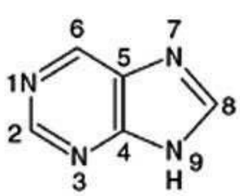
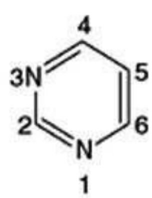
Structure of Nucleic Acids

The nucleic acid structure could be simplified into three main parts, namely, the nitrogenous bases, a sugar moiety and a phosphate group. [redacted] bases that are found among nucleic acids [redacted] are heterocyclic organic compounds. The [redacted] ns that there are two or more elements th [redacted] e ring system. In the case of the nitrogeno [redacted] s are Carbon and Nitrogen. The nitrogenous [redacted] according to the type of ring system the [redacted] is composed of two fused rings, one bei [redacted] e the other is a five-membered ring system. On the other hand, a pyrimidine ring is consists of a single ring system only.



Purine

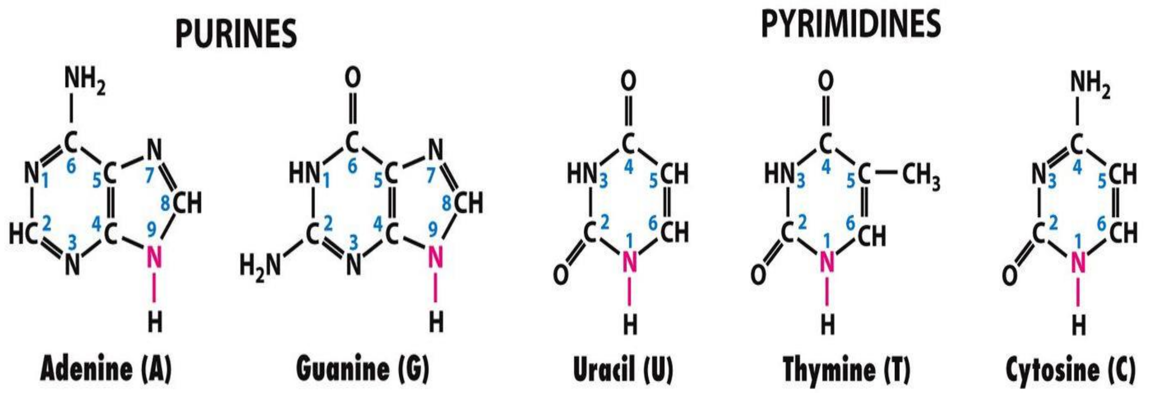


Pyrimidine

[redacted] *n the Latin words purus which* [redacted] *meaning uric acid.*

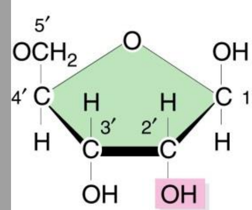
[redacted] *contraction of* "im" *from the* [redacted] *pyr means fire, as pyridine, the* [redacted] *first derived from coal tar.*

As in the case of organic compounds, the atoms in every position of the ring are assigned with a corresponding number for easier citation. Consider that the Nitrogen atoms within the ring are given priority in alignment of lower locate designati[redacted]e position of atoms in a purine ring are numb[redacted]ise, while the atoms in the purine ring are [redacted]ockwise manner. The nitrogenous bases are clas[redacted] purine or pyrimidine. Adenine and Guanine [redacted]e Cytosine, Thymine and Uracil are pyrimidi[redacted]



