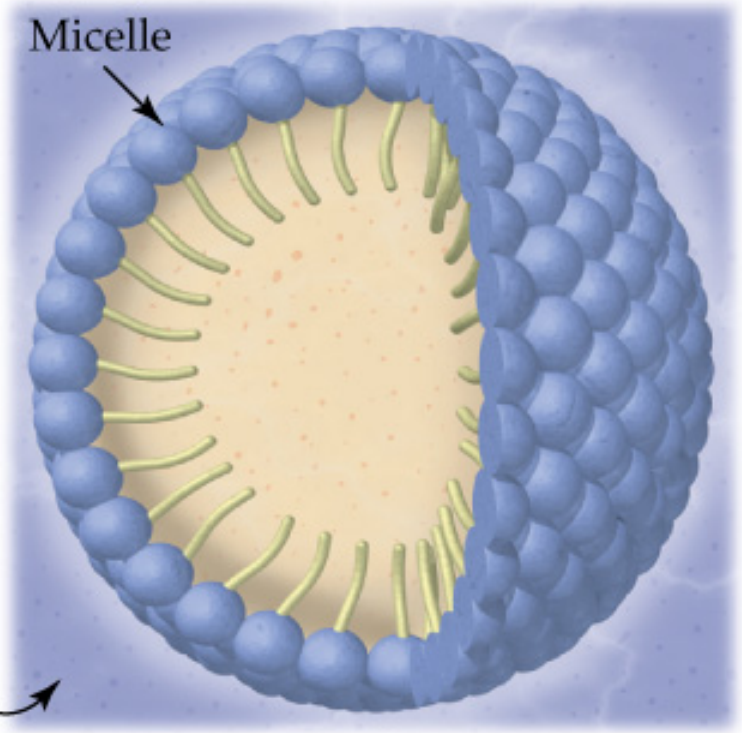


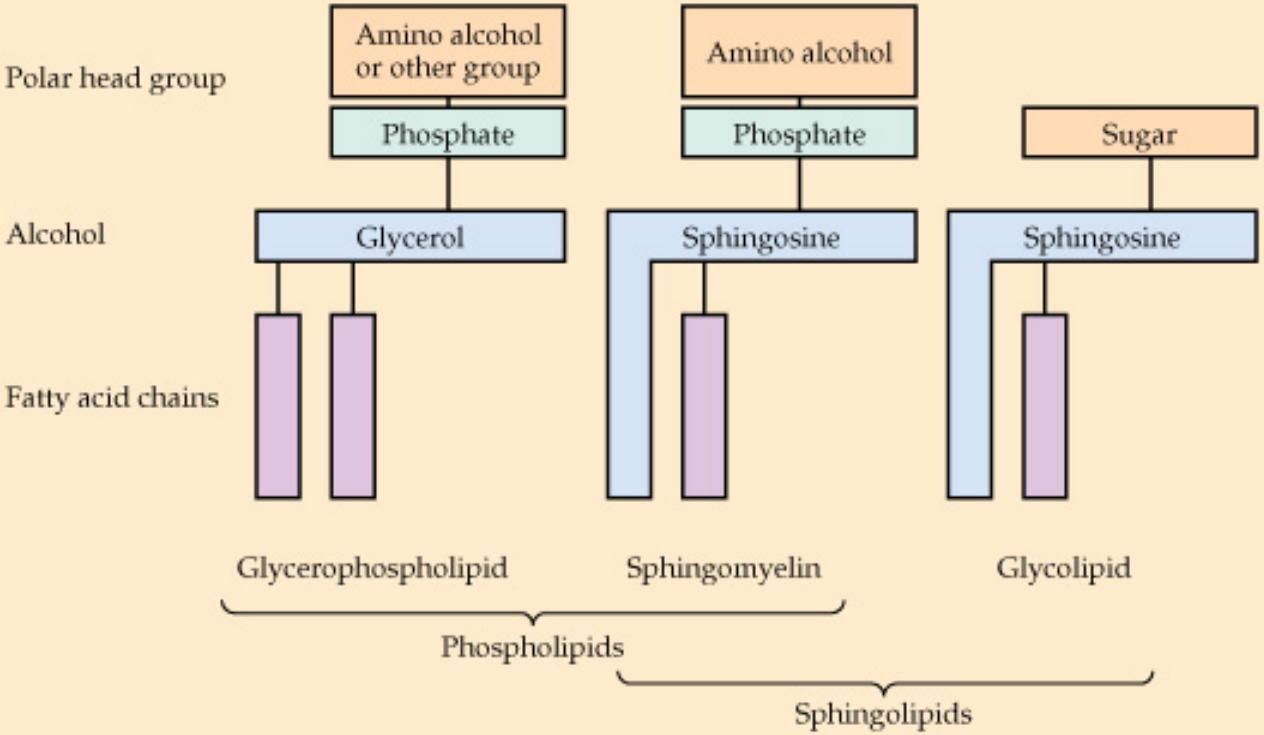
A *cis* unsaturated fatty acid
(linolenic acid)

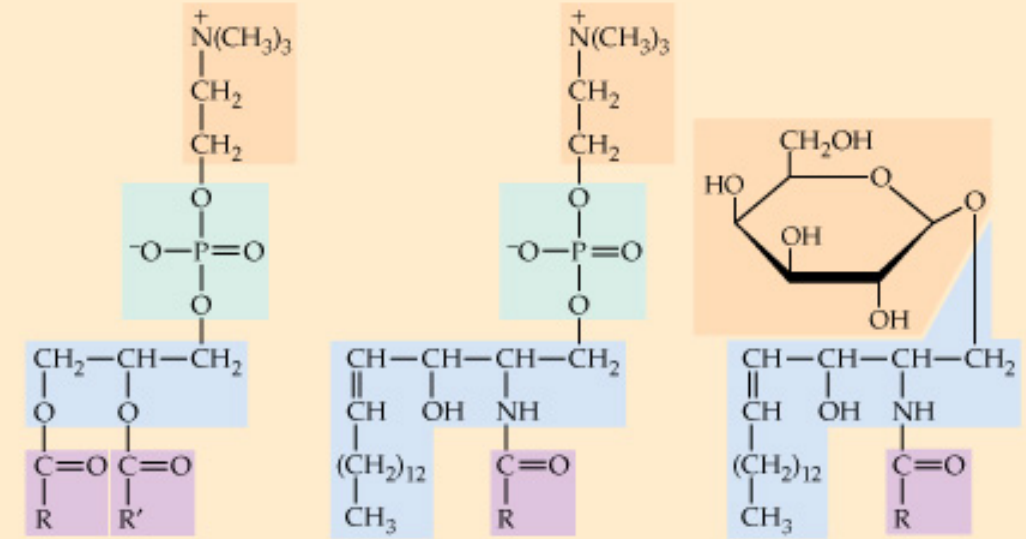


Stearic acid, an 18-carbon saturated fatty acid

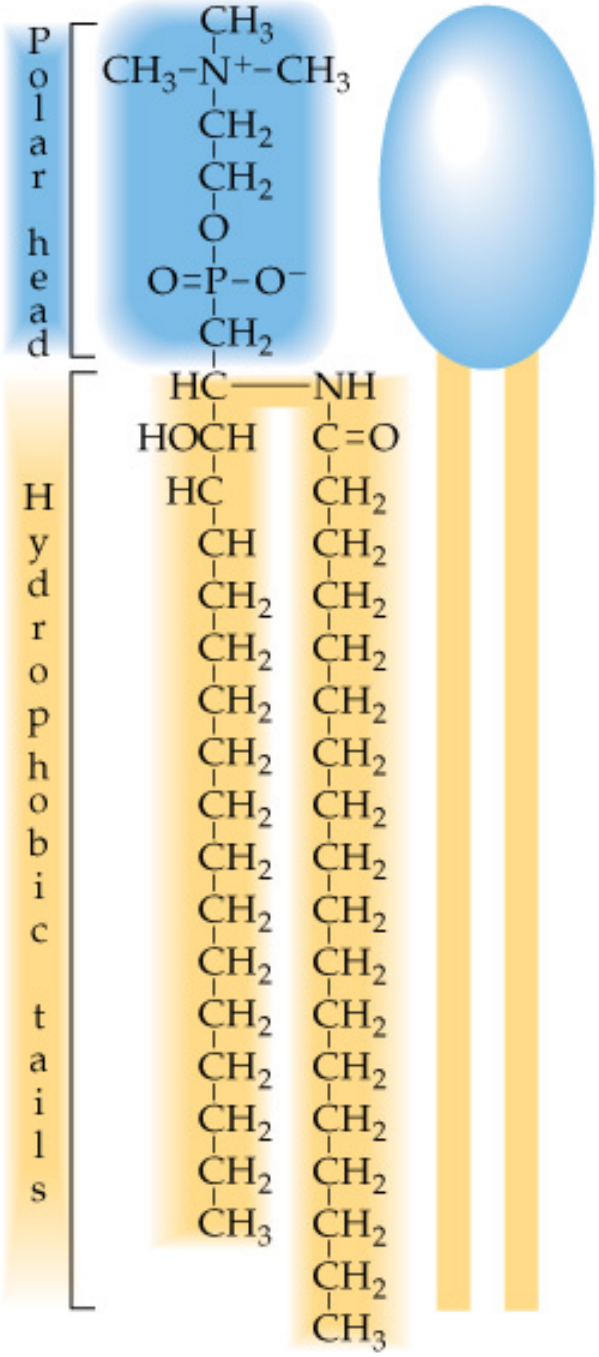

Air
Water


Micelle
Water

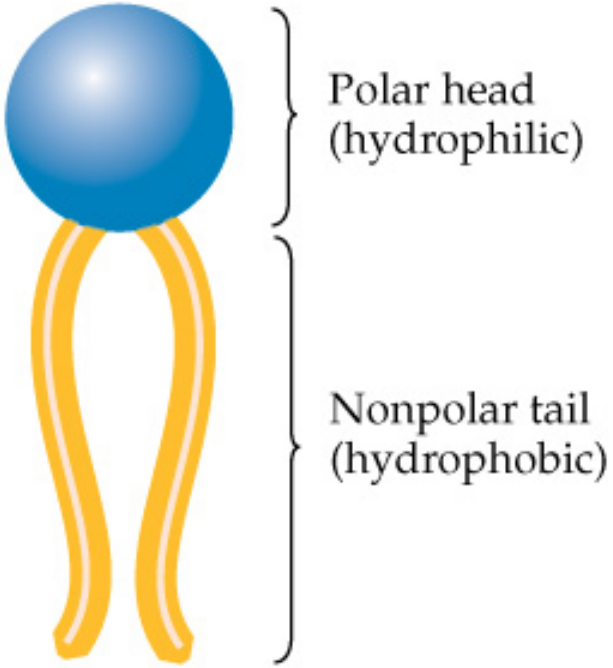




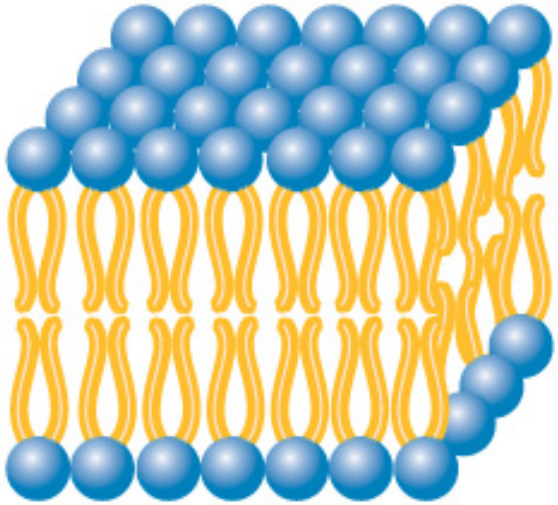
A glycerophospholipid (a phosphatidylcholine) | A sphingomyelin | A glycolipid



