NUCLEIC ACIDS

PAPER 2

UNIT 1.2

NUCLEIC ACIDS

- Hereditary determinants
- Macromolecules
- Free state
- Bound state– Nucleoproteins

Nucleotides are biopolymers of high molecular weight with mononucleotides as their repeating units

NUCLEIC ACIDS

- DNA (Deoxyribonucleic acid)
- RNA (Ribonucleic acid)

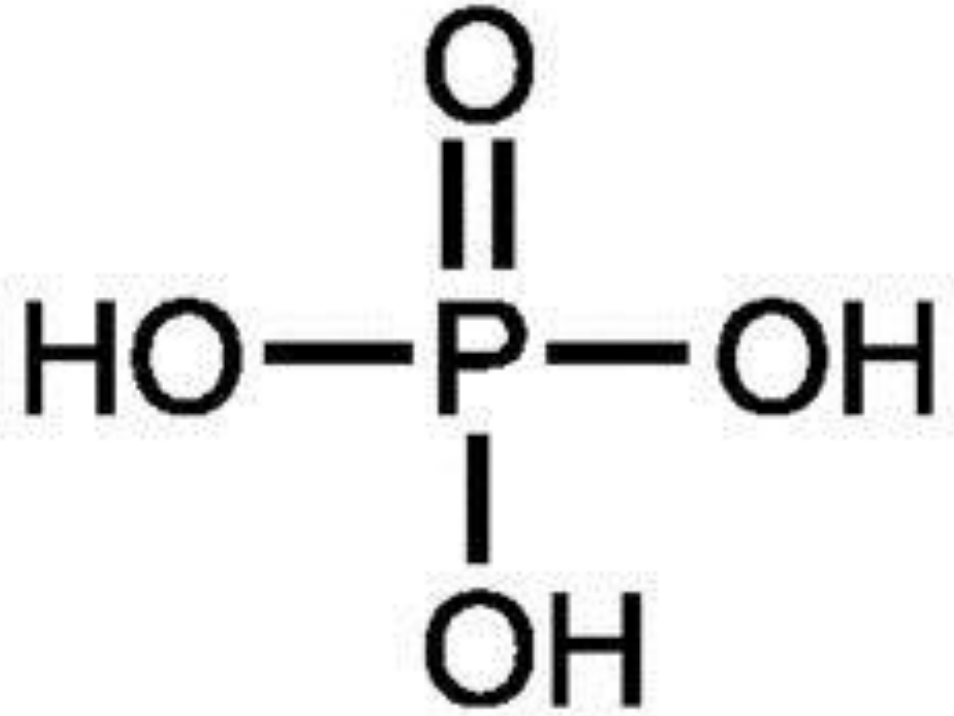
NUCLEIC ACIDS

- DNA--- Chromatin of cell nucleus
- RNA--- Cell cytoplasm, Nucleolus
- Extranuclear DNA--- Mitochondria, Chloroplast