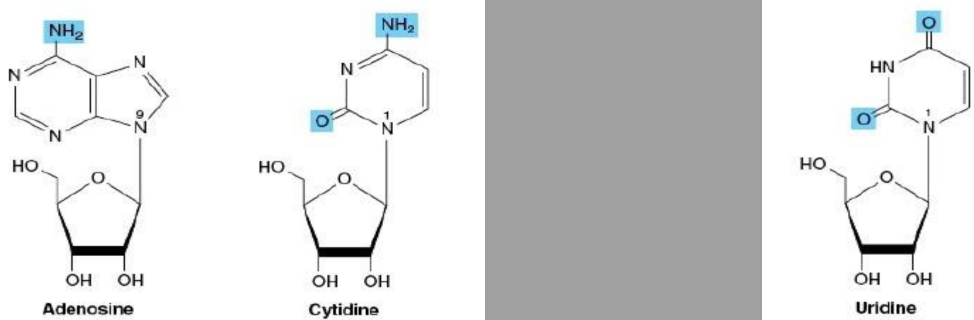
Adenine is also called 6-am[redacted]ne is also referred to as 2-amino-6-oxy-pu[redacted]uggest the different functional groups that [redacted]wo purines. Consequently, cytosine is 2-oxy-[redacted] thymine is 2,4-dioxy-5-methyl-pyrimidine a[redacted] 2,4-dioxy-pyrimidine. Notice that the [redacted]etween the structure of thymine and uracil [redacted]f a methyl group at the fifth position with[redacted]ing of the former that is absent on the latte[redacted]

Nucleic aci[redacted] sugar units, particularly ribose. This five[redacted]ists in a ring configuration, and is represent[redacted]Haworth structure. The carbon atoms are identif[redacted]h C5 and are assigned with a prime (‘) symbol[redacted]rentiate from the position of atoms in the nit[redacted]urthermore, the sugar unit in RNA is simply rib[redacted]sugar moiety in the DNA is 2’-deoxyrobose. The [redacted]sence of an oxygen atom at the 2’ position of the[redacted].

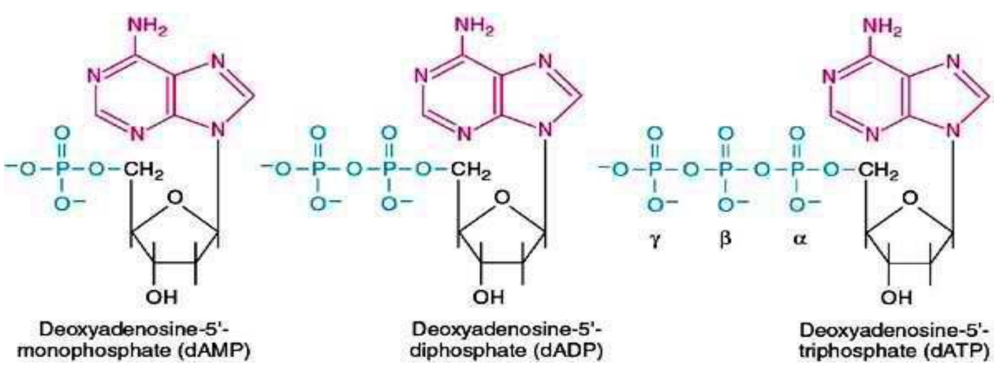


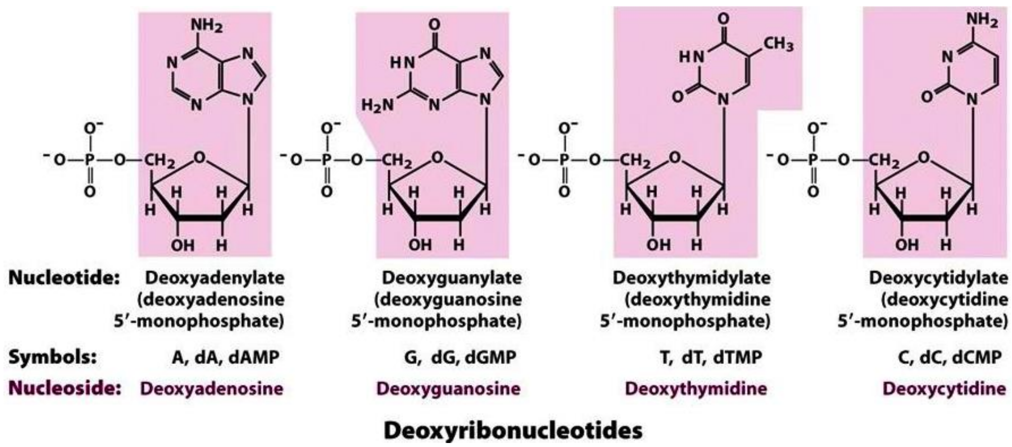
Ribose

When a suga[redacted] with a nitrogenous base, a nucleoside is for[redacted] attachment in both ribose and deoxyribose units[redacted]th respect to the nitrogenous rings, the linka[redacted]bhydrate group is in N9 for purines and N1 fo[redacted]e bond between the nitrogenous base and the sug[redacted]d an *N*-linked glycosidic bond that is related [redacted]d glycosidic bond which was introduced in the[redacted]bohydrates. Purine nucleosides are named by attaching the suffi [redacted] e purine rings end with the syllable -idine.