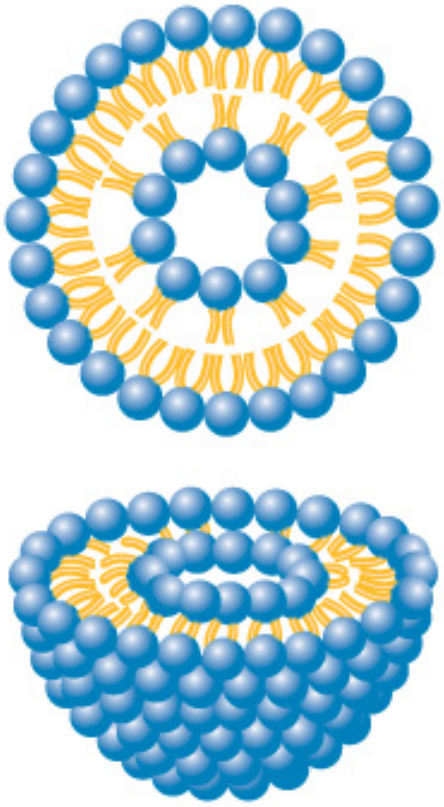
A sphingomyelin



Membrane lipid



Lipid bilayer

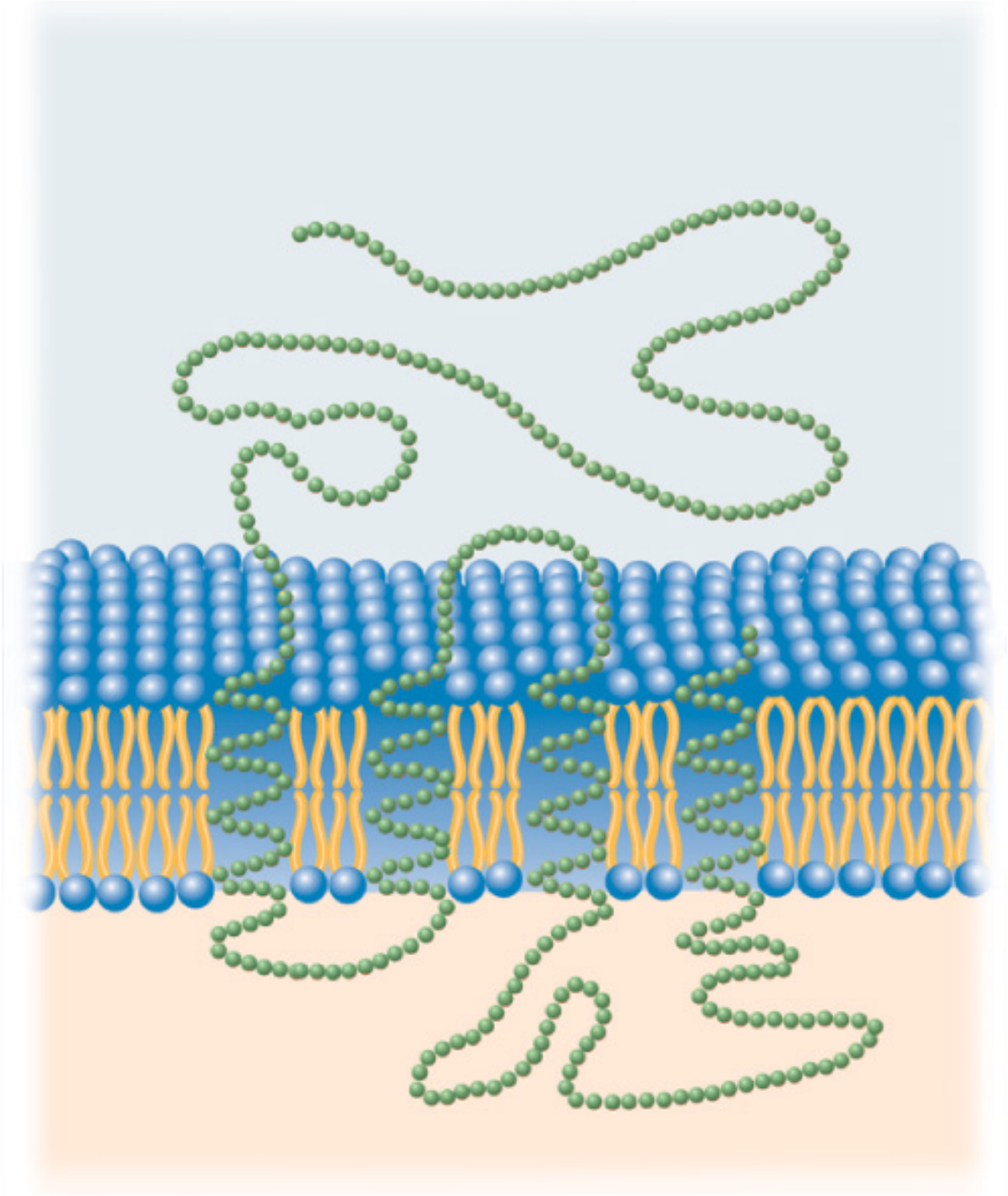


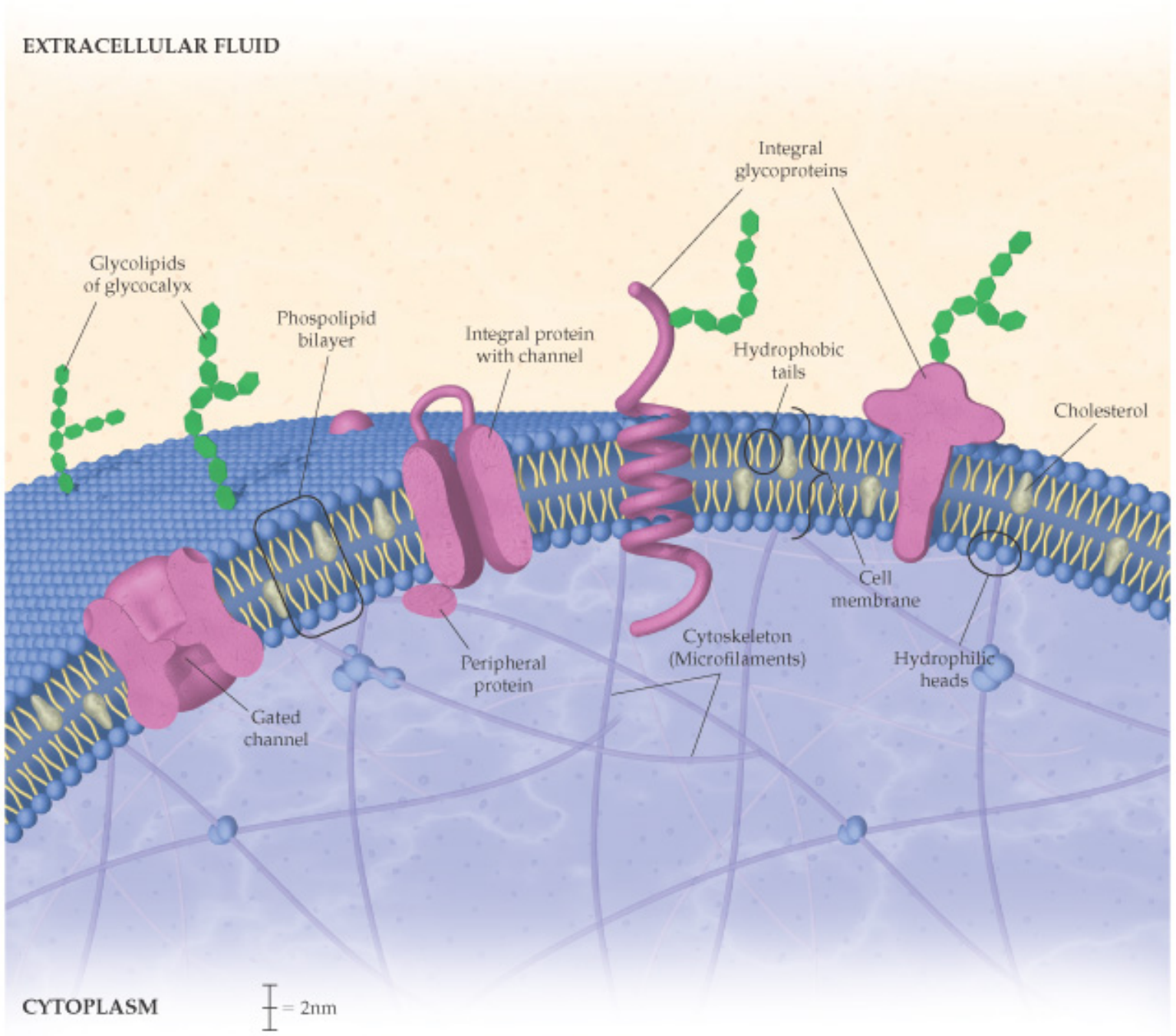
Liposome

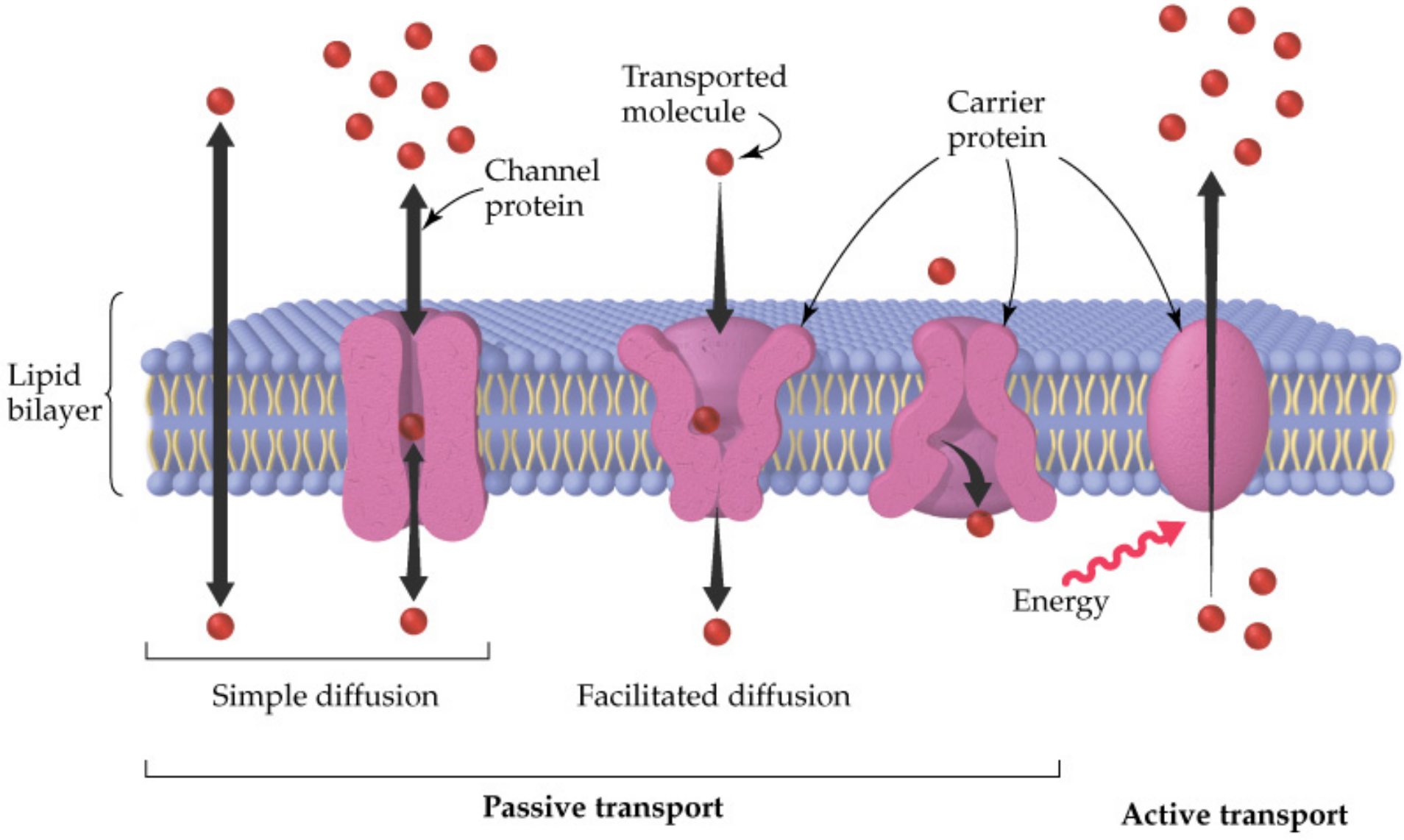
Properties of cell membranes:

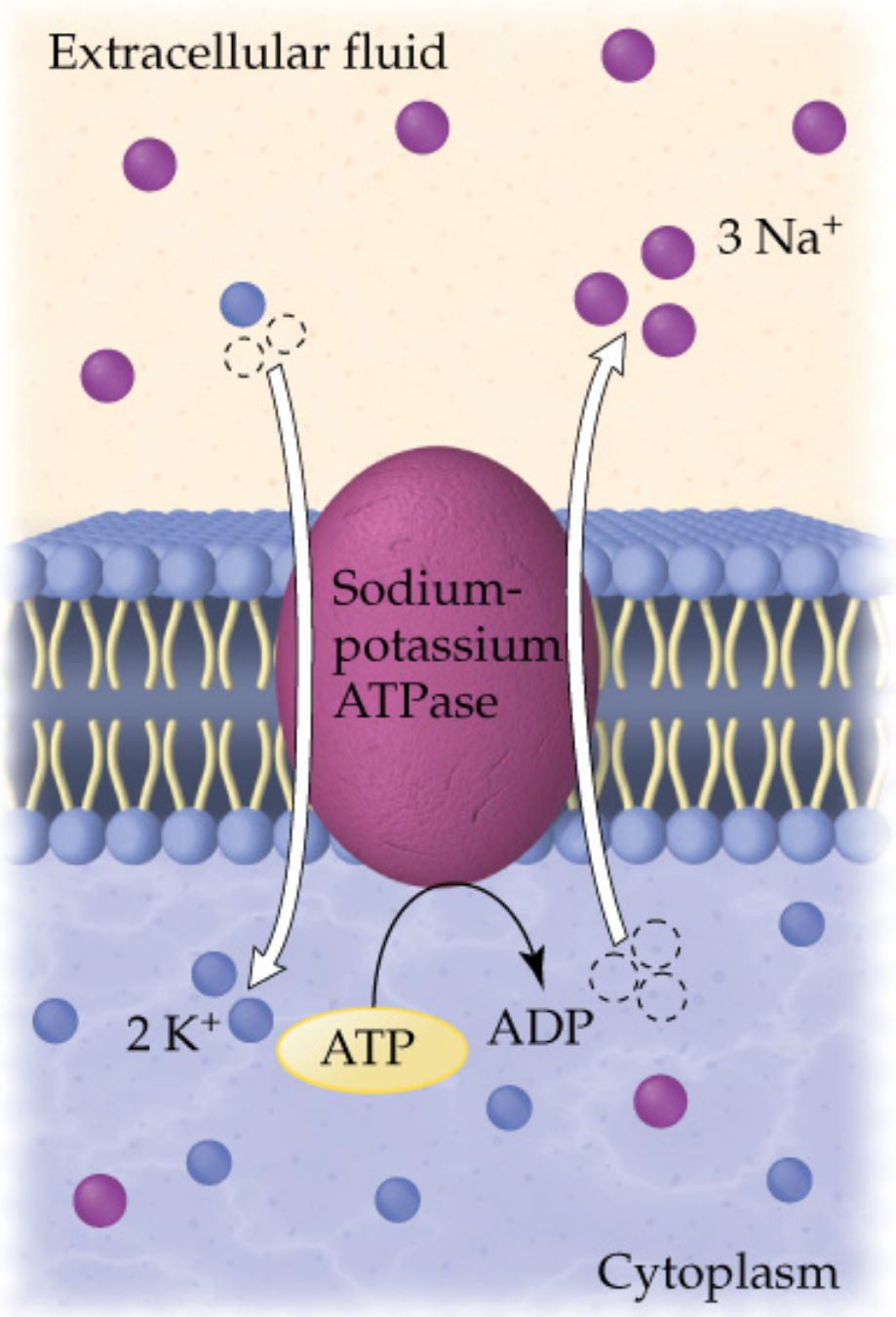
- Cell membranes are composed of a fluid like phospholipid bilayer.
- The bilayer incorporates cholesterol, proteins, and glycolipids.
- Small nonpolar molecules cross by diffusion through the lipid bilayer.
- Small ions and polar molecules diffuse through the aqueous media in protein pores.
- Glucose and certain other substances cross with the aid of proteins without energy input.
- Na^+, K^+, and other substances that maintain concentration gradients inside and outside the cell cross with expenditure of energy and the aid of proteins.

- Small ions and polar molecules diffuse through the aqueous media in protein pores.
- Glucose and certain other substances cross with the aid of proteins without energy input.
- Na^+, K^+, and other substances that maintain concentration gradients inside and outside the cell cross with expenditure of energy and the aid of proteins.

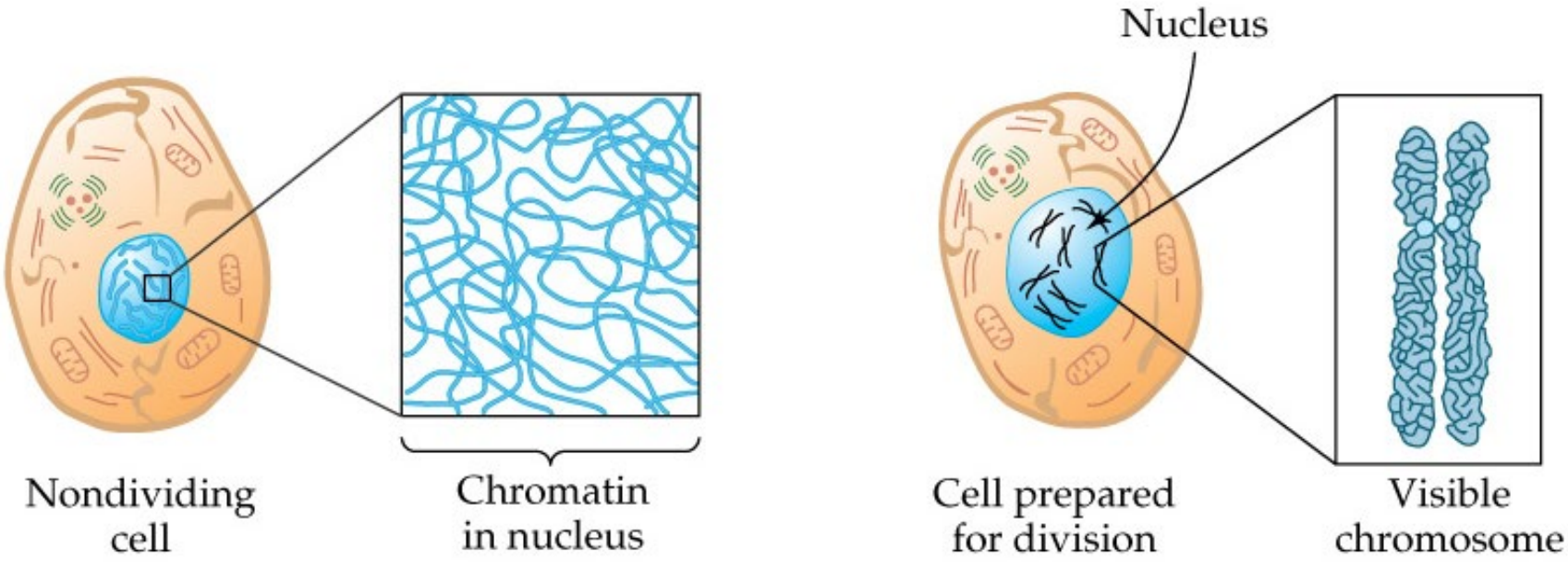



EXTRACELLULAR FLUID
Integral glycoproteins
Glycolipids of glycocalyx
Phospolipid bilayer
Integral protein with channel
Hydrophobic tails
Cholesterol
Cell membrane
Cytoskeleton (Microfilaments)
Peripheral protein
Hydrophilic heads
Gated channel
CYTOPLASM
= 2nm

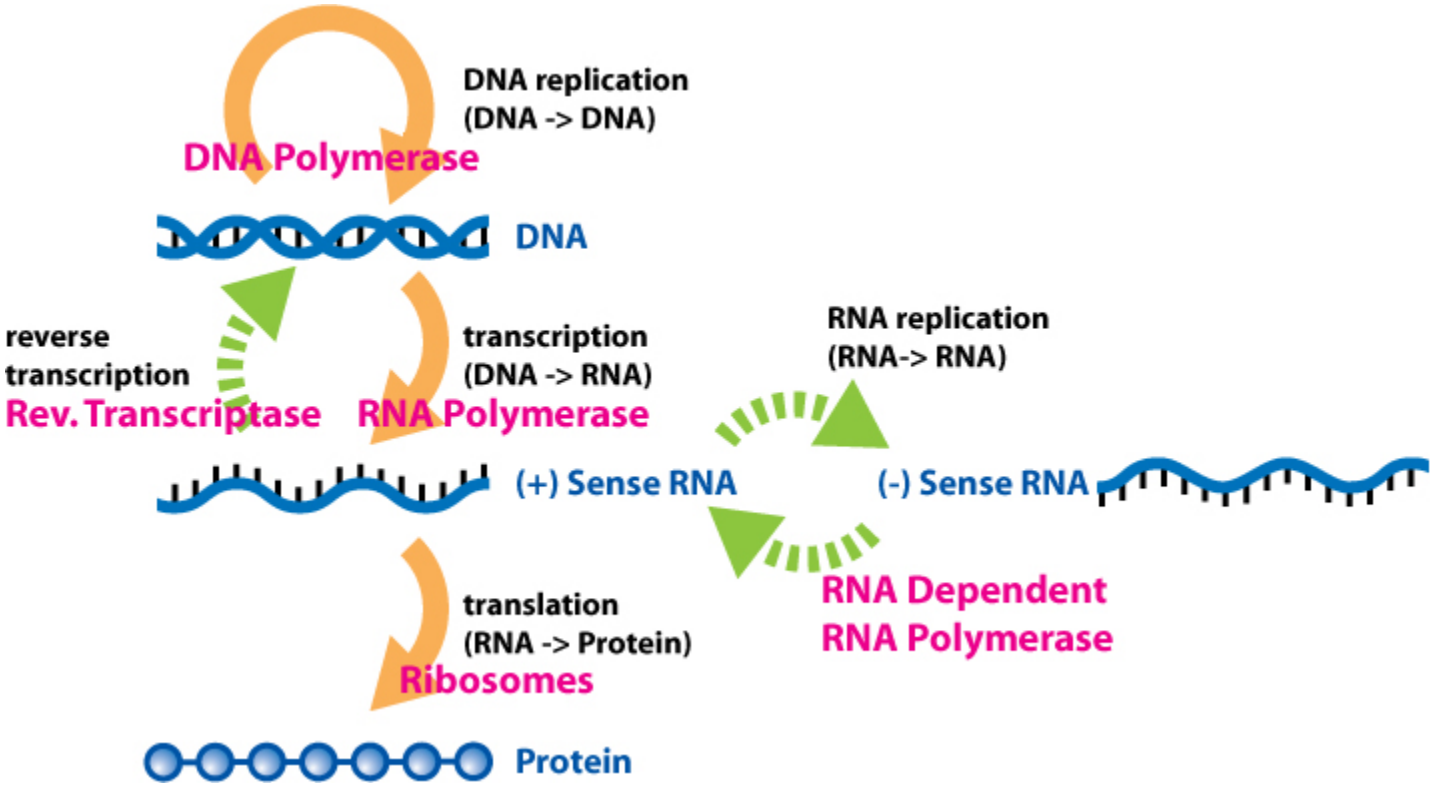

Transported molecule
Carrier protein
Channel protein
Lipid bilayer
Energy
Simple diffusion
Facilitated diffusion
Passive transport
Active transport


Extracellular fluid
3 Na+
Sodium-
potassium
ATPase
2 K+
ATP
ADP
Cytoplasm

DNA


Nucleus
Nondividing cell
Chromatin in nucleus
Cell prepared for division
Visible chromosome

