

## **Dr. Kathleen Hill**

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*Department of Biology*

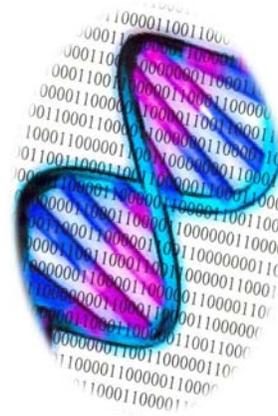
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<http://www.uwo.ca/biology/Faculty/hill/index.htm>



## **Genomes DNA Genes to Proteins**

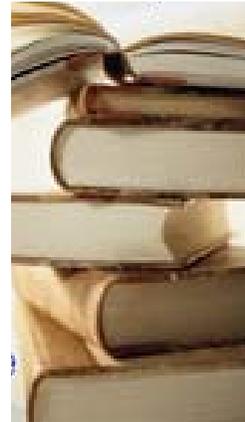


**Kathleen Hill**

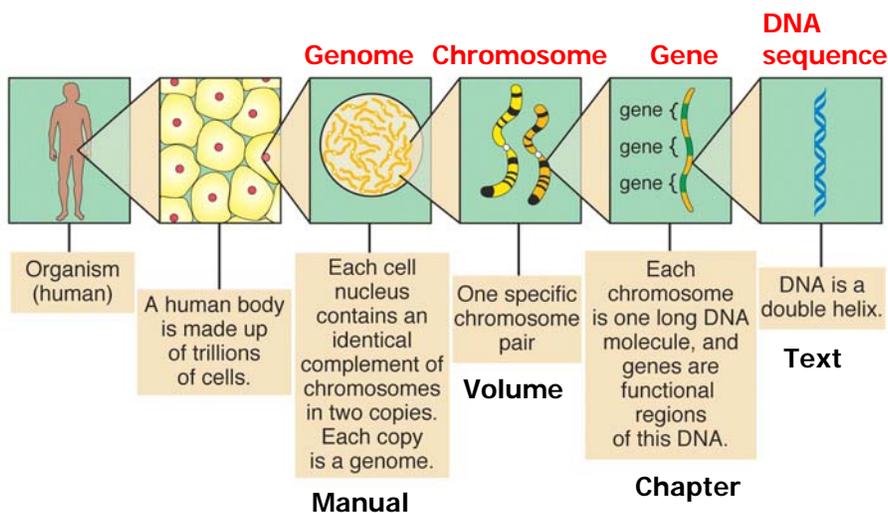
**Lab Tour WSC 333**

## The human genome is a multi-volume instruction manual

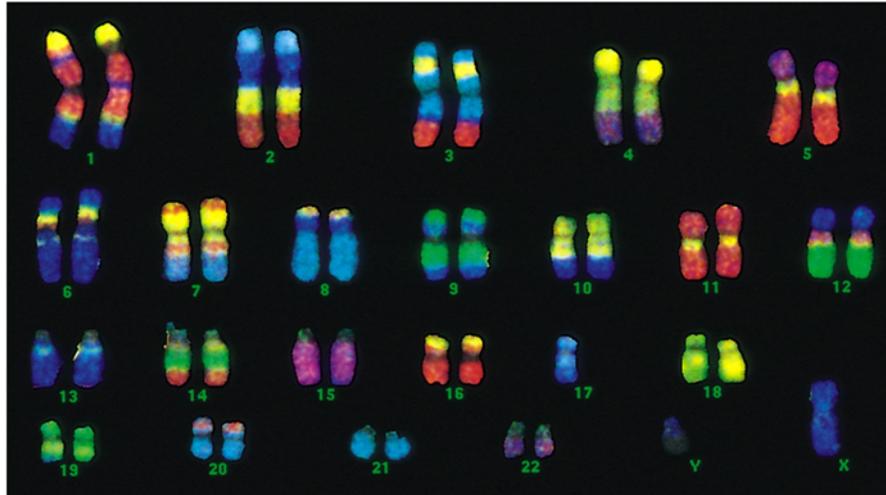
- The **GENOME** is a multi-volume instruction manual
- Each **CHROMOSOME** is a volume of text
- **Genes** are a chapter of text in the volume
- The text is written in a chemical language that has a four letter alphabet **A,C,G,T NUCLEOTIDES**