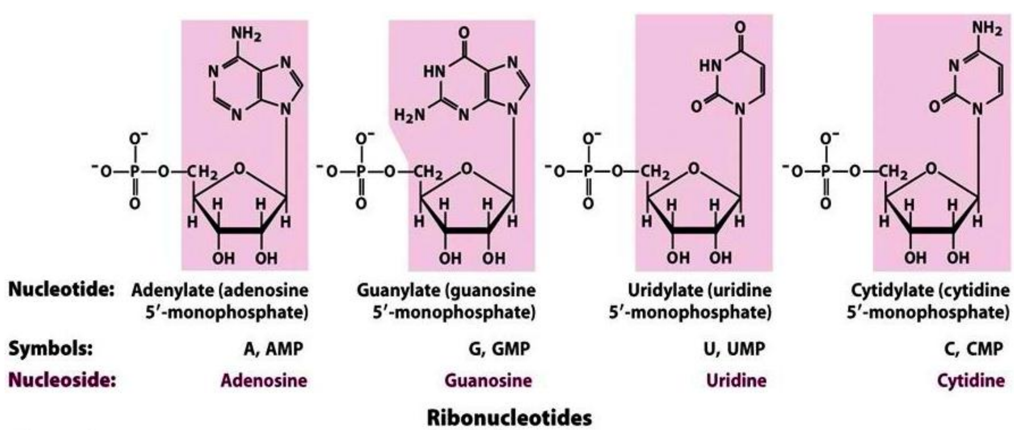


More often than not, a pho [redacted] s attached to the C5’ position of the ribose ring [redacted] ide. This leads to formation of a nucleotide. Nucl [redacted] mmon in the human body. Aside from being a mon [redacted] or nucleic acids, nucleotides can also serve as a [redacted] y carrier in cells such as the Adenosine triphospha [redacted]





Depending on the sugar unit tha[redacted] nucleotides could be classified as deoxyribonuc[redacted]nucleotides. There are various ways in which nuc[redacted]ed, as shown below.



Nucleic acids are composed of [redacted] are linked through phosphodiester bonds. In the [redacted] nucleotide, the sugar units and the phosphate gr[redacted]ortant role in the formation of the backbone.[redacted]condensation reaction between the hydroxyl group [redacted] C3′ of the first nucleotide and the phosphate [redacted] the C5′ of the succeeding nucleotide is respo[redacted]formation of the phosphodiester bond. As each ph[redacted] the nucleic acid structure is negatively charge[redacted]arge of both DNA and RNA is negative.

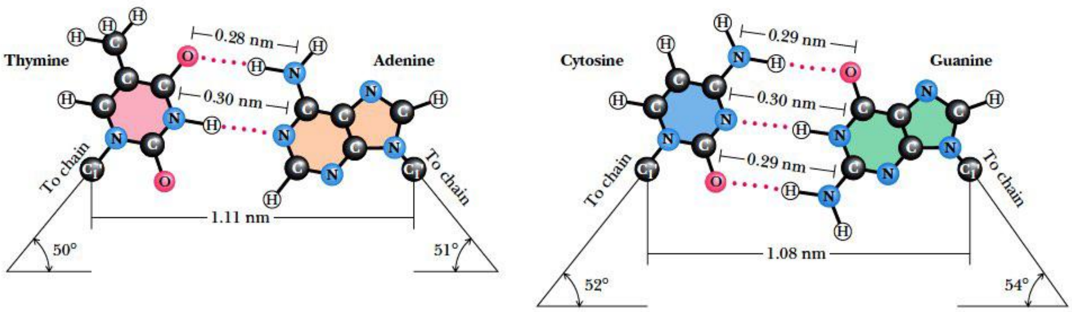
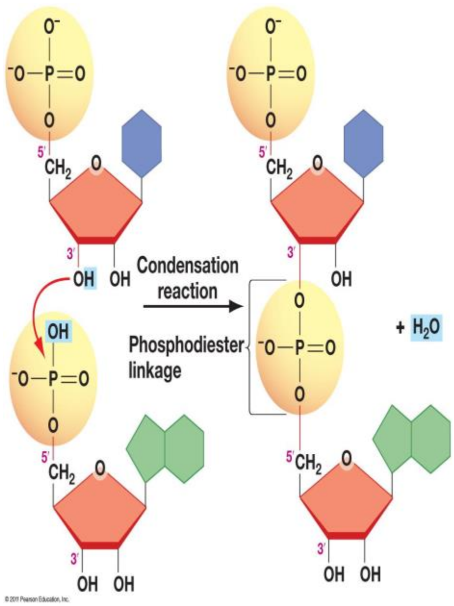