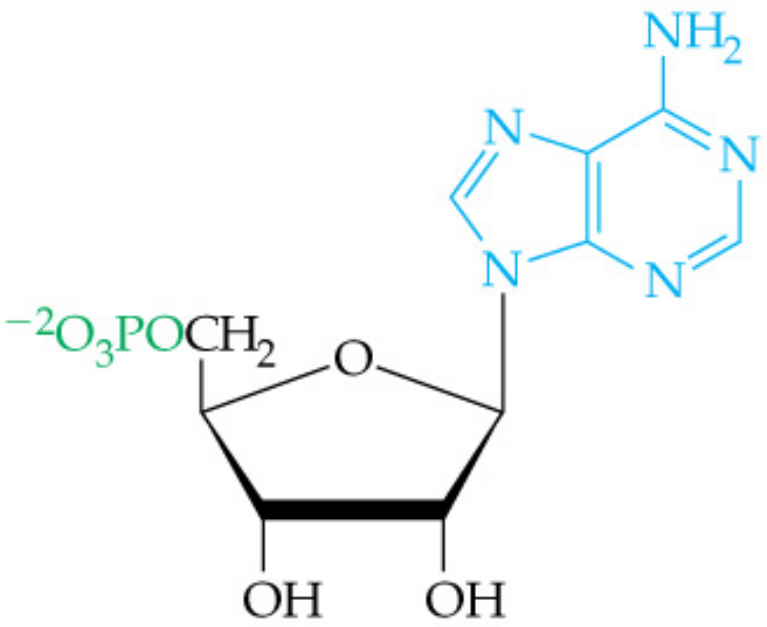
Central Dogma



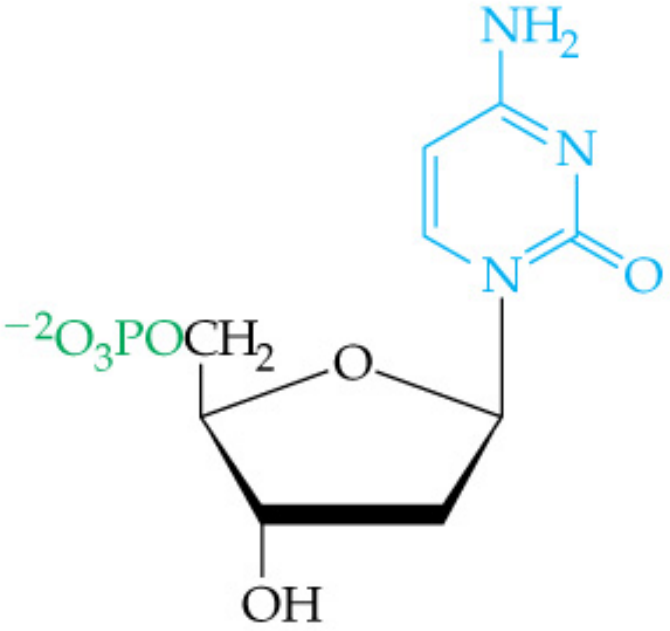
From DNA to Protein

https://www.youtube.com/watch?v=gG7uCskUOrA

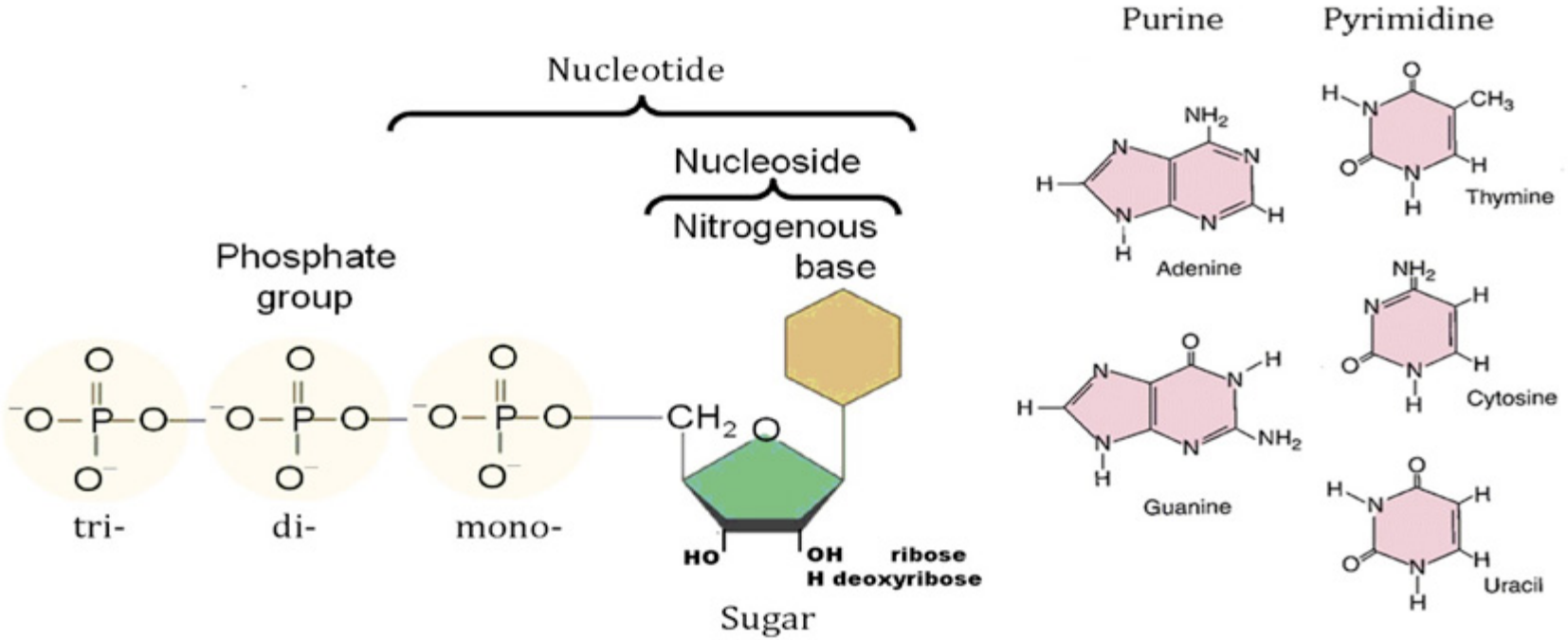
- In RNA, the sugar is ribose.
- In DNA, the sugar is deoxyribose.

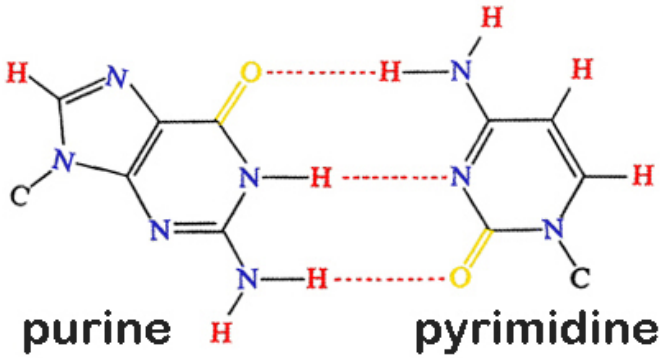


Adenosine 5′-monophosphate (AMP)
(a ribonucleotide)

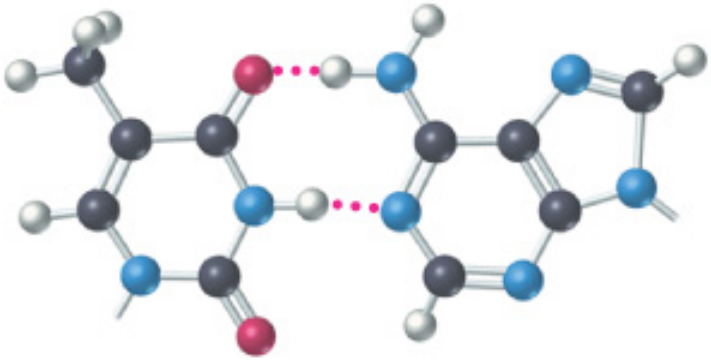


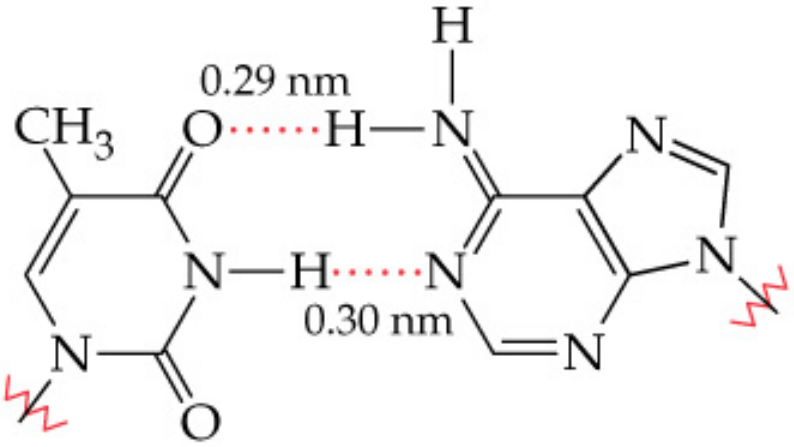
Deoxycytidine 5′-monophosphate (dCMP)
(a deoxyribonucleotide)


Purine
Pyrimidine
Nucleotide
Nucleoside
Nitrogenous base
Phosphate group
tri-
di-
mono-
HO
OH
H
ribose
deoxyribose
Sugar
Adenine
Thymine
Cytosine
Guanine
Uracil