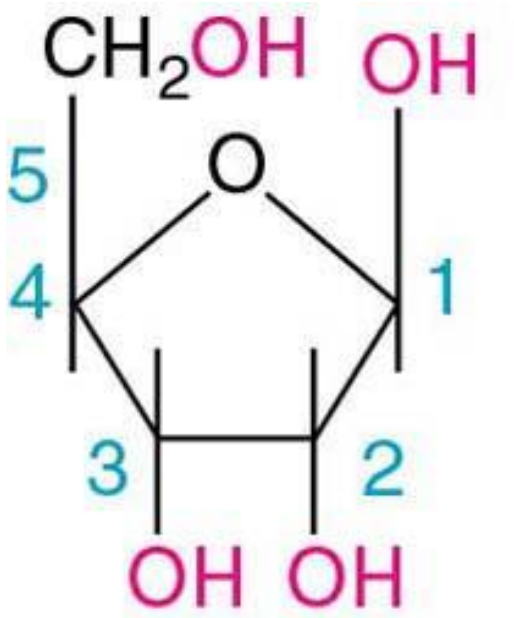
COMPOSITION OF NUCLEIC ACIDS

NUCLEIC ACID= PHOSPHORIC ACID + PENTOSE SUGAR+ NITROGENOUS BASE

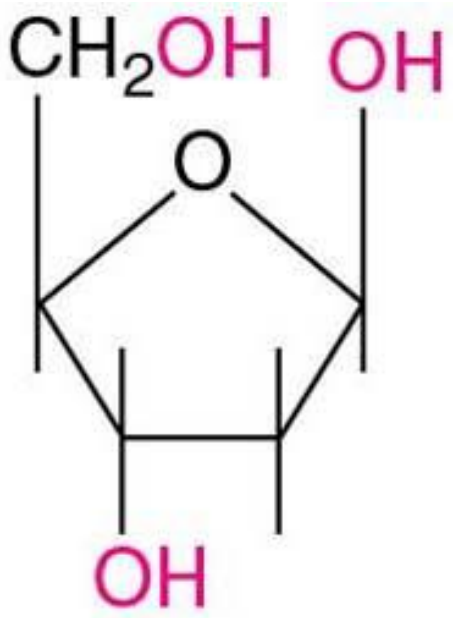
PHOSPHORIC ACID



PENTOSE SUGAR

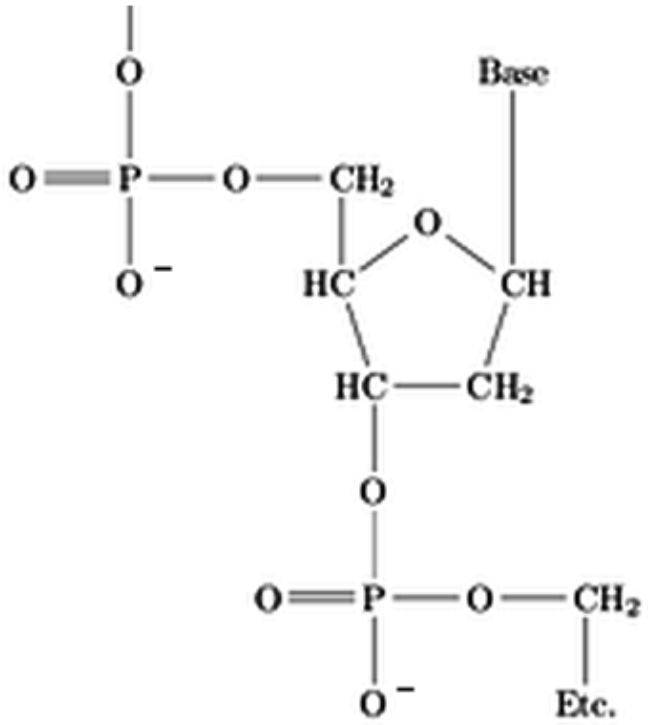


Ribose



2-deoxyribose

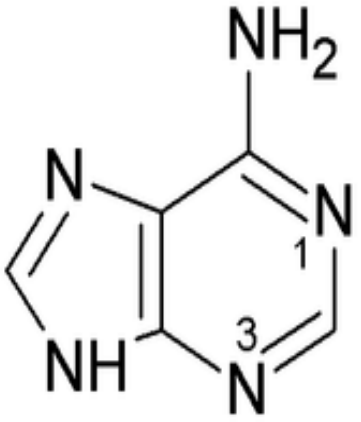
PHOSPHODIESTER BOND



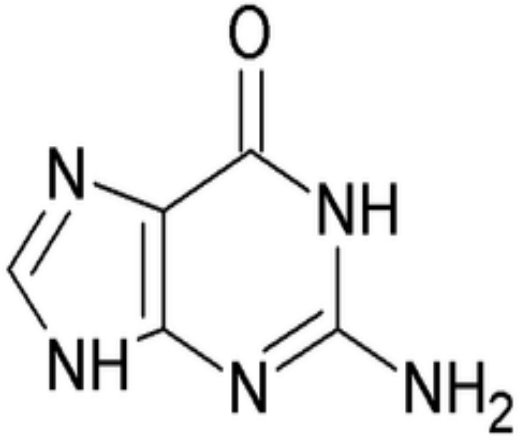
NITROGENOUS BASES

- PYRIMIDINES
- PURINES

Purines

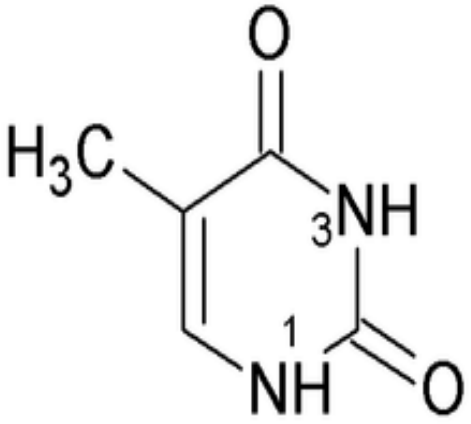


Adenine

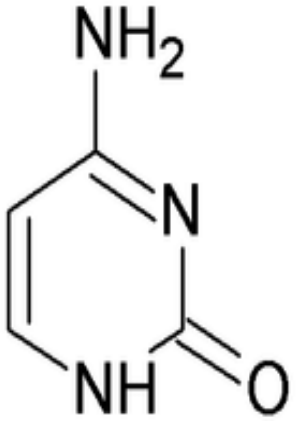


Guanine

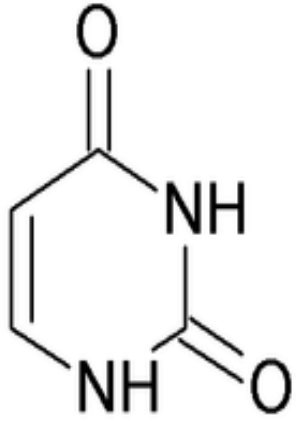
Pyrimidines



Thymine



Cytosine



Uracil

NUCLEOSIDES

NITROGENOUS BASES– PURINES OR PYRIMIDINES ARE CONJUGATED TO THE PENTOSE SUGARS RIBOSE OR DEOXYRIBOSE BY β-GLYCOSIDIC LINKAGE

NUCLEOSIDES

- RIBONUCLEOSIDES
- DEOXYRIBONUCLEOSIDES

RIBONUCLEOSIDES

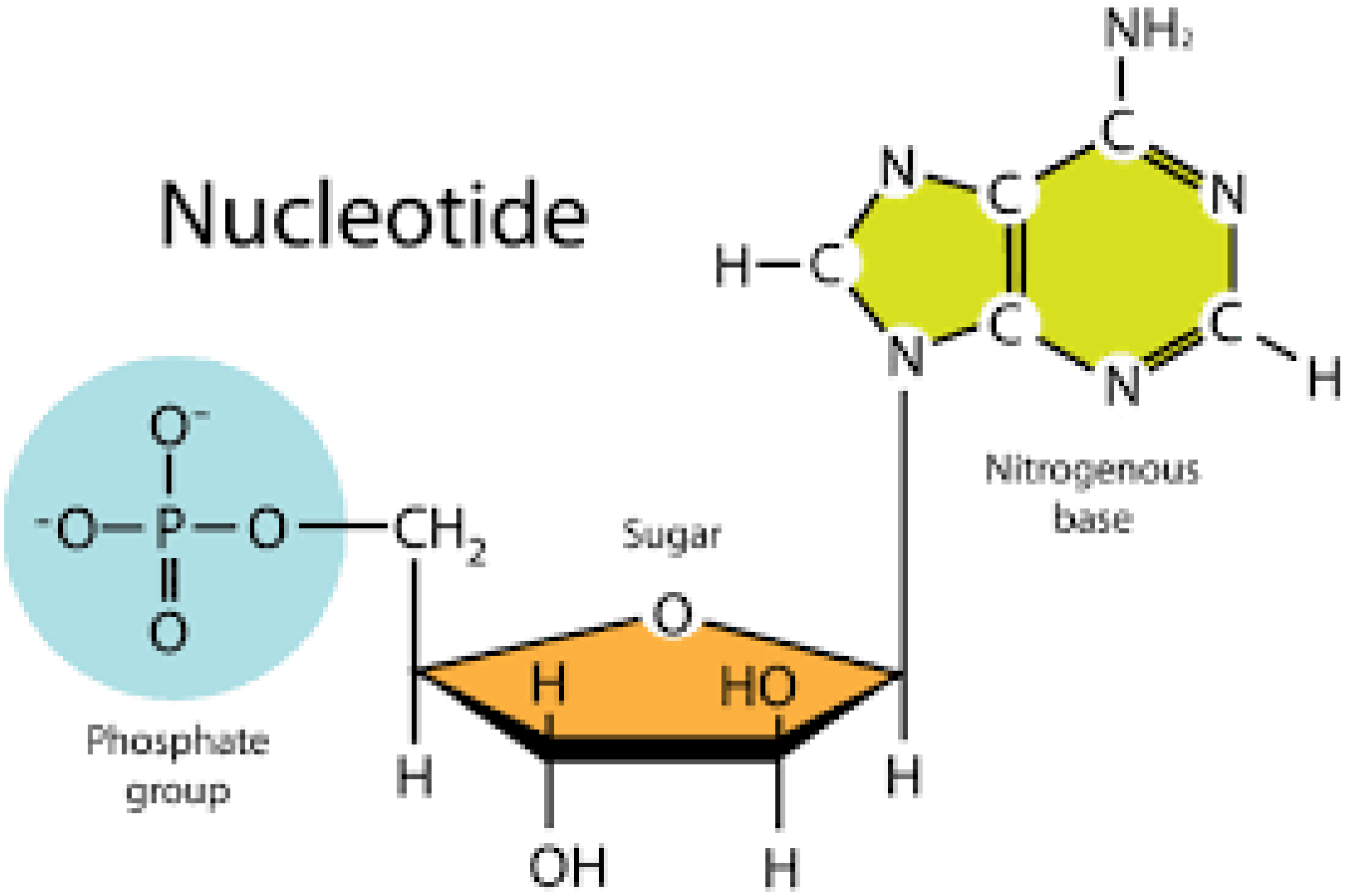
BASE	NUCLEOSIDE	TRIVIAL NAME	ABBREVIATION
ADENINE	ADENINE RIBONUCLEOSIDE	ADENOSINE	AR
GUANINE	GUANINE RIBONUCLEOSIDE	GUANOSINE	GR
CYTOSINE	CYTOSINE RIBONUCLEOSIDE	CYTIDINE	CR
THYMINE	THYMINE RIBONUCLEOSIDE	THYMIDINE	TR
URACIL	URACIL RIBONUCLEOSIDE	URIDINE	UR