FIGURE 11.20 • The Watson–Crick base pairs A : T and G : C.

In the nucleic acid structur[redacted]nit plays a crucial role in a nucleotide struc[redacted]s a point of attachment for other components. C[redacted] nitrogenous base is bound through an *N*-linked g[redacted]2′ indicates whether the nucleic acid is a DNA c[redacted]droxyl group at the C3′ position is connect t[redacted]g nucleotide through a phosphodiester bond and C[redacted] a phosphate group. All nucleotides have two enc[redacted]sphate group at the C3′ and a free hydroxyl grou[redacted], thus these two terminals are called the 3′ ([redacted]ime) and 5′ (read as five-prime) ends of a nucle[redacted]



5'
CH2
3'
OH
OH
Condensation reaction
Phosphodiester linkage
+ H2O
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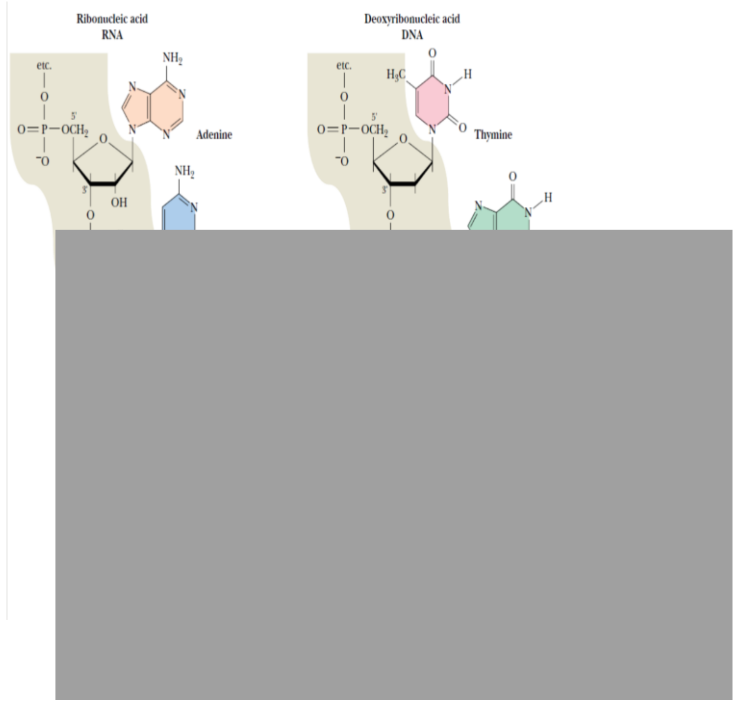