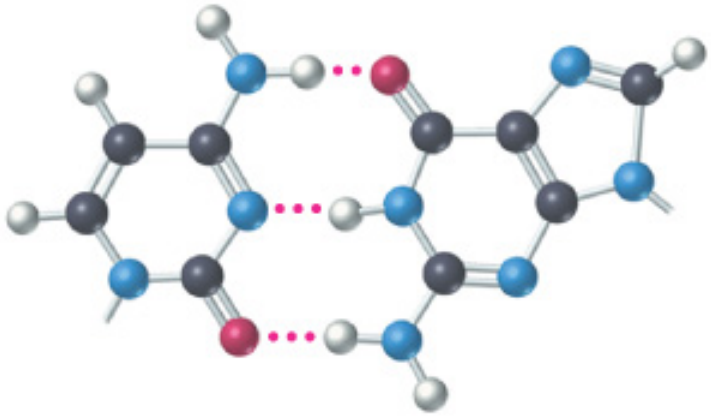

purine
pyrimidine

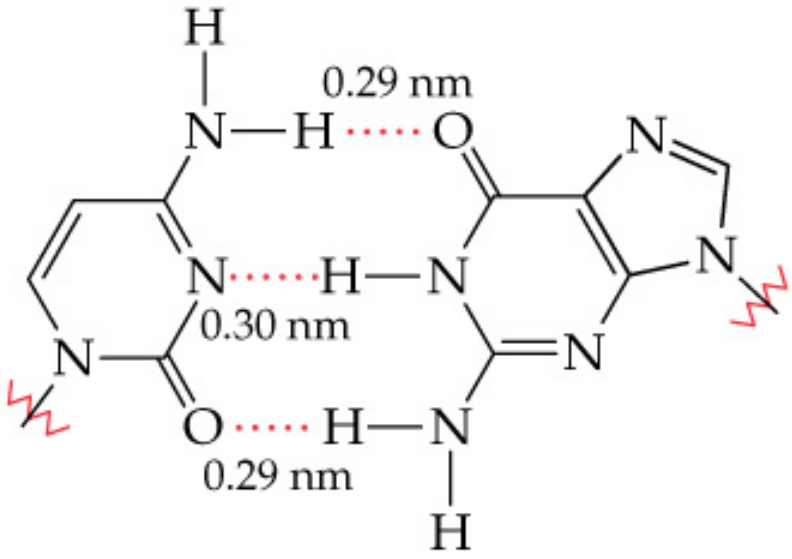
Thymine–Adenine

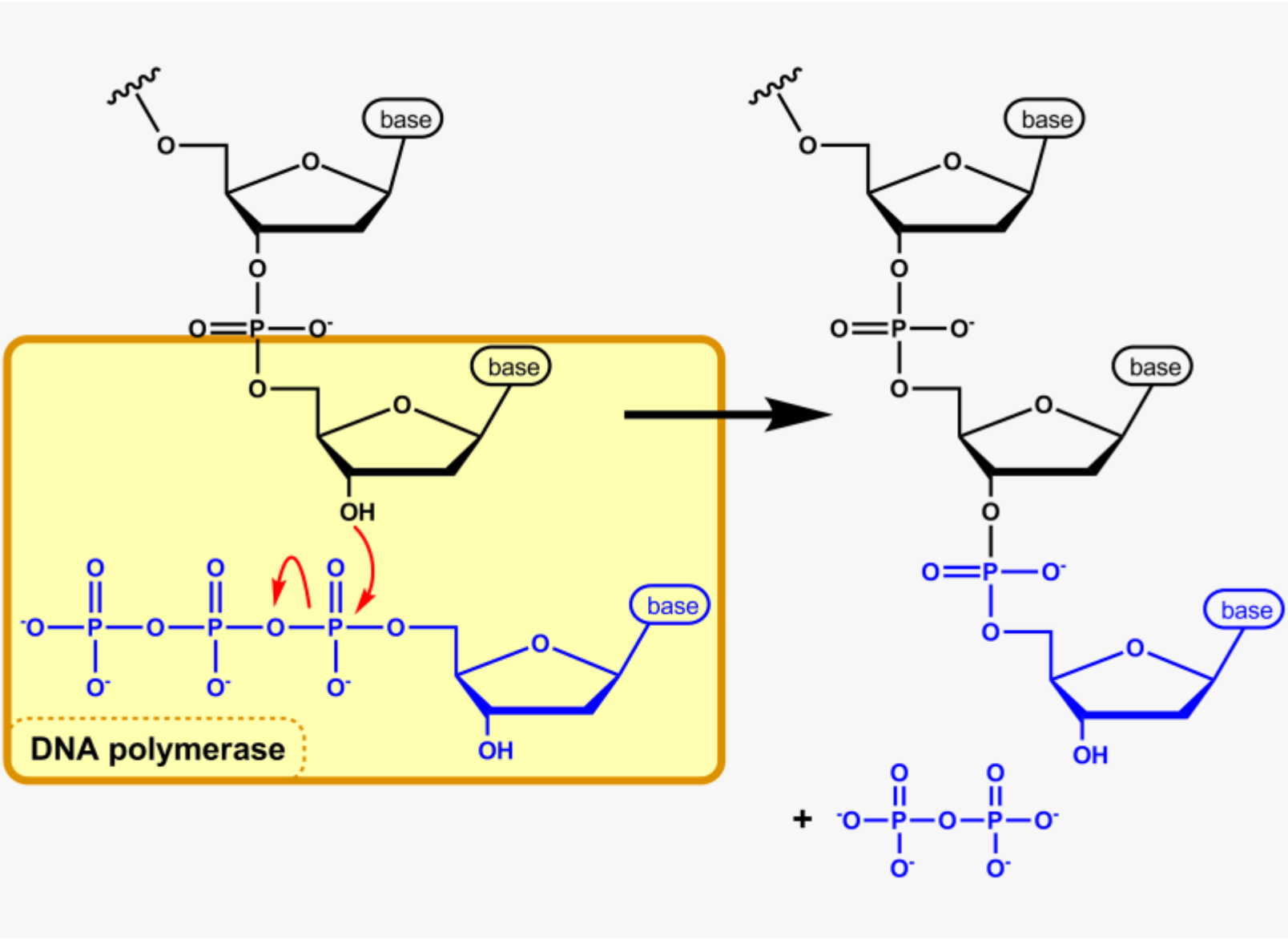


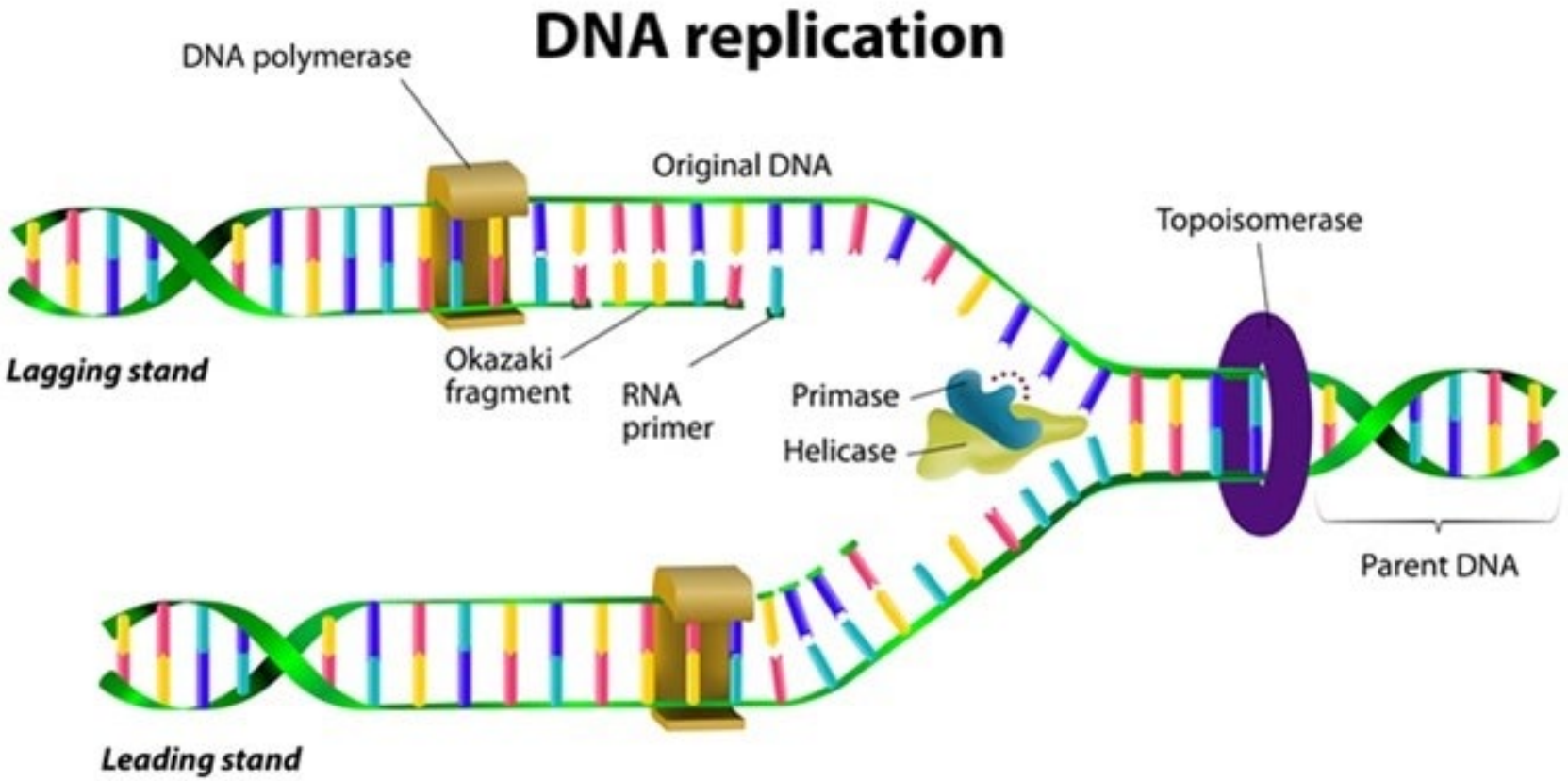


Cytosine–Guanine

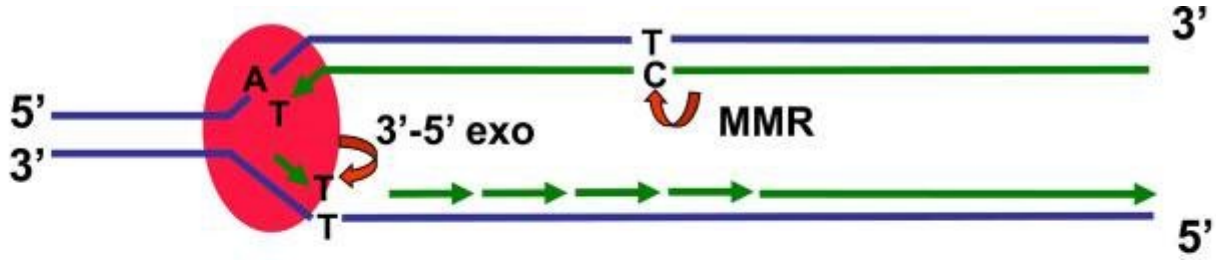





base
O
O
O
O=P—O⁻
OH
DNA polymerase
+



https://youtu.be/TNKWgcFPHqw

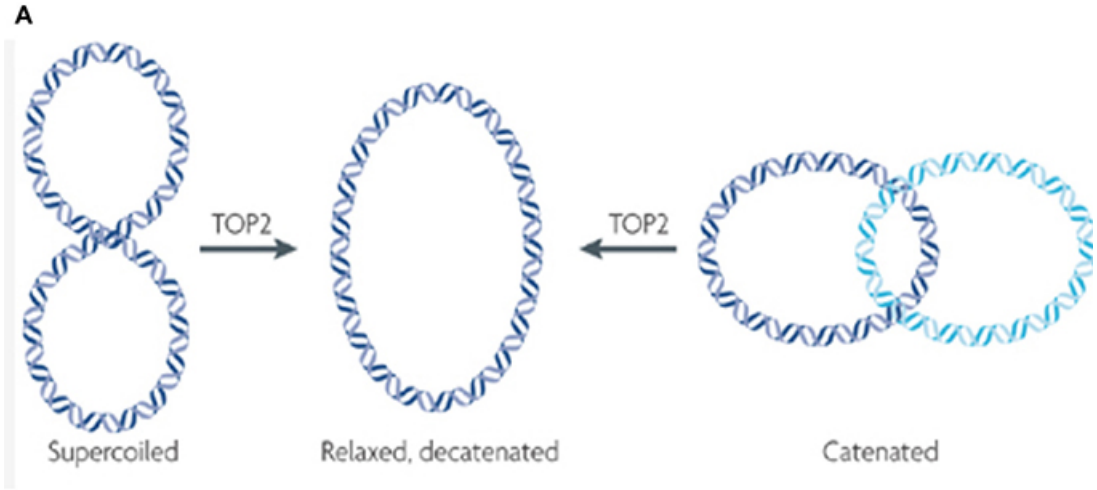


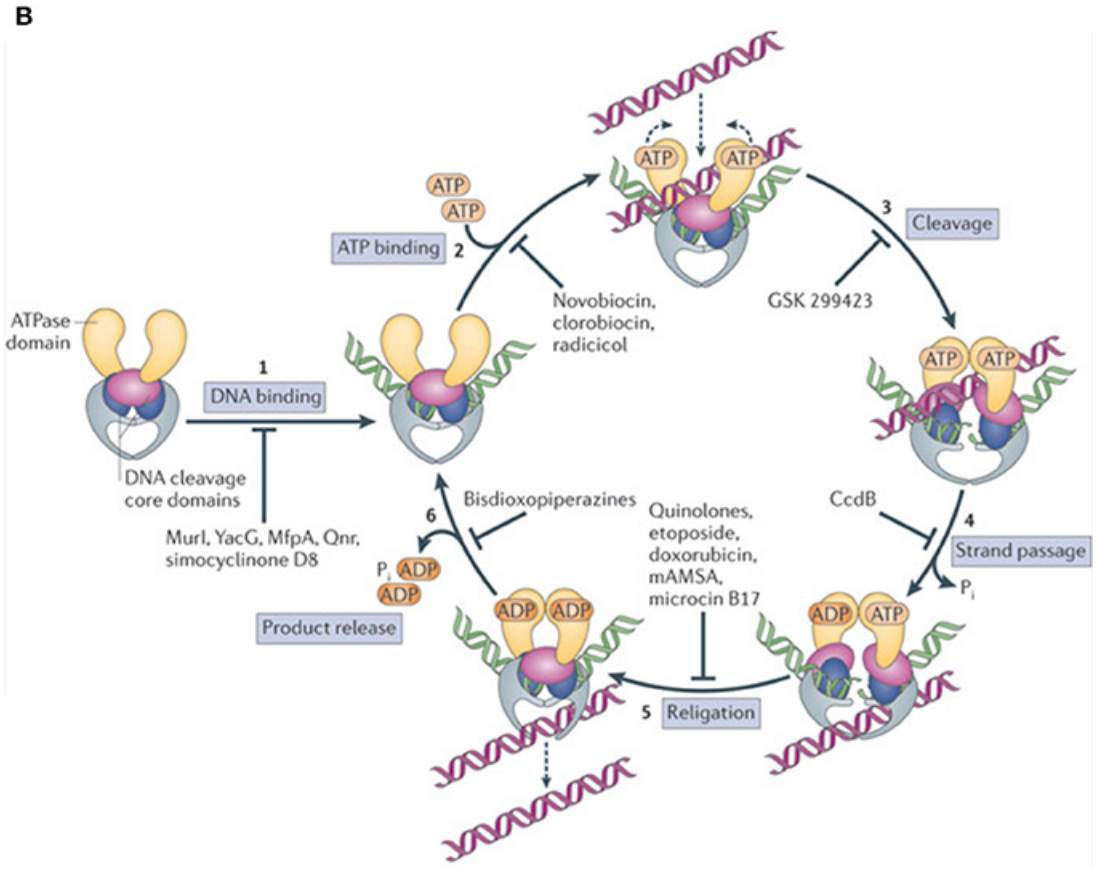
BASE SELECTION $10^{-4} – 10^{-5}$

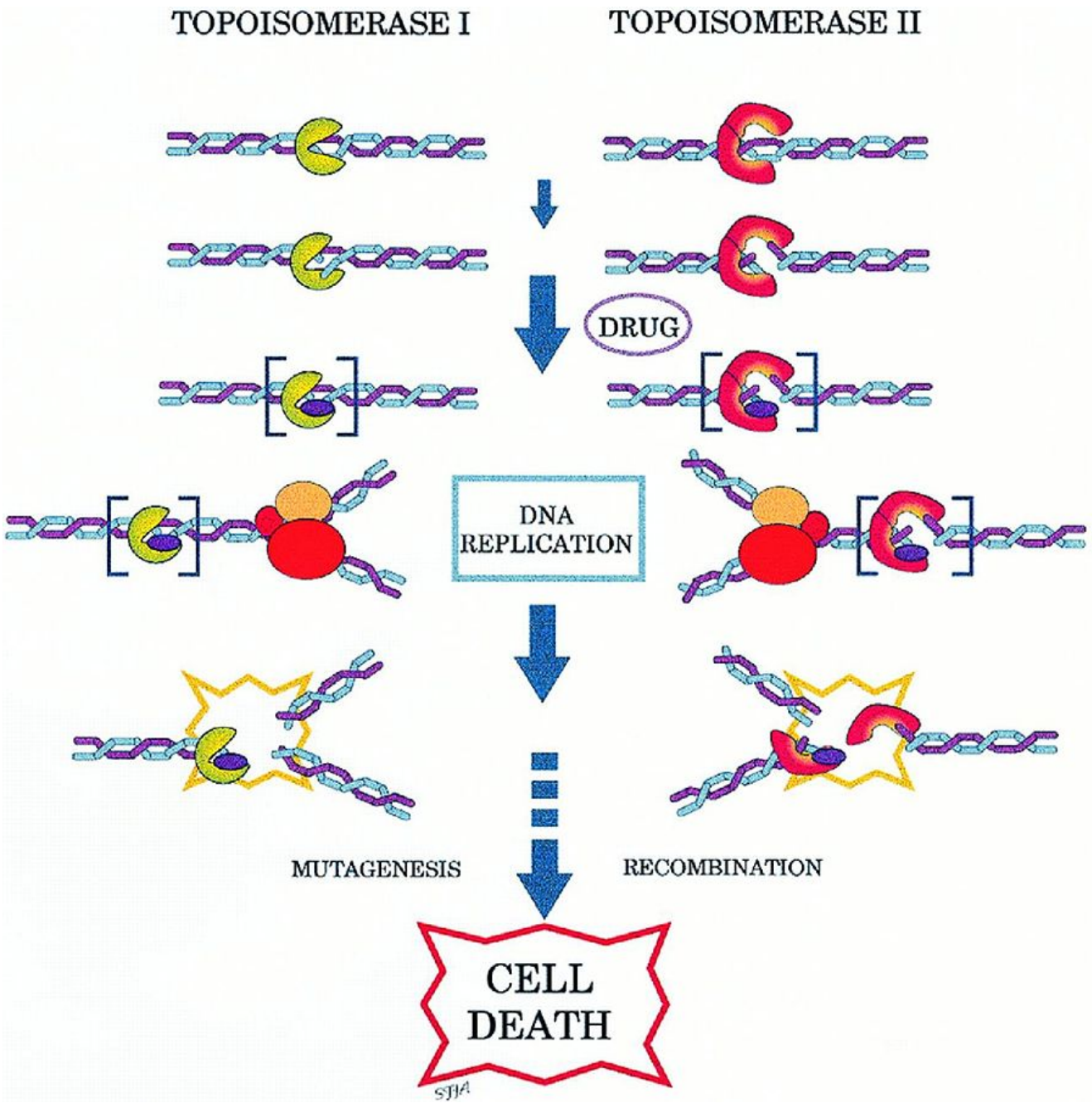
3'-5' EXONUCLEASE 10^{-2}