## Our instruction manual can be read in our DNA



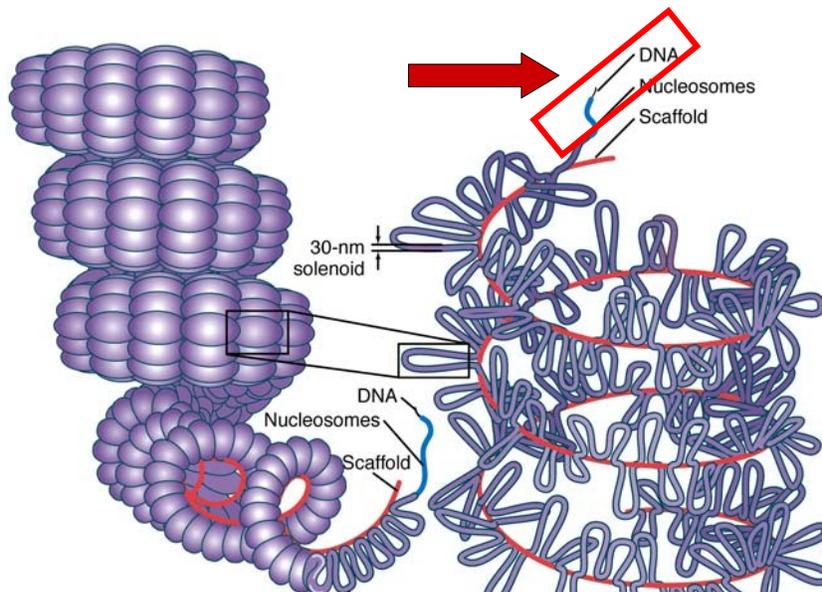
## Human Genome



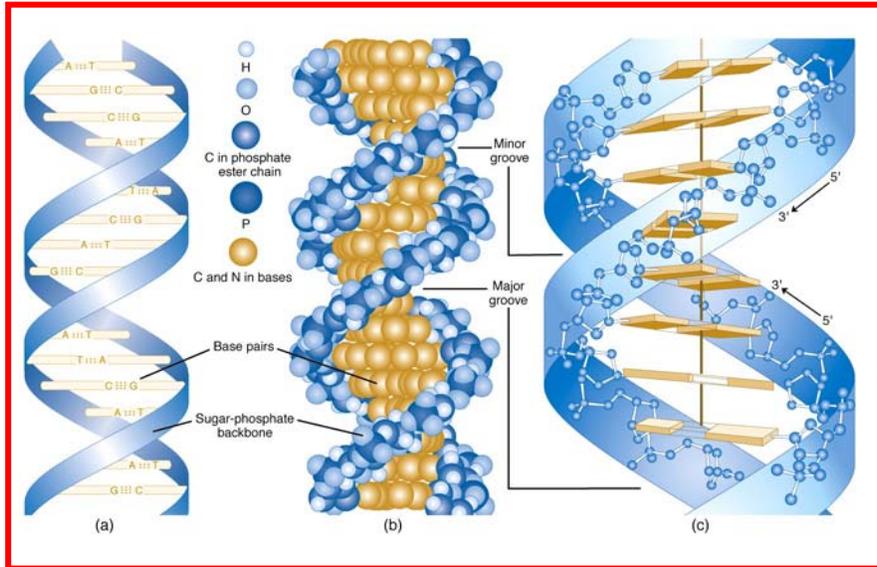
46 chromosomes  
22 pairs of autosomes  
1 pair of sex chromosomes

Male Karyotype

## Human nuclear DNA is highly packaged in chromosomes



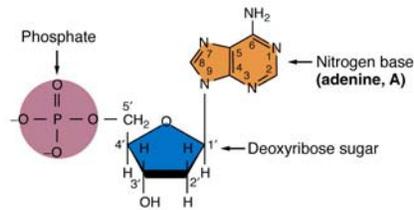
# DNA has a double helix structure



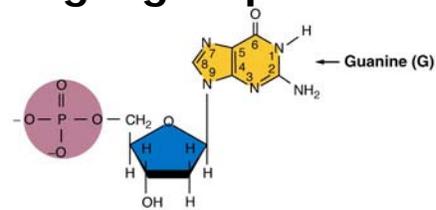
# Nitrogenous Bases

## The DNA language alphabet

### Purine nucleotides

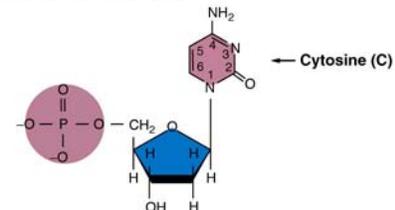


Deoxyadenosine 5'-phosphate (dAMP)