Ribonucleic acid
RNA
Deoxyribonucleic acid
DNA
etc.
Adenine
Thymine

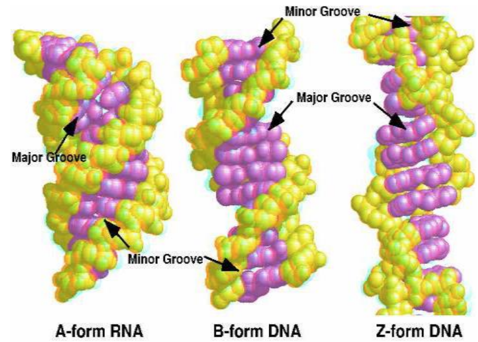
Structure of Nucleic Acids

The Structural Features of the DNA

The DNA is composed of two [redacted] re geld together by hydrogen bonds. In the histo[redacted], Erwin Chargaff proposed that there is an exi[redacted]e proportion of nucleotides within the DNA. [redacted]studied the the nucleic acids in various organi[redacted]the table below, he pointed out that there is a [redacted] the Adenine and Thymine, as with Guanine and Cy[redacted] him to proposed such relationship that is now [redacted]Chargaff's Rule. When James Watson and Francis [redacted]fe-size model of the DNA, they considered the [redacted]base pairing as suggested by the Chagaff's Ru[redacted], they realized that in terms of the structure, [redacted]orm two hydrogen bonds with Thymine, while Gua[redacted] three hydrogen bonds with Cytosine.

Moreover, when Watson and Crick performed measurements within the model that they generated, they noted that the length of the hydrogen bond between adenine and thymine ranges from 0.28 to 0.30 nanometers. This measurement is also similar with the length of hydrogen bonds between guanine and cytosine. This suggests that the diameter of the entire DNA molecule is almost the same throughout its entire length.

Feature	B-DNA	A-DNA	Z-DNA
Type of helix	Right-handed	Right-handed	Left-handed
Helical diameter (nm)	2.37	2.55	1.84
Rise per base pair (nm)	0.34	0.29	0.37
Distance per complete turn (pitch) (nm)	3.4	3.2	4.5
Number of base pairs per complete turn	10	11	12
Topology of major groove	Wide, deep	Narrow, deep	Flat
Topology of minor groove	Narrow, shallow	Broad, shallow	Narrow, deep



The two strands of the [illegible]llel. This means that one of their strands run [illegible]rection while the other on the 5′ to 3′ or[illegible] that these two designations are due to the [illegible] hydroxyl groups that are located at the ends [illegible]

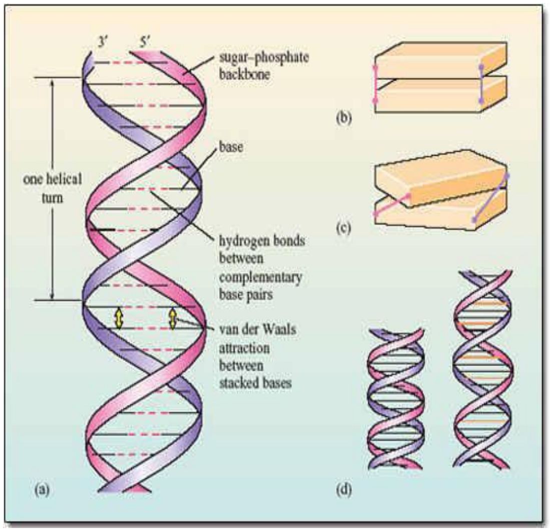
Molar Ratios Leading to the Formulation of Chargaff's Rules

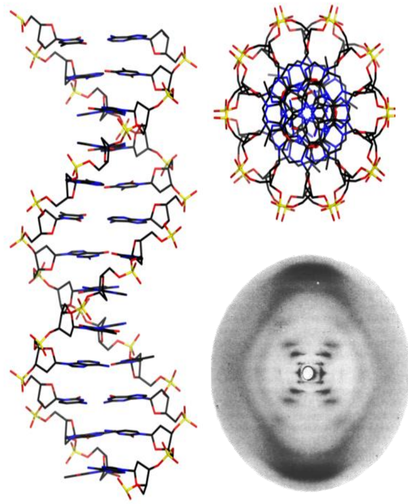
Source	Adenine to Guanine	Thymine to Cytosine	Adenine to Thymine	Guanine to Cytosine	Purines to Pyrimidines
Ox	1.29	1.43	1.04	1.00	1.1
Human	1.56	1.75	1.00	1.00	1.0
Hen	1.45	1.29	1.06	0.91	0.99
Salmon	1.43	1.43	1.02	1.02	1.02
Wheat	1.22	1.18	1.00	0.97	0.99
Yeast	1.67	1.92	1.03	1.20	1.0
Hemophilus influenzae	1.74	1.54	1.07	0.91	1.0
E. coli K-12	1.05	0.95	1.09	0.99	1.0
Avian tubercle bacillus	0.4	0.4	1.09	1.08	1.1
Serratia marcescens	0.7	0.7	0.95	0.86	0.9
Bacillus schatz	0.7	0.6	1.12	0.89	1.0

Source: After Chargaff, E., 1951. *Federation Proceedings* **10**:654–659.