DEOXYRIBONUCLEOSIDES

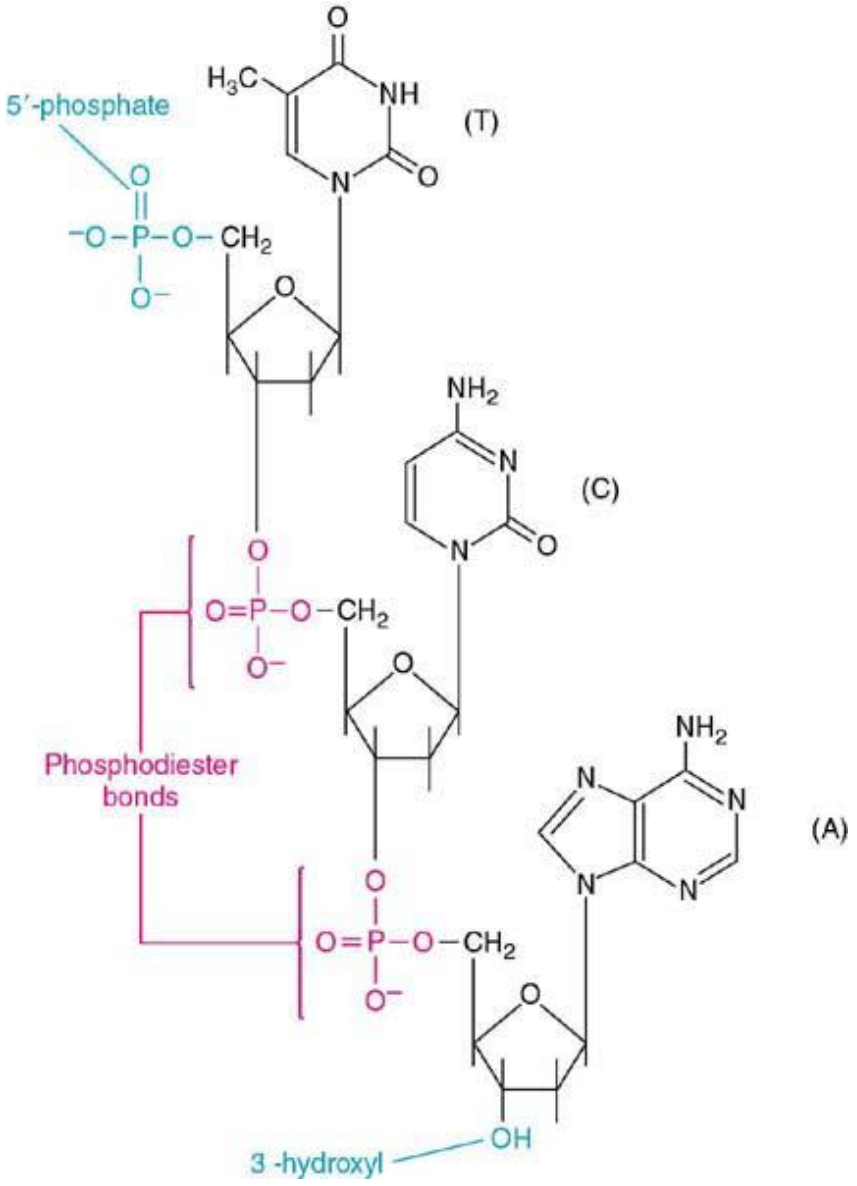
BASE	NUCLEOSIDE	TRIVIAL NAME
ADENINE	ADENINE DEOXYRIBONUCLEOSIDE	DEOXYADENOSINE
GUANINE	GUANINE DEOXYRIBONUCLEOSIDE	DEOXYGUANOSINE
CYTOSINE	CYTOSINE DEOXYRIBONUCLEOSIDE	DEOXYCYTIDINE
THYMINE	THYMINE DEOXYRIBONUCLEOSIDE	DEOXYTHYMIDINE
URACIL	URACIL DEOXYRIBONUCLEOSIDE	DEOXYURIDINE

NUCLEOTIDES ARE PHOSPHORIC ACID ESTERS OF NUCLEOSIDES

Nucleotide


NH2
C
N
C
N
H
C
C
C
N
N
C
H
Nitrogenous base
O⁻
⁻O
P
O
O
CH2
Sugar
O
H
HO
H
H
OH
H
Phosphate group