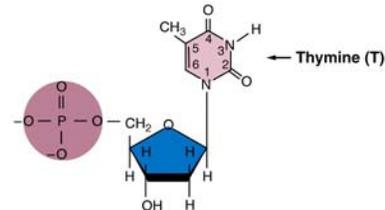


Deoxyguanosine 5'-phosphate (dGMP)

### Pyrimidine nucleotides



Deoxycytidine 5'-phosphate (dCMP)



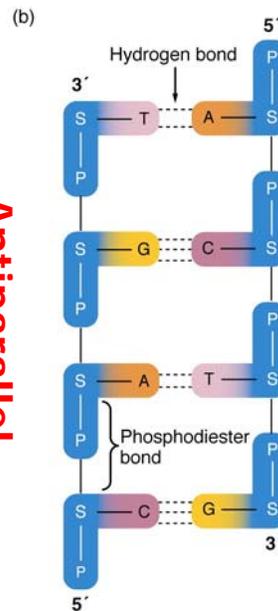
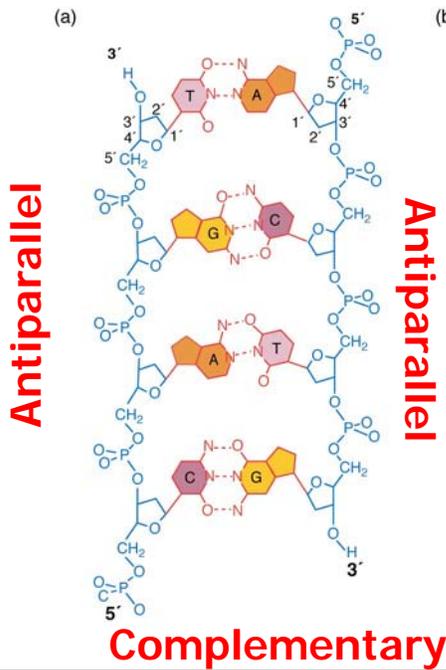
Deoxythymidine 5'-phosphate (dTMP)