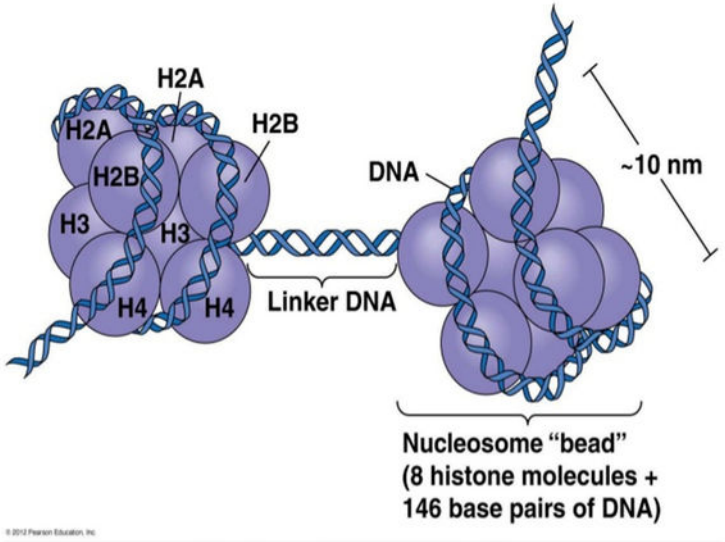
MISMATCH REPAIR 10^{-3}

DNA REPLICATION FIDELITY 10^{-10}

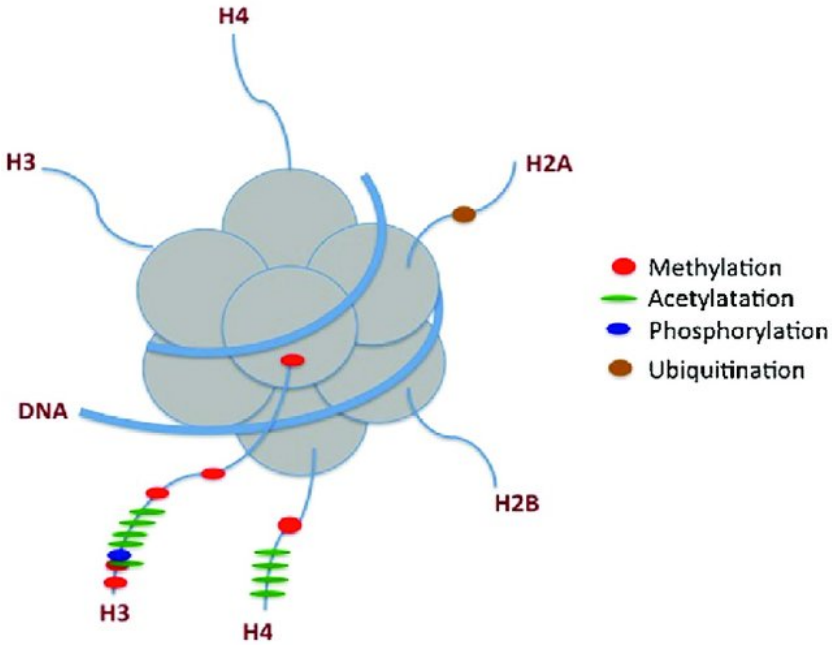

A
TOP2
TOP2
Supercoiled
Relaxed, decatenated
Catenated

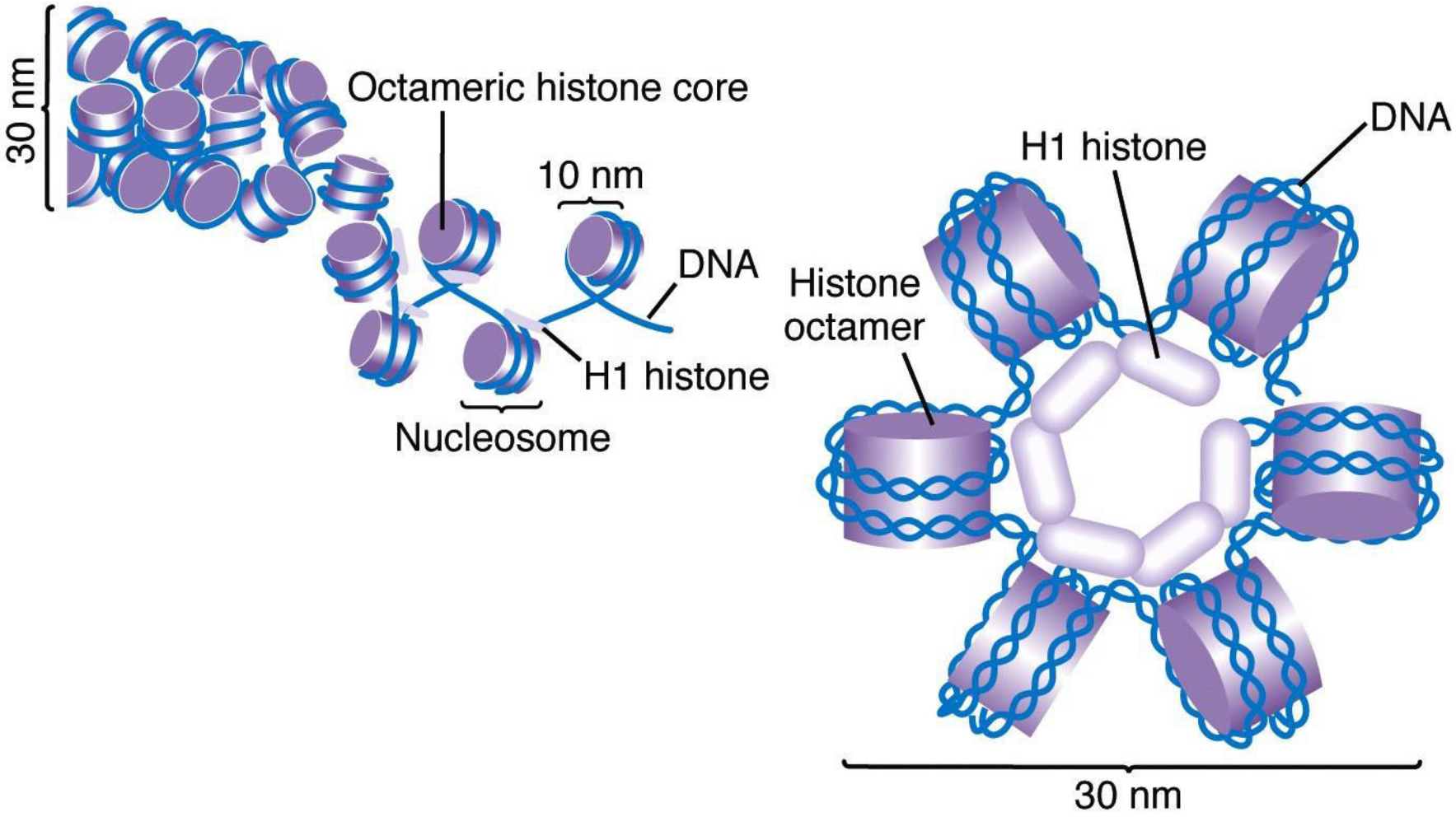

B
ATP
ATP
ATP binding
2
Novobiocin,
clorobiocin,
radicicol
3
Cleavage
GSK 299423
ATPase
domain
1
DNA binding
DNA cleavage
core domains
MurI, YacG, MfpA, Qnr,
simocyclinone D8
6
Bisdioxopiperazines
Quinolones,
etoposide,
doxorubicin,
mAMSA,
microcin B17
CcdB
4
Strand passage
P_i
ADP
ADP
Product release
5
Religation