NUCLEOTIDES

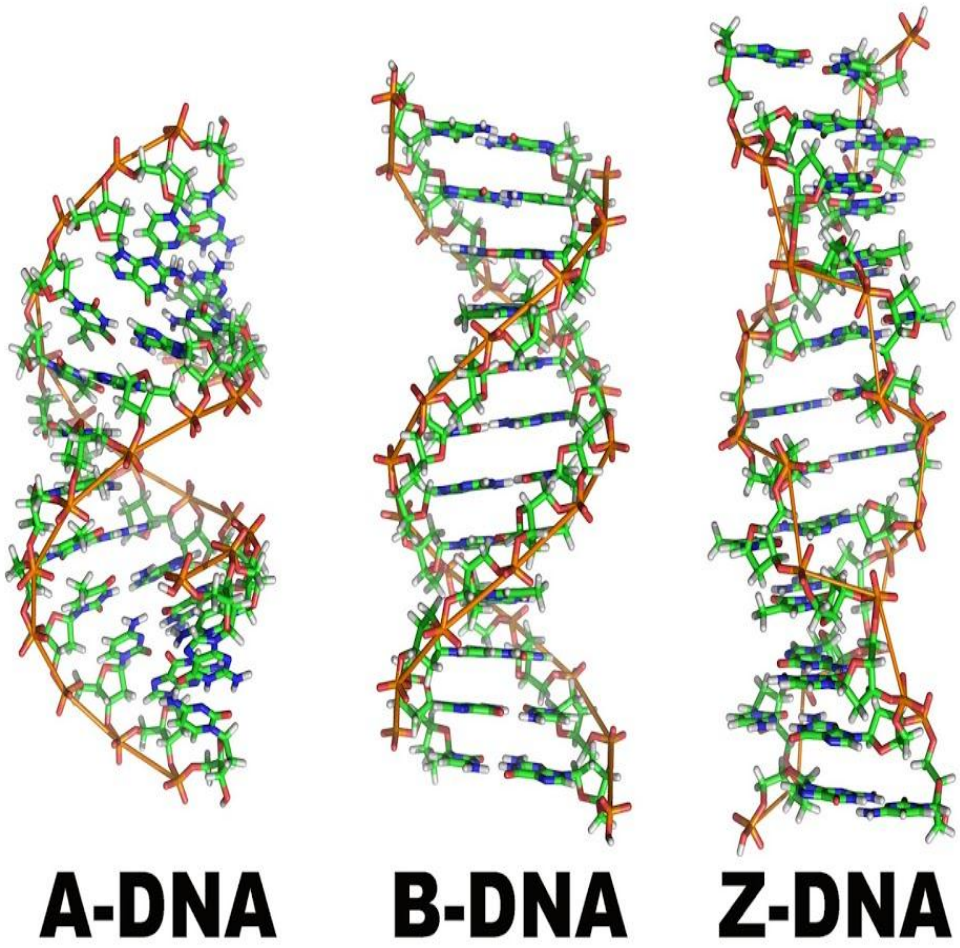


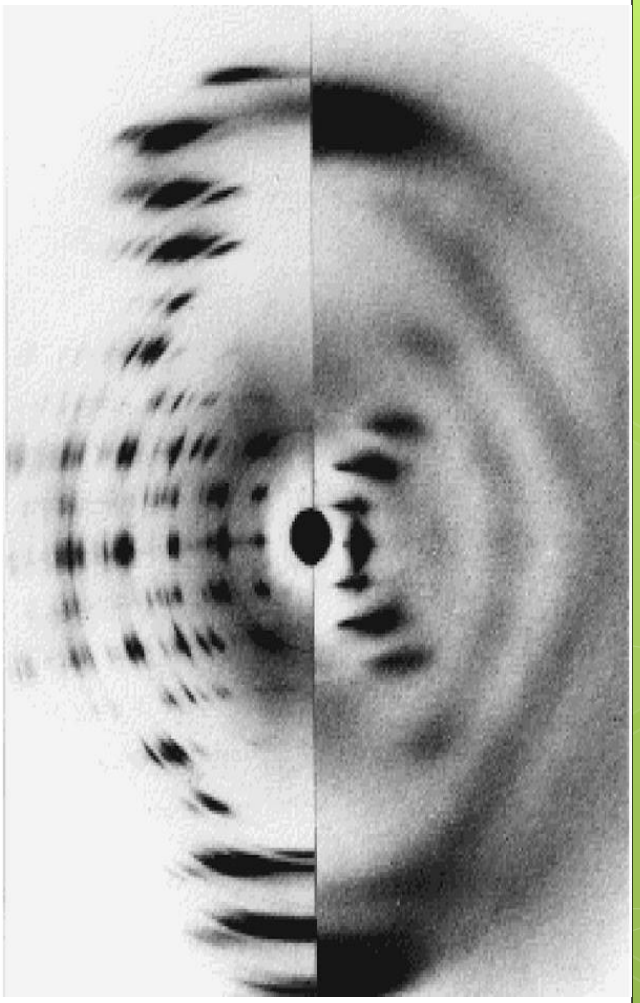
RIBONUCLEOTIDES

RIBONUCLEOTIDES	TRIVIAL NAME	ABBREVIATIONS
ADENOSINE 5' MONOPHOSPHATE	ADENYLIC ACID	AMP
GUANOSINE 5' MONOPHOSPHATE	GUANYLIC ACID	GMP
CYTIDINE 5' MONOPHOSPHATE	CYTIDYLIC ACID	CMP
URIDINE 5' MONOPHOSPHATE	URIDYLIC ACID	UMP

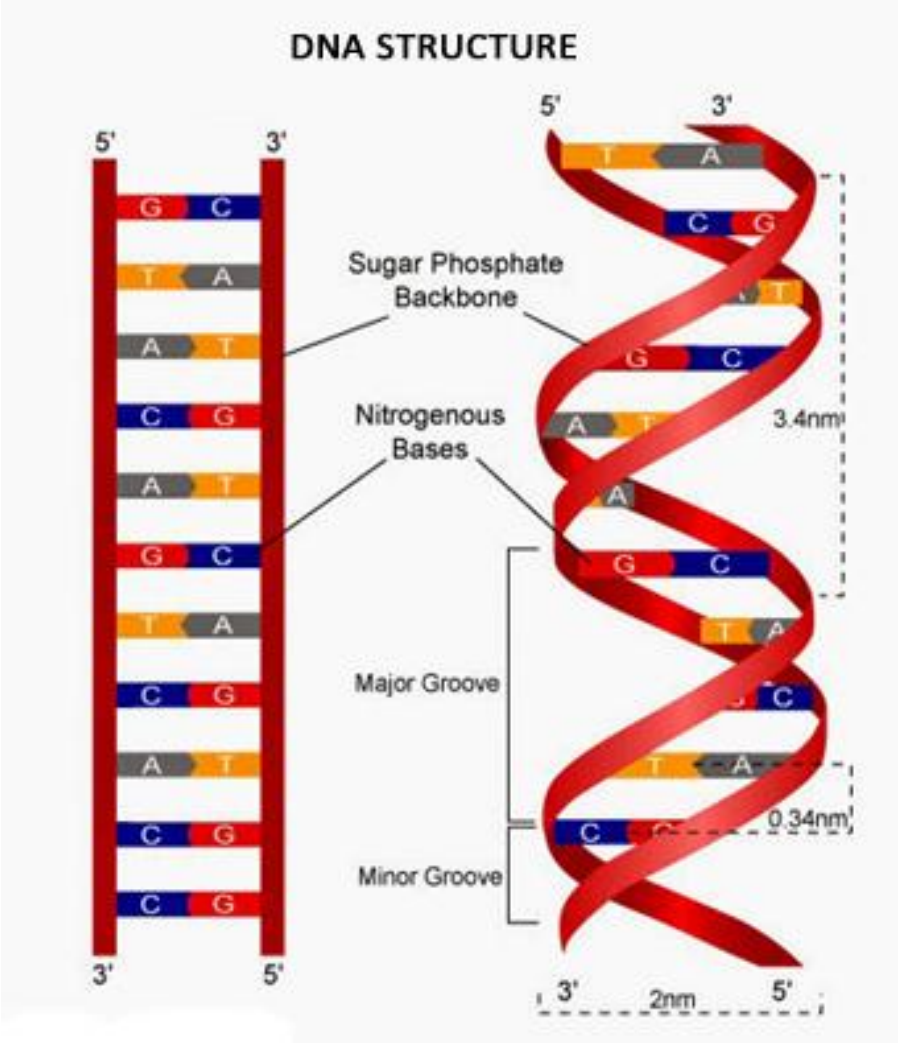
2'DEOXYRIBONUCLEOTIDES

RIBONUCLEOTIDES	TRIVIAL NAME	ABBREVIATIONS
DEOXYADENOSINE 5' MONOPHOSPHATE	DEOXYADENYLIC ACID	AMP
DEOXYGUANOSINE 5' MONOPHOSPHATE	DEOXYGUANYLIC ACID	GMP
DEOXYCYTIDINE 5' MONOPHOSPHATE	DEOXYCYTIDYLIC ACID	CMP
DEOXYURIDINE 5' MONOPHOSPHATE	DEOXYURIDYLIC ACID	UMP


A-DNA
B-DNA
Z-DNA



WATSON AND CRICK MODEL OF DNA



SALIENT FEATURES OF WATSON-CRICK MODEL OF DNA

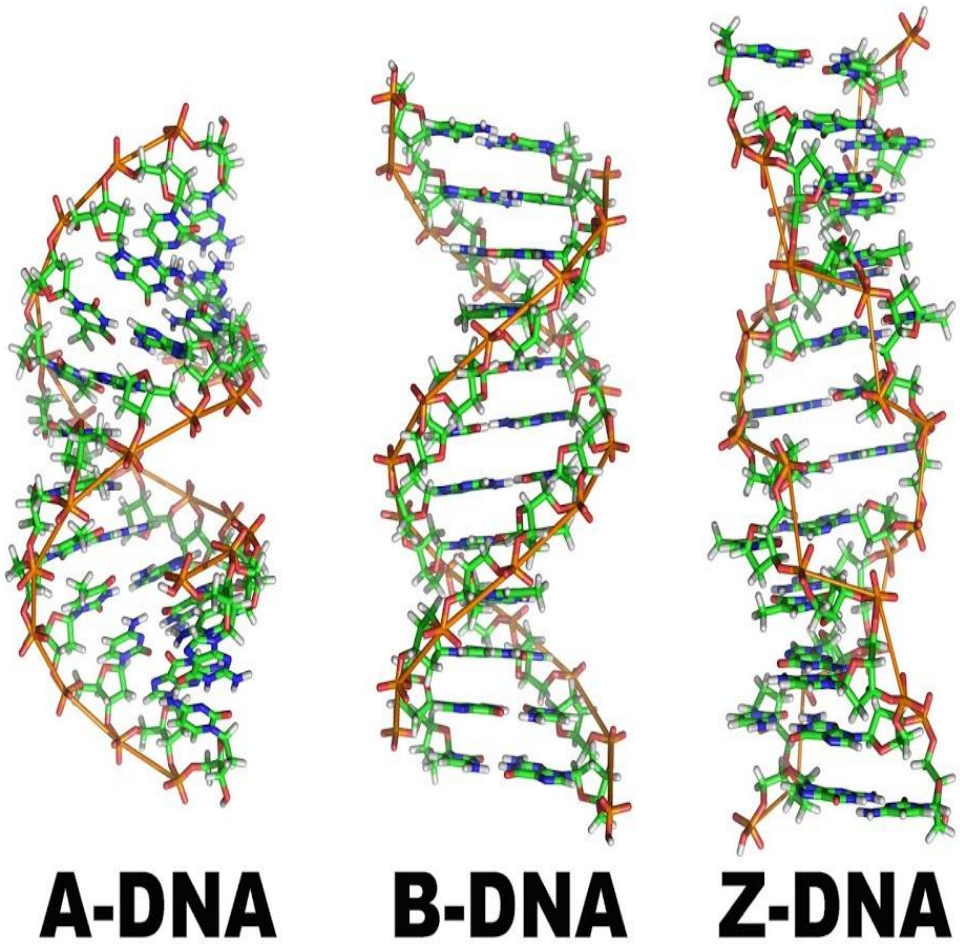
- 2 helical polynucleotide chains which are coiled around a common axis in the form of **Right handed Double helix**.
- Interchain spacings
- **Major groove** (Width 12 A^0 and 8.5 A^0)
- **Minor groove** (Width 6 A^0 and depth 7.5 A^0)
- Base pair are not diametrically opposite to each other
- **Protein interaction** with specific sequence of DNA