The DNA is a helical molecule which contains major and minor grooves. These grooves serve as binding sites for proteins and enzymes that [redacted] the DNA. In terms of helical typologies, there [redacted] stinct types of DNA helices, namely the A, B a [redacted] B form is the most common type of DNA which con [redacted] tides per complete turn. The A form of DNA is qu [redacted] pared to the B form, as it has 11 nucleotides pe [redacted] Both the A and B forms twist on a right-hande [redacted] the Z form is a left-handed helix. moreover, [redacted] 2 nucleotides per turn, yet is the most narrow t [redacted] distance per complete turn is 4.5 nanometers th [redacted] longer than those of the A and B forms with 3.2 [redacted] s, respectively.

Aside from the hydrogen bonds, the stacking of the nitrogen bases at the middle portion of the DNA helix contributes to the stability of the structure of the DNA. The non-polar interactions among purine and pyrimidine rings become significant as the DNA strand becomes longer.





Structural Differences between DNA and RNA

In [redacted] structural features ion the DNA, RNA is simpler, [redacted] is composed of only a single strand. The DNA [redacted] genous bases namely adenine, guanine, cytosine [redacted] whereas RNA is composed of adenine, guanine, [redacted] cil. On elf the most obvious structural differen [redacted] and RNA is the sugar unit that they contain. [redacted] NA, it is ribose. As there is just one strand, [redacted] base pairing can exist within the structure [redacted] lecule, and such folding are called superseco [redacted], in which adenine pairs with uracil and guanine still pairs with cytosine. In terms of stability, RNA is easily degraded by enzymes, heat, chemical agents, desiccation and mechanical stress.

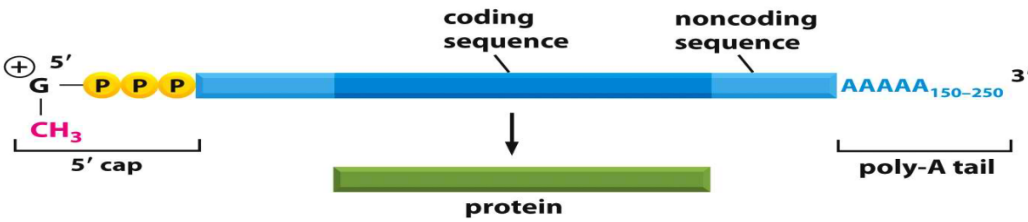
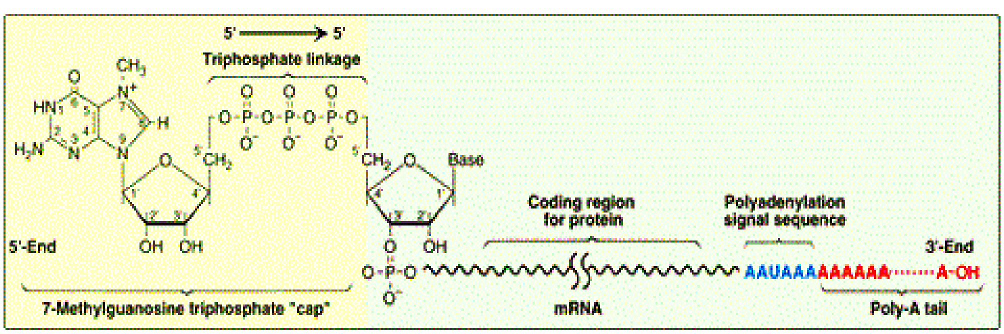
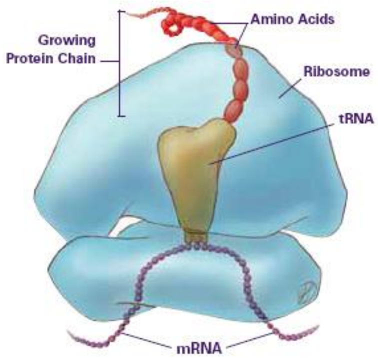