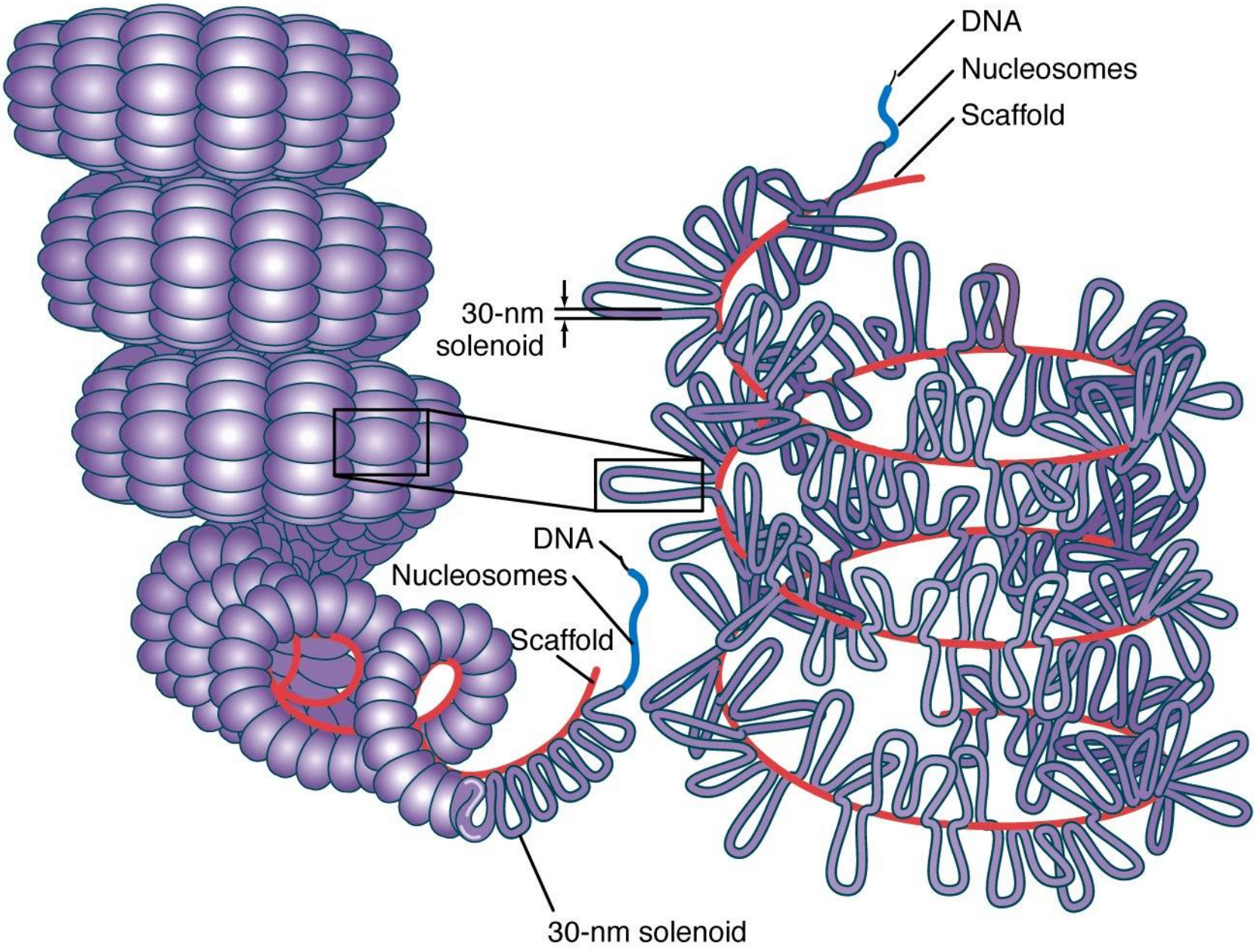

TOPOISOMERASE I
TOPOISOMERASE II
DRUG
DNA REPLICATION
MUTAGENESIS
RECOMBINATION
CELL DEATH

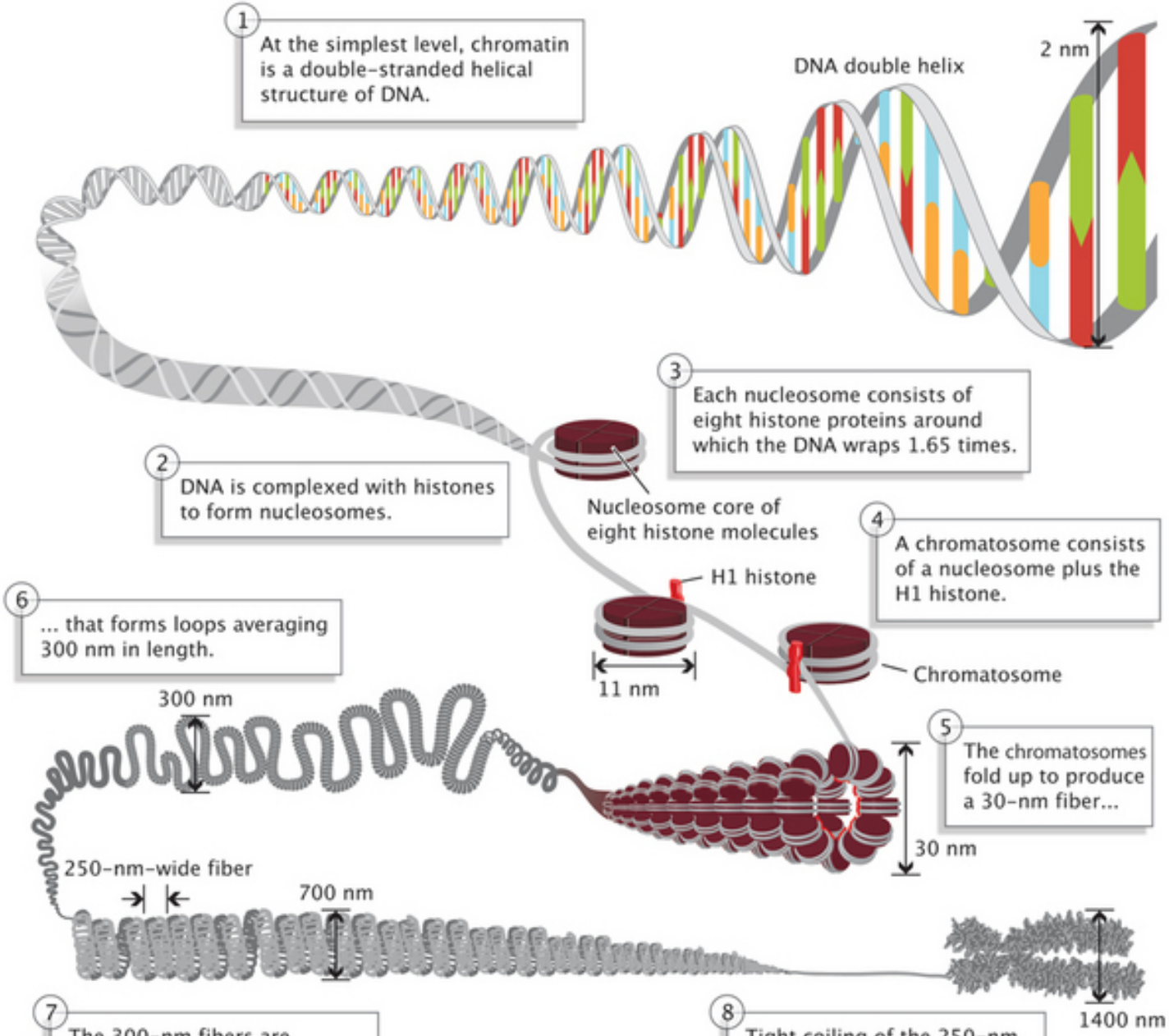


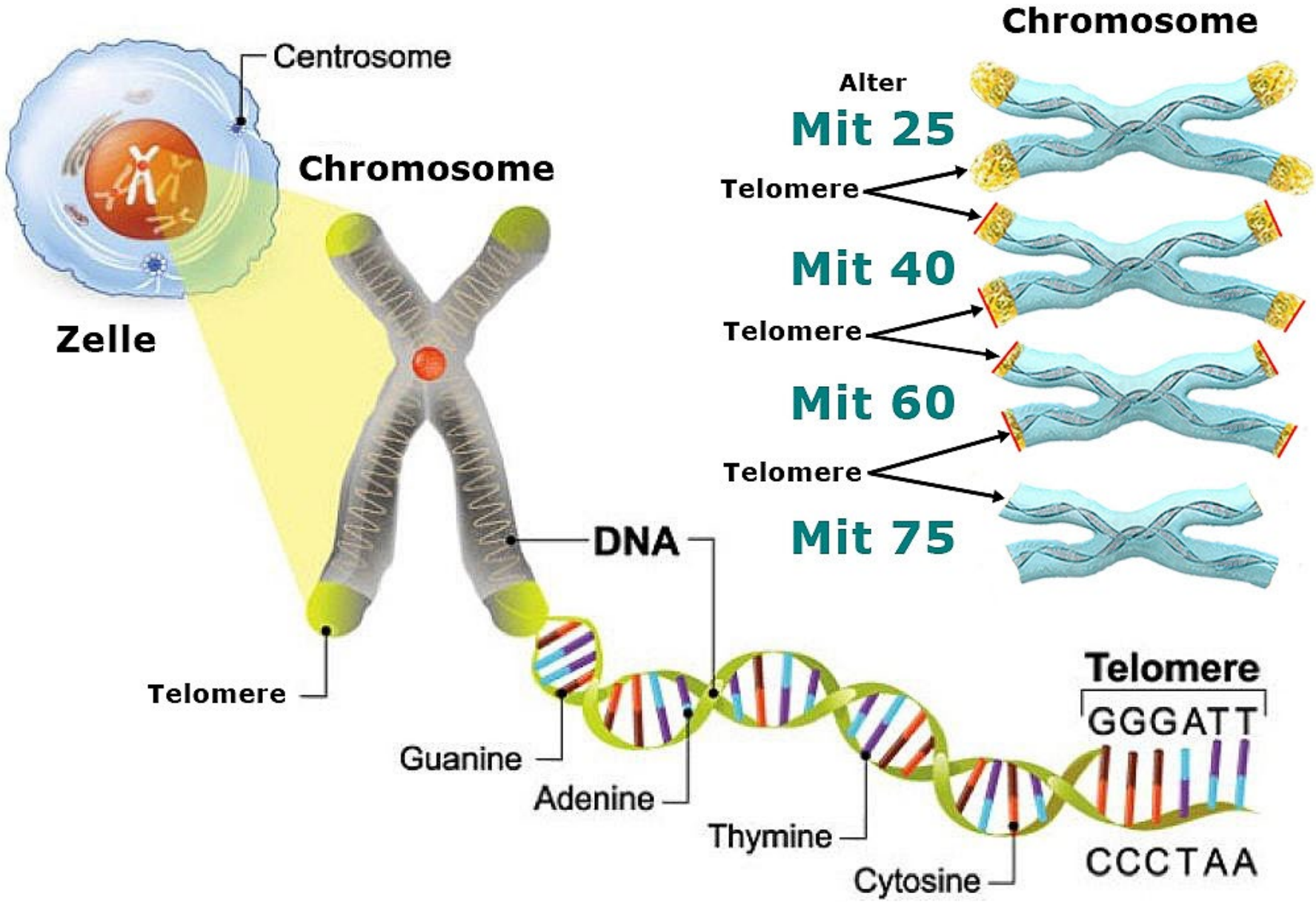
https://www.slideshare.net/jannatiftikhar/role-of-histone-in-dna-packaging