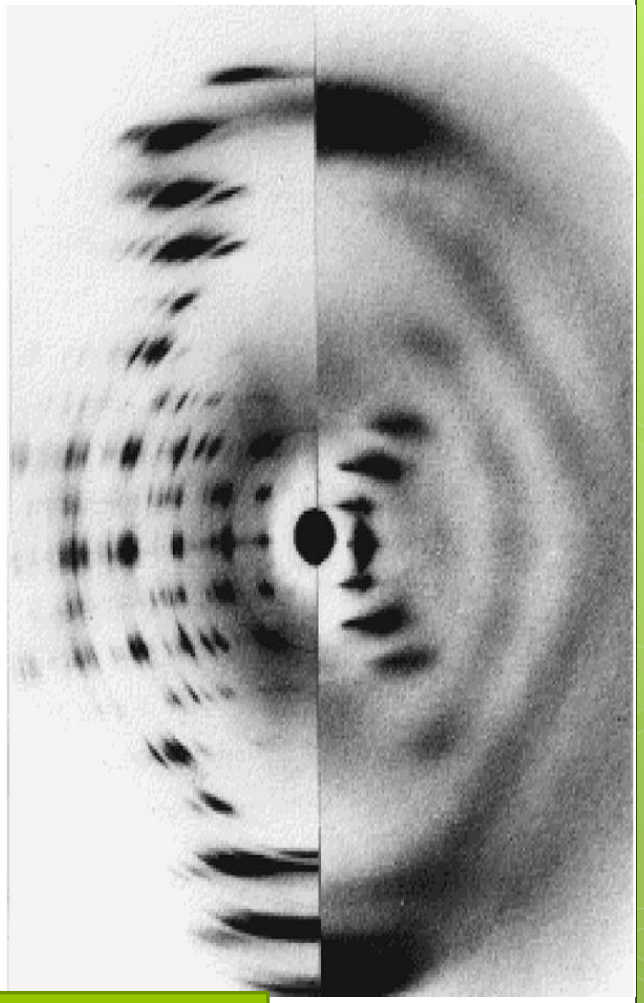
SALIENT FEATURES OF WATSON-CRICK MODEL OF DNA

- Plectomic coils– coils interlocked around same axis
- Antiparallel
- Complementary
- Phosphate and deoxyribose --- periphery of the helix
- Purines and Pyrimidines --- centre

SALIENT FEATURES OF WATSON-CRICK MODEL OF DNA

- Diameter of the helix– 20 A^0
- Bases--- 3.4 A^0
- Each turn of helix – 10 nucleotides
- Hydrogen bonds between base pairs
- A=T, G=C Base Complementarity
- Precise sequence of bases carries the genitc information





RIGHT HANDED

LEFT HANDED

RNA types & functions

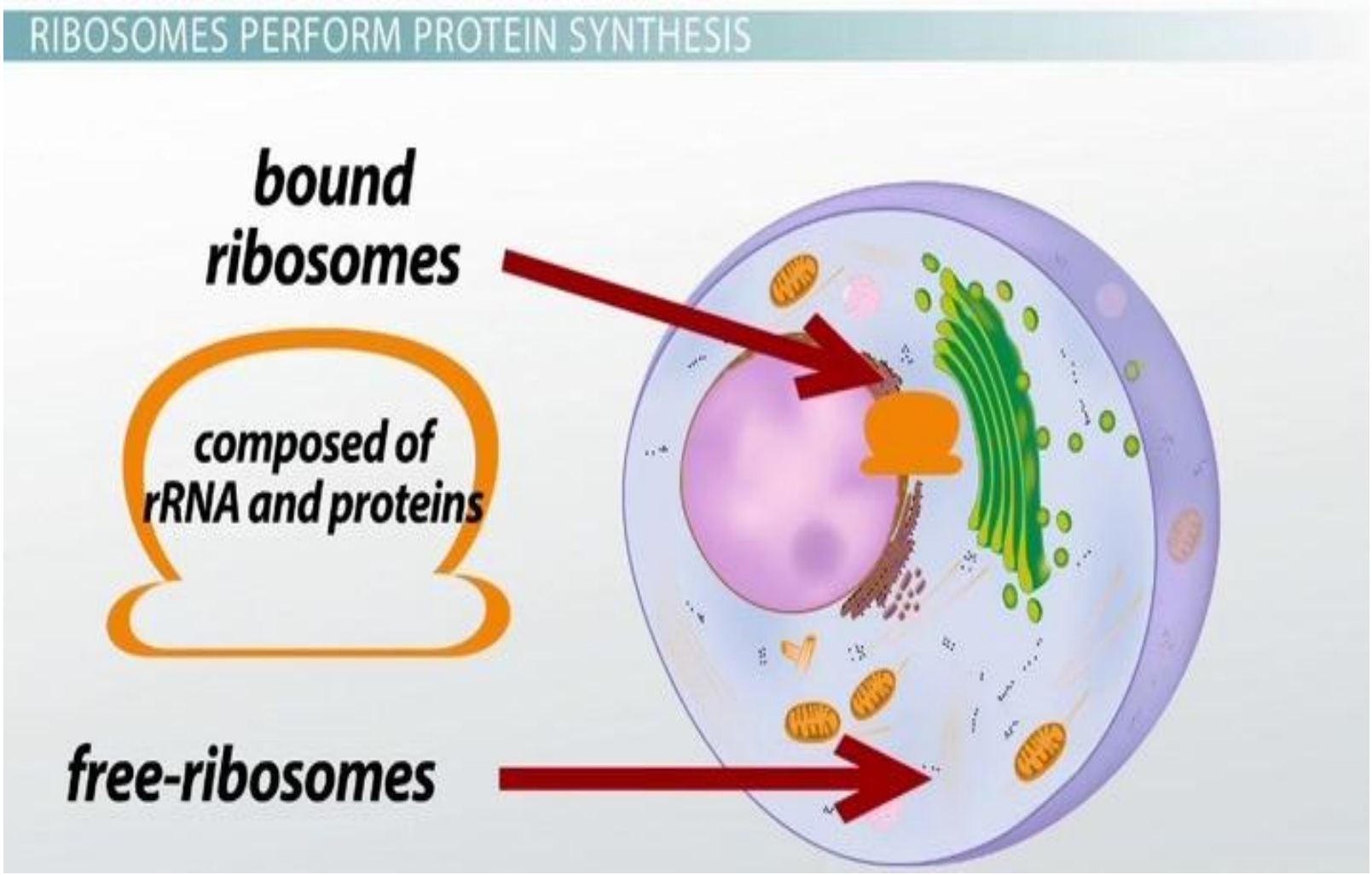
Types of RNAs	Primary Function(s)
mRNA - messenger	translation (protein synthesis) regulatory
rRNA - ribosomal	translation (protein synthesis) <catalytic>
t-RNA - transfer	translation (protein synthesis)
hnRNA - heterogeneous nuclear	precursors & intermediates of mature mRNAs & other RNAs
scRNA - small cytoplasmic	signal recognition particle (SRP) tRNA processing <catalytic>
snRNA - small nuclear snoRNA - small nucleolar	mRNA processing, poly A addition <catalytic> rRNA processing/maturation/methylation
regulatory RNAs (siRNA, miRNA, etc.)	regulation of transcription and translation,