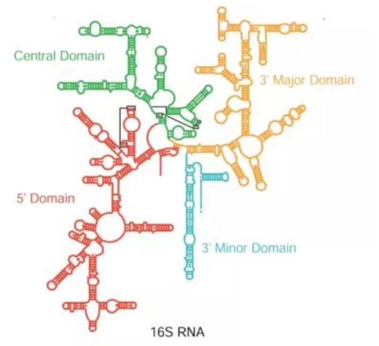
Figure 7-16a Essential Cell Biology 3/e (© Garland Science 2010)

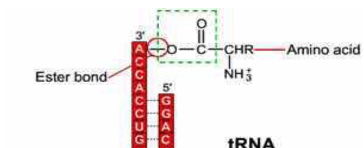
Three predominant types of [illegible]ll include the messenger RNA (mRNA), ribosomal [illegible] transfer RNA (RNA). The mRNA is synthesized in [illegible]the cell, using the 3′ to 5′ strand of the DN[illegible]ate to acquire information that is used to prod[illegible]t are required by the cell. After post tra[illegible]ents including addition of about 200 adennine-b[illegible] at the 3′ end and a 7′-methyl-guanosine cap on [illegible]he mRNA, it is then transported out of the nu[illegible]l towards the ribosome for translation. The mRN[illegible] soon as it is used in translation.



The rRNA is a component of [redacted] which are responsible for synthesis of protein [redacted] us concepts about enzymes, it has been mentione [redacted] ut not all enzymes are proteins. This is due to [redacted] rRNA that could also facilitate formation of p [redacted] nce exhibit catalytic action. The rRNAs are a [redacted] **zymes**. The ability of RNA to carry genetic in [redacted] same time facilitate catalytic functions [redacted] RNA world hypothesis, which claims that earlie [redacted] could have used RNA first rather than DNA and p [redacted] alone could perform the functions of proteins and [redacted] s important during translation event, as it carr [redacted] towards the small-large ribosome complex. Each t [redacted] carries a specific amino acid in their 3’ end. [redacted] ontains the anti-codon that pairs with the corresponding codon that is found in the mRNA. the variable loop of the tRNA molecule is the one being recognized by the enzyme tRNA-aminoacyltransferse, which loads amino acids to the tRNA. The ammonia acids being carried by the tRNA is in the cytoplasm, which were acquired by the cell from the diet.



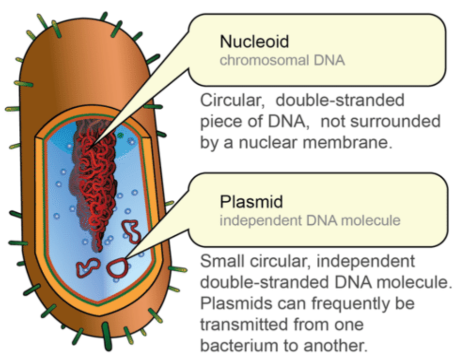


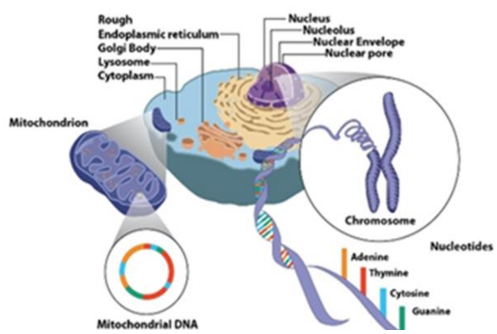


Second letter

	U	C	A	G	
U	UUU, UUC: Phe; UUA, UUG: Leu	UCU, UCC, UCA, UCG: Ser	UAU, UAC: Tyr; **UAA Stop**; **UAG Stop**	UGU, UGC: Cys; **UGA Stop**; UGG Trp	U C A G
	CUU	CCU	CAU	CGU	U