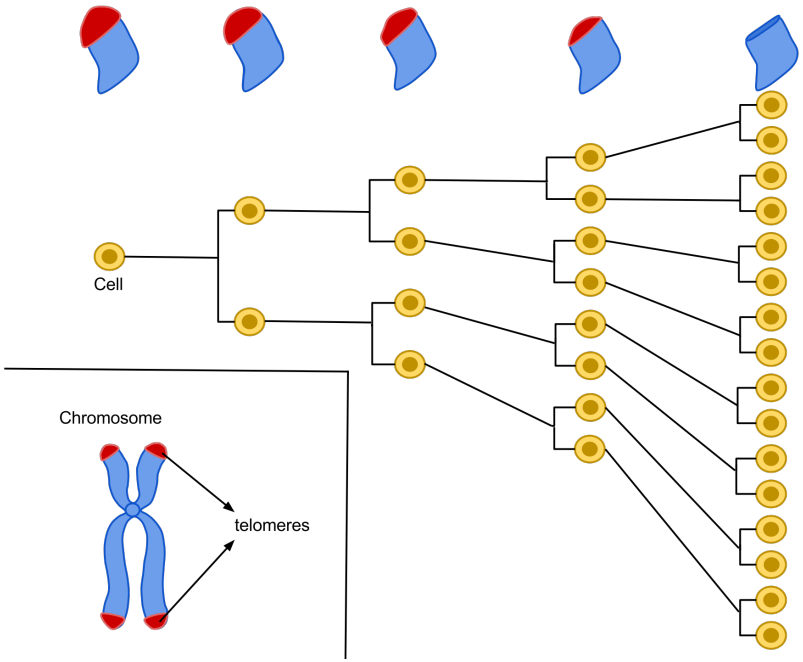


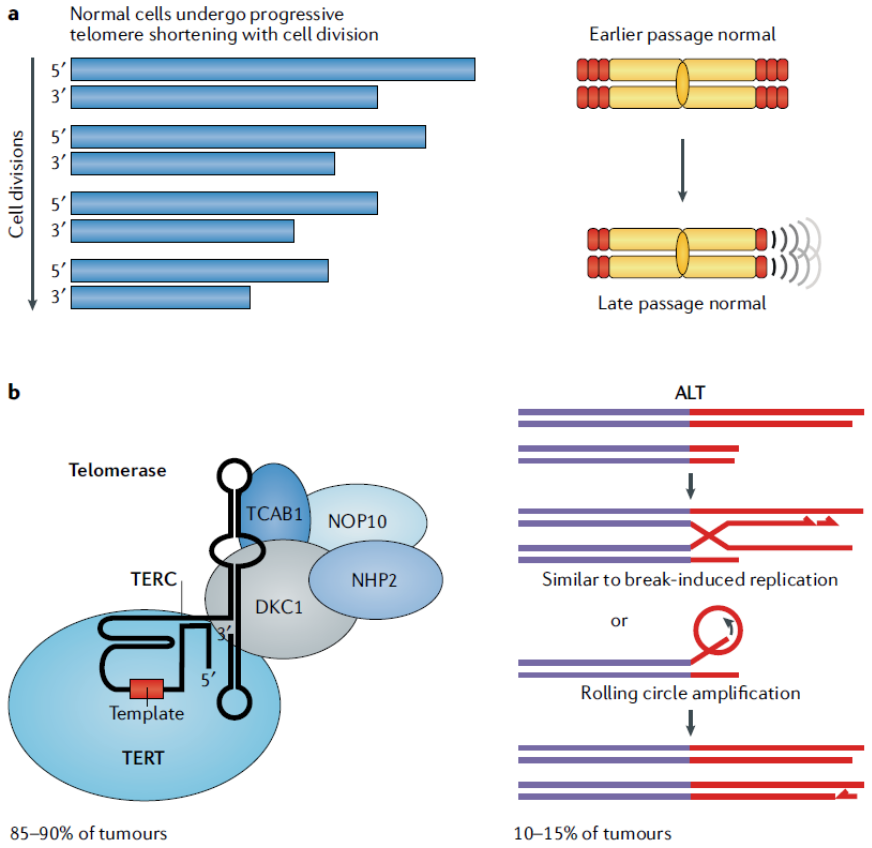

30 nm
Octameric histone core
10 nm
DNA
H1 histone
Nucleosome
DNA
H1 histone
Histone
octamer
30 nm

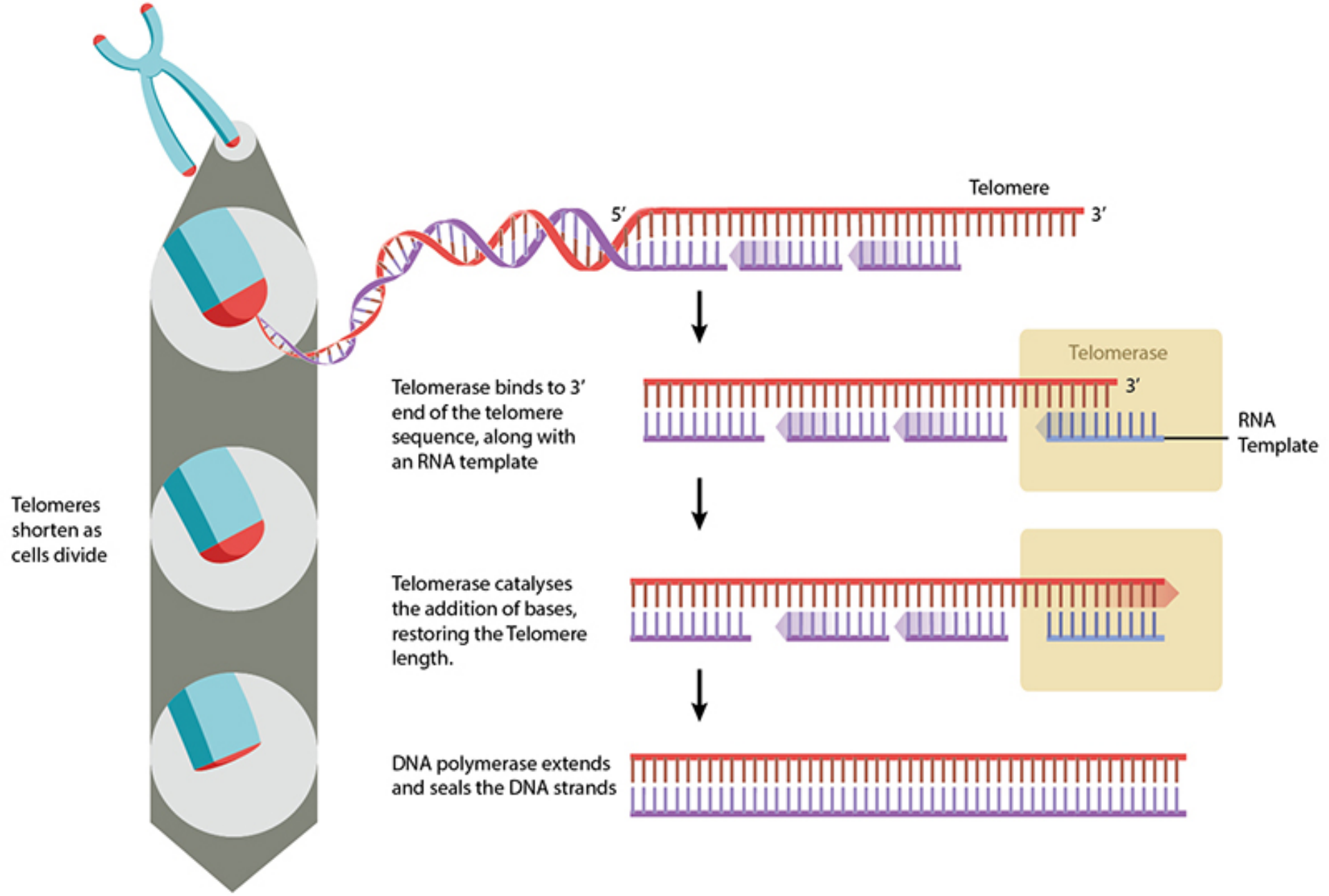

DNA
Nucleosomes
Scaffold
30-nm
solenoid
DNA
Nucleosomes
Scaffold
30-nm solenoid


1
At the simplest level, chromatin is a double-stranded helical structure of DNA.
DNA double helix
2 nm
3
Each nucleosome consists of eight histone proteins around which the DNA wraps 1.65 times.
2
DNA is complexed with histones to form nucleosomes.
Nucleosome core of eight histone molecules
4
A chromatosome consists of a nucleosome plus the H1 histone.
H1 histone
11 nm
Chromatosome
6
... that forms loops averaging 300 nm in length.
300 nm
5
The chromatosomes fold up to produce a 30-nm fiber...
30 nm
250-nm-wide fiber
700 nm
1400 nm
7
The 300-nm fibers are compressed and folded to produce a 250-nm-wide fiber.
8
Tight coiling of the 250-nm fiber produces the chromatid of a chromosome.


Centrosome
Zelle
Chromosome
Telomere
DNA
Guanine
Adenine
Thymine
Cytosine
Chromosome
Alter
Mit 25
Telomere
Mit 40
Telomere
Mit 60
Telomere
Mit 75
Telomere
GGGATT
CCCTAA

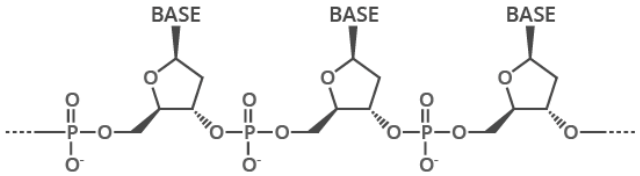

Cell
Chromosome
telomeres


a
Normal cells undergo progressive telomere shortening with cell division
Cell divisions
5′
3′
Earlier passage normal
Late passage normal
b
Telomerase
TCAB1
NOP10
NHP2
DKC1
TERC
3′
5′
Template
TERT
85–90% of tumours
ALT
Similar to break-induced replication
or
Rolling circle amplification
10–15% of tumours
c
T-loop
POT1
ACD
TIN2
TRF1
TRF2
RAP1
5′
(TTAGGG)n
3′
(AATCCC)n


Telomeres shorten as cells divide
Telomere
5′
3′
Telomerase binds to 3′ end of the telomere sequence, along with an RNA template
Telomerase
3′
RNA Template
Telomerase catalyses the addition of bases, restoring the Telomere length.
DNA polymerase extends and seals the DNA strands

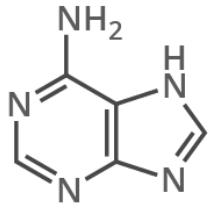
THE CHEMICAL STRUCTURE OF DNA

THE SUGAR PHOSPHATE 'BACKBONE'

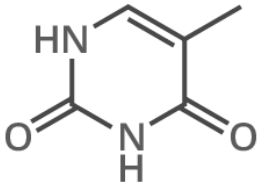


DNA is a polymer made up of units called nucleotides. The nucleotides are made of three different components: a sugar group, a phosphate group, and a base. There are four different bases: adenine, thymine, guanine and cytosine.

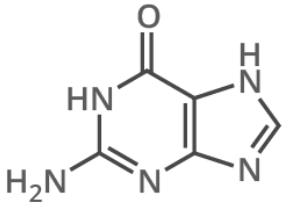
A ADENINE



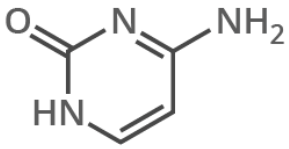
T THYMINE



G GUANINE

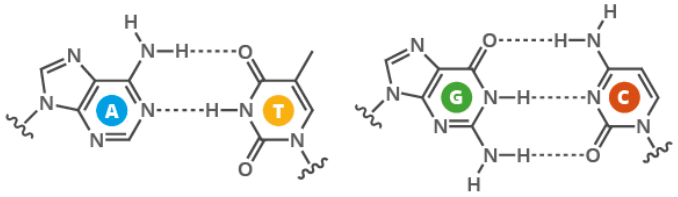


C CYTOSINE



WHAT HOLDS DNA STRANDS TOGETHER?

DNA strands are held together by hydrogen bonds between bases on adjacent strands. Adenine (A) always pairs with thymine (T), while guanine (G) always pairs with cytosine (C). Adenine pairs with uracil (U) in RNA.



FROM DNA TO PROTEINS

The bases on a single strand of DNA act as a code. The letters form three letter codons, which code for amino acids - the building blocks of proteins.

An enzyme, RNA polymerase, transcribes DNA into mRNA (messenger ribonucleic acid). It splits apart the two strands that form the double helix, then reads a strand and copies the sequence of nucleotides. The only difference between the RNA and the original DNA is that in the place of thymine (T), another base with a similar structure is used: uracil (U).

In multicellular organisms, the mRNA carries genetic code out of the cell nucleus, to the cytoplasm. Here, protein synthesis takes place. 'Translation' is the process of turning the mRNA's 'code' into proteins. Molecules called ribosomes carry out this process, building up proteins from the amino acids coded for.

Triple and Quadruple Strained DNA