RNA

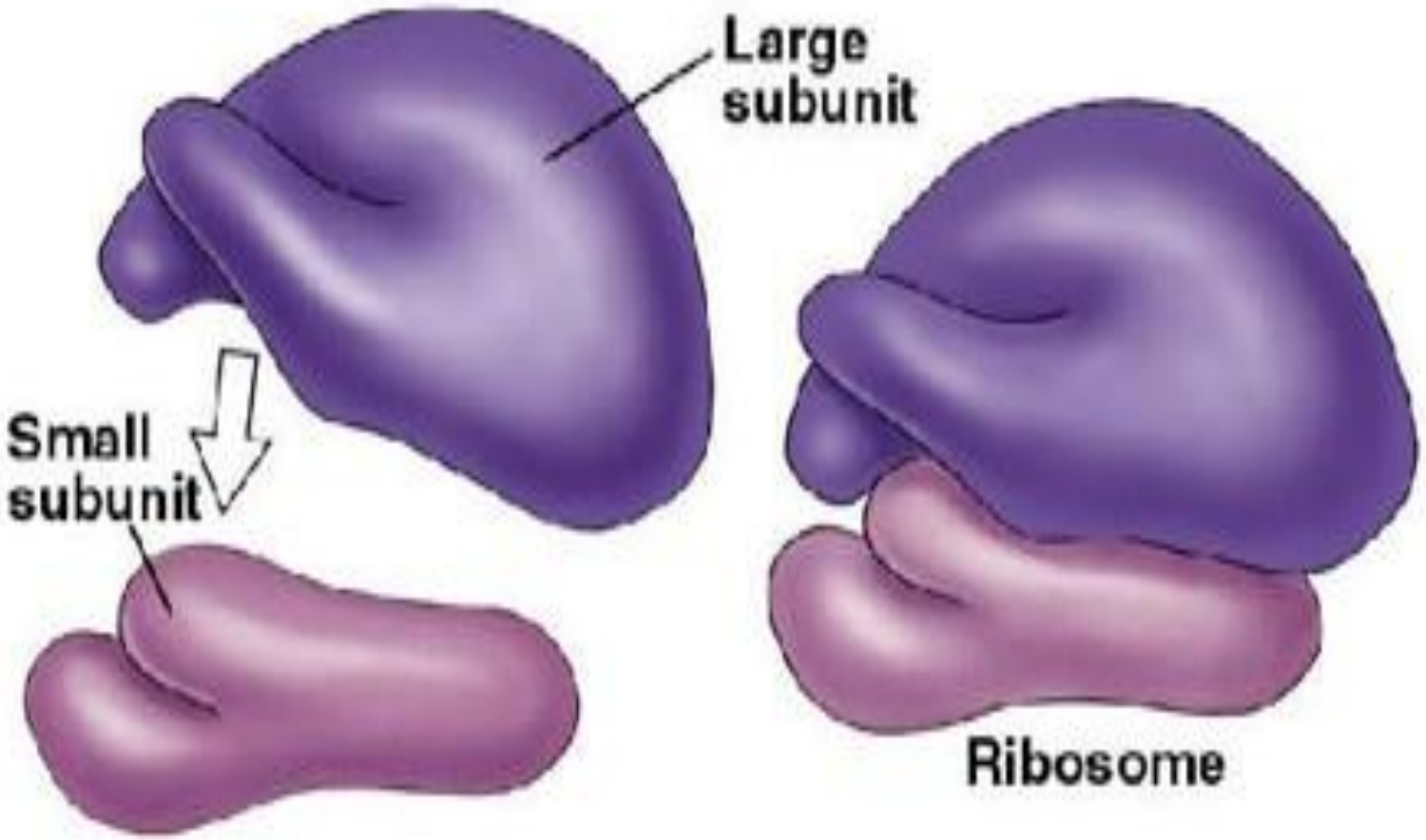
- Ribosomal RNA
- Transfer RNA
- Messenger RNA