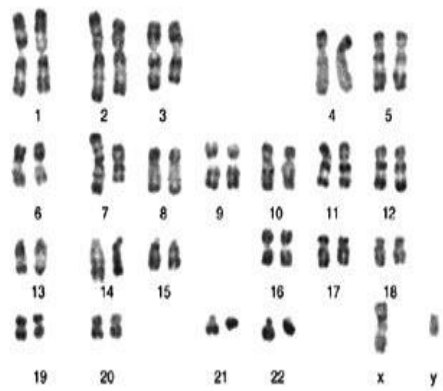
Nuclear and Mitochondrial DNA

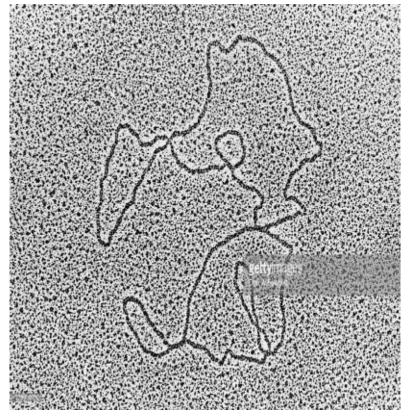




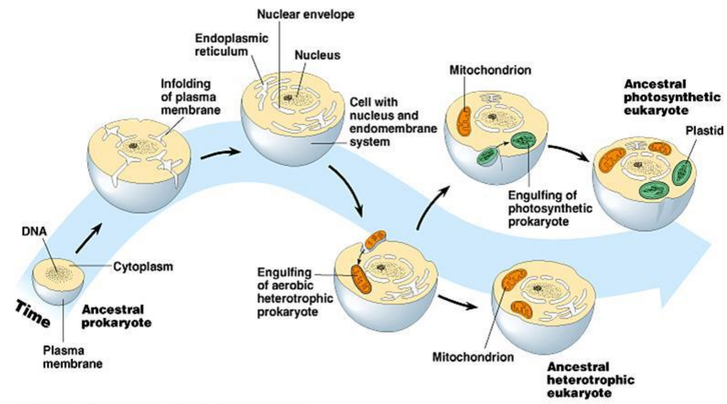
The suitability of the DNA as genetic material of organisms is due to its three fundamental characteristics. (1) The DNA can serve a s repository of information that is transmitted from one generation to the next. This is made possible through information that is carried by codons within each gene that correspond to an amino acid. (2) Its capability of replication within the cell dur[redacted] of the cell cycle ensures that daughter cells [redacted]copy of the genetic material from the parent ce[redacted]ability of DNA due to its extensive hydrogen b[redacted] Waals interaction among the stacked nitrogenous [redacted] intermolecular interactions prevent its easy de[redacted]ermore, the cell is capable of repairing the [redacted]lteration of DNA sequence (*mutation*) occurs.

The genetic mat[redacted]otic organisms is located in the cytoplasm, and [redacted]*id.* The genomic DNA contains all genes that are [redacted] survival. Prokaryotes also contain extrachromos[redacted] plasmids. Plasmids contain genes that provide [redacted]tures to enhance bacterial survival. Some bact[redacted]ids that contain genes for antibiotic resistanc[redacted] DNA and plasmids are both circular in typology[redacted]are easier to be replicated, thus providing an advantage in terms of the rate of DNA replication, which allows most prokaryotic organisms to reproduce in faster rate. In eukaryotes, two types of DNA are present, namely nuclear and mitochondrial DNA.





These two types of DNA differ in nuclear DNA is linear and is packaged in chromosomes, while the mitochondrial DNA necessary genes for survival of euk contributed by the nuclear DNA. The mit other hand, contains genes that code for and enzymes that facilitate cellular processes. The circular typology of provides proof of the *endosymbiotic thec* the mitochondrion, as well as other rela the chloroplast were once free-living engulfed and co-existed with larger orga years of evolution.


Nuclear envelope
Endoplasmic reticulum
Nucleus
Infolding of plasma membrane
Cell with nucleus and endomembrane system
Mitochondrion
Ancestral photosynthetic eukaryote
Plastid
Engulfing of photosynthetic prokaryote
DNA
Cytoplasm
Time
Ancestral prokaryote
Plasma membrane
Engulfing of aerobic heterotrophic prokaryote
Mitochondrion
Ancestral heterotrophic eukaryote