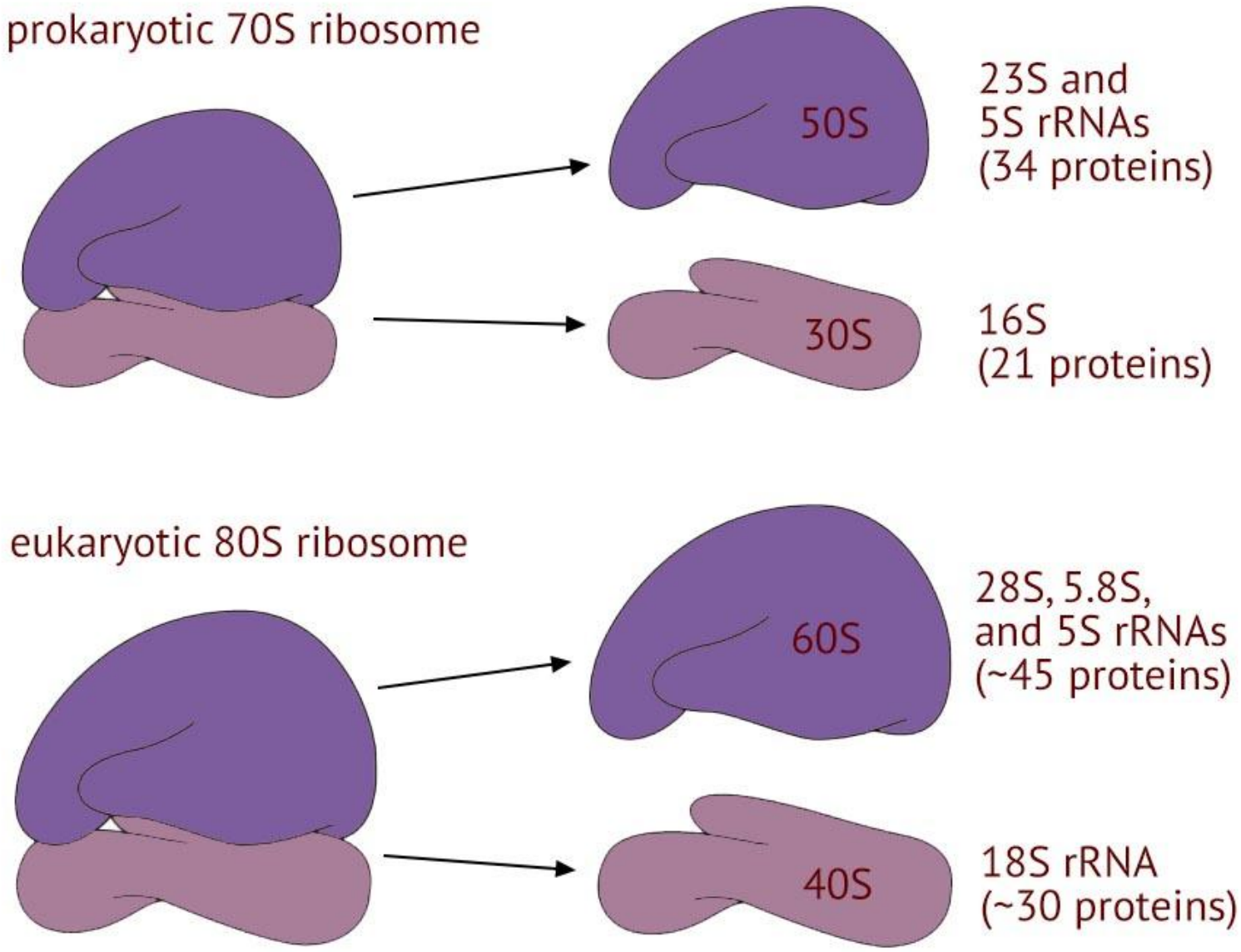
RIBOSOMAL RNA

- Most stable form of RNA
- Found in ribosomes
- Highest molecular weight
- Abundant of all the types
- 80% of the total RNA of the cell
- Represents 40-60% of the total weight of ribosomes


RIBOSOMES PERFORM PROTEIN SYNTHESIS
bound ribosomes
composed of rRNA and proteins
free-ribosomes

Ribosome



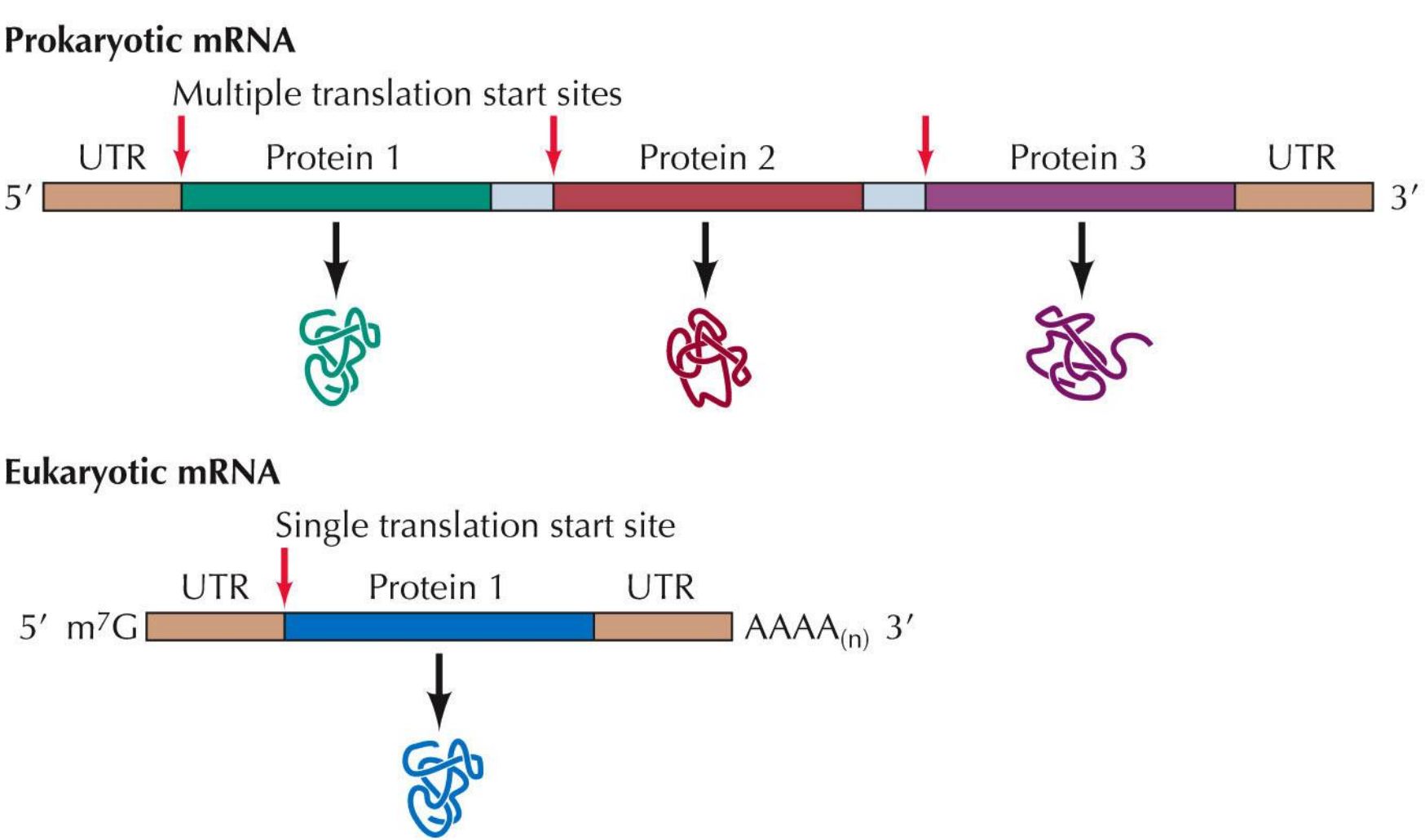

prokaryotic 70S ribosome
50S
23S and
5S rRNAs
(34 proteins)
30S
16S
(21 proteins)
eukaryotic 80S ribosome
60S
28S, 5.8S,
and 5S rRNAs
(~45 proteins)
40S
18S rRNA
(~30 proteins)

RIBOSOMAL RNA

- Highest GC content
- More than 50%
- Necessary for ribosomal assembly
- Provides specific sequence to which messenger RNA molecule can bind in order to be translated

MESSENGER RNA

- Heterogeneous in size and stability
- Amounts to 5% of the total RNA
- Synthesized on the surface of DNA template
- Base sequence complementary to DNA
- Carries the genetic information (message) for the assembly of amino acids from DNA to ribosomes
- Synthesized by DNA dependent RNA polymerase



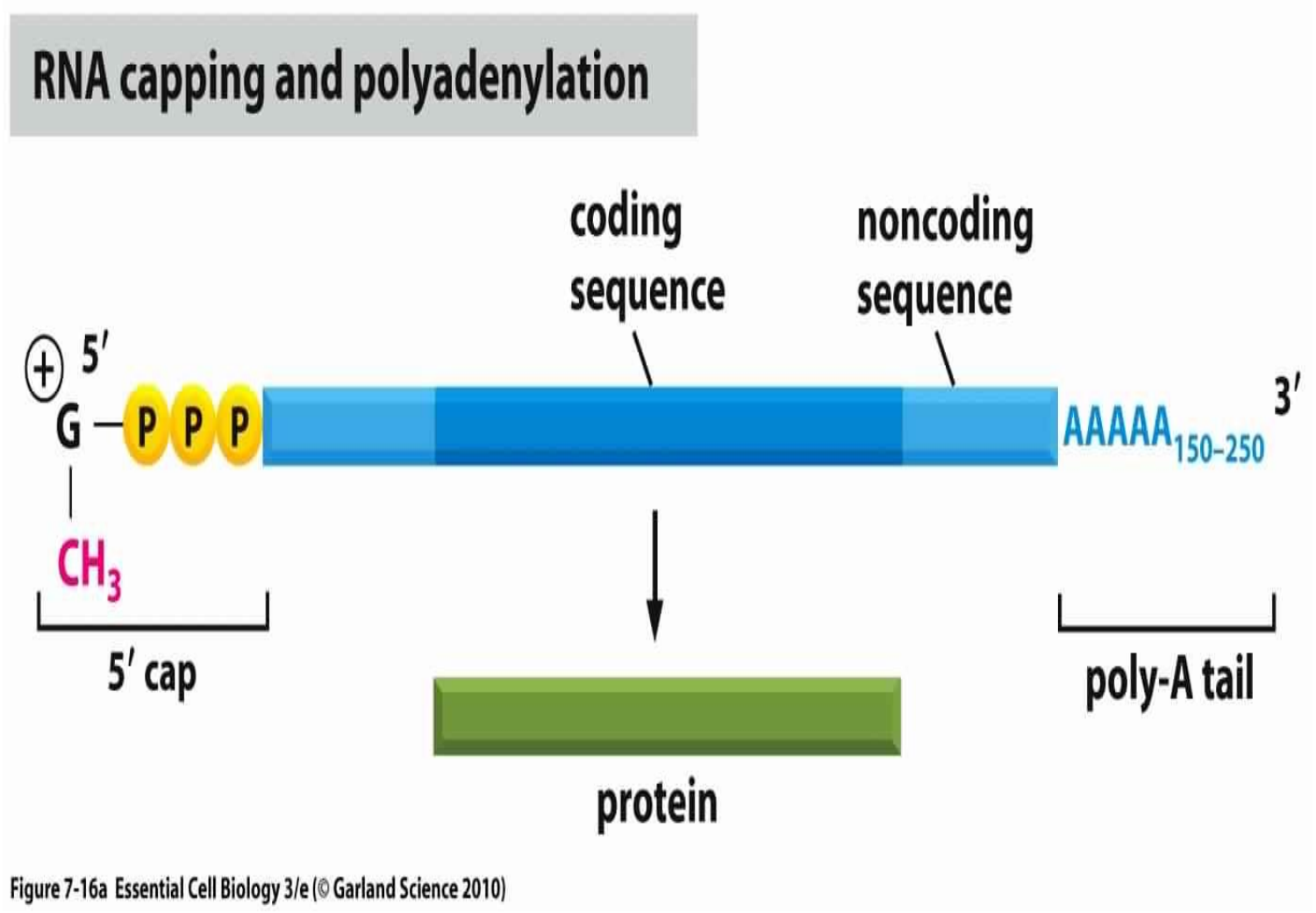


Figure 7-16a Essential Cell Biology 3/e (© Garland Science 2010)

TRANSFER RNA

- t RNA
- Soluble RNA
- Smallest polymeric form of RNA
- 15% of the total RNA of cell
- Acts as specific carriers of activated **amino acids** to specific sites on protein synthesizing templates

Structure of tRNA

- **Primary structure**- linear sequence of nucleotides
- **Secondary structure**-Clover leaf model
- **Tertiary structure**- 3-D structure of tRNA , L shape, Helix stacking

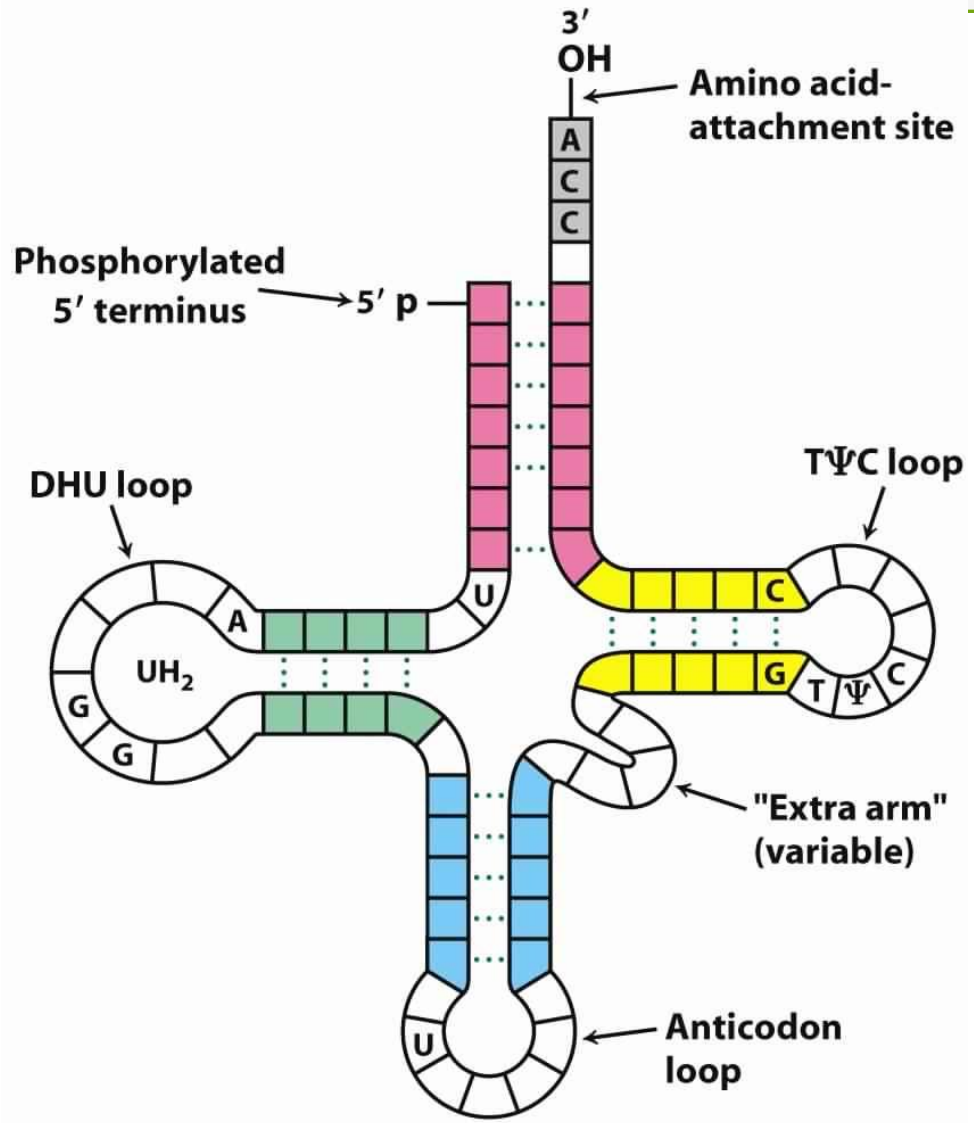


Figure 30.3
***Biochemistry,* Seventh Edition**

DIFFERENCE BETWEEN DNA & RNA

	DNA	RNA
Location	Chromatin of nucleus	Cytoplasm=90% Nucleolus=1-%
State	Never present in free state in cytoplasm	May be present in free state
Strands	Normally double stranded and rarely single stranded	Normally single stranded and rarely single stranded
	Both sense and antisense strands	Sequence is same as that of antisense strand
Sugar moiety	2'deoxyribose	ribose
Nitrogenous bases	A, T, G, C (No uracil)	A, U, G, C (No thymine
Base pairing	A=T & G=C	A=U & G=C
Base pairing	Entire length	50% of the entire length (helical region)
Unusual base pairs	Few unusual base pairs	More unusual base pairs

DIFFERENCE BETWEEN DNA & RNA

	DNA	RNA
Molecular weight	Large number of nucleotides , high molecular weight	Fewer nucleotides hence low molecular weight
Stability	Alkali stable	Alkali labile
Synthesis	Acts as template for its synthesis	Does not acts as template for its synthesis
Replication and Transcription	Undergoes Replication and transcription	Does not undergo replication and transcription
Genetic material	Usual genetic material	Only for some viruses