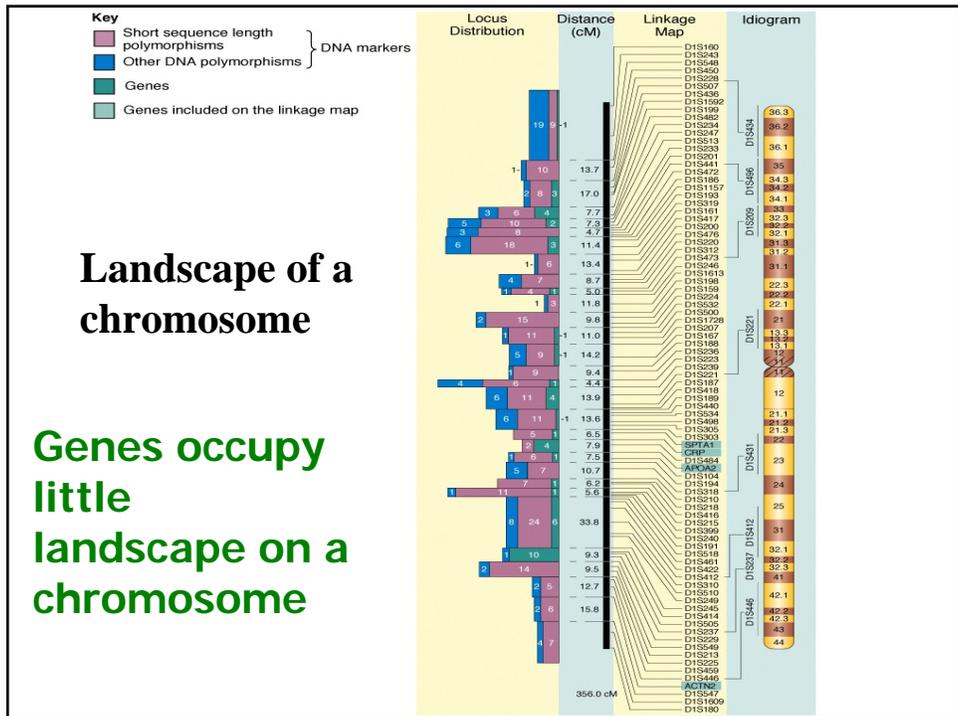
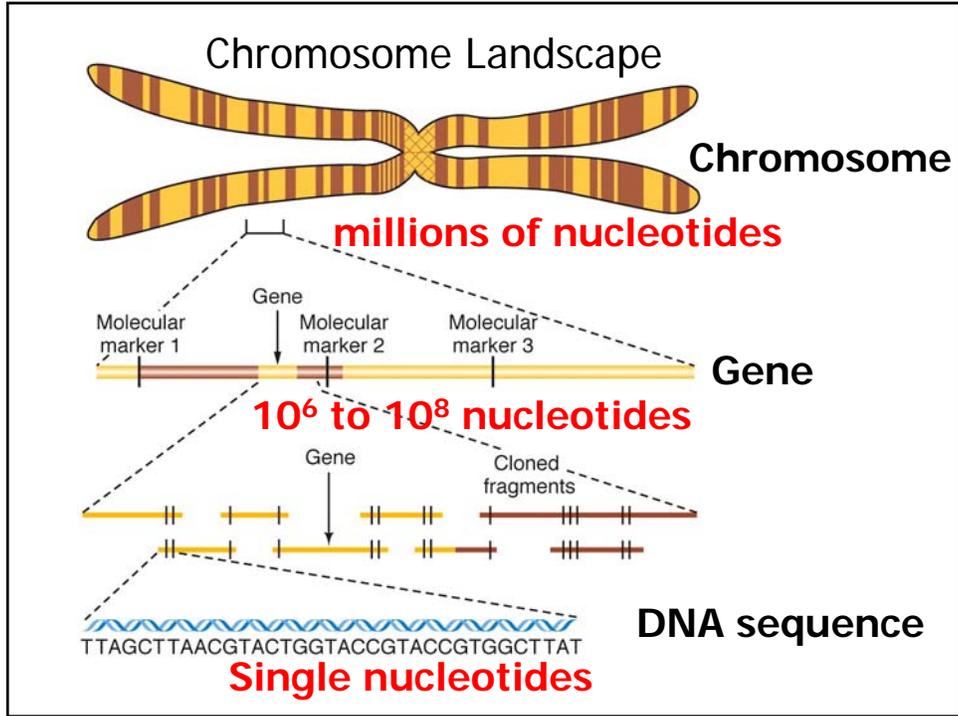
# Key Concepts

Two key properties of nucleic acids

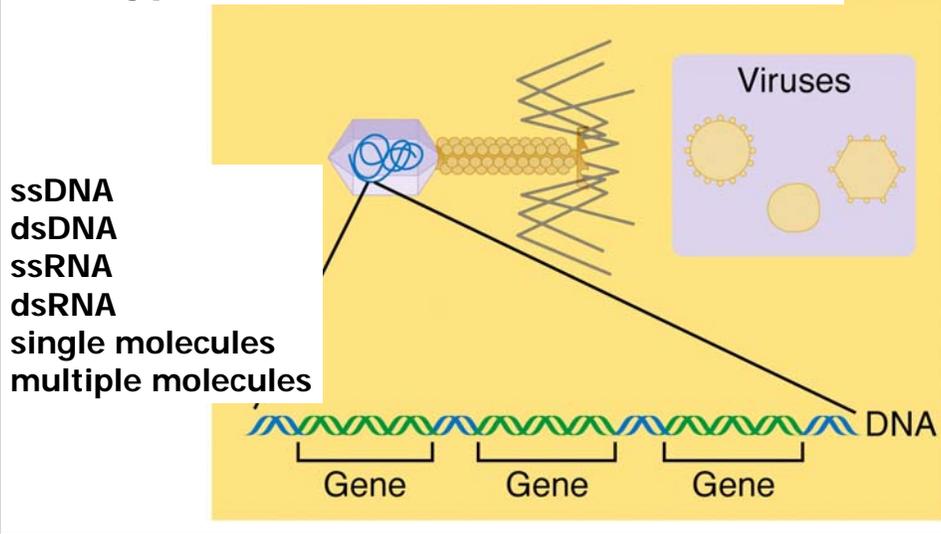
ACGT  
TGCA **Complementary**

5' → 3'  
ACGT **Antiparallel**  
TGCA  
← 3' 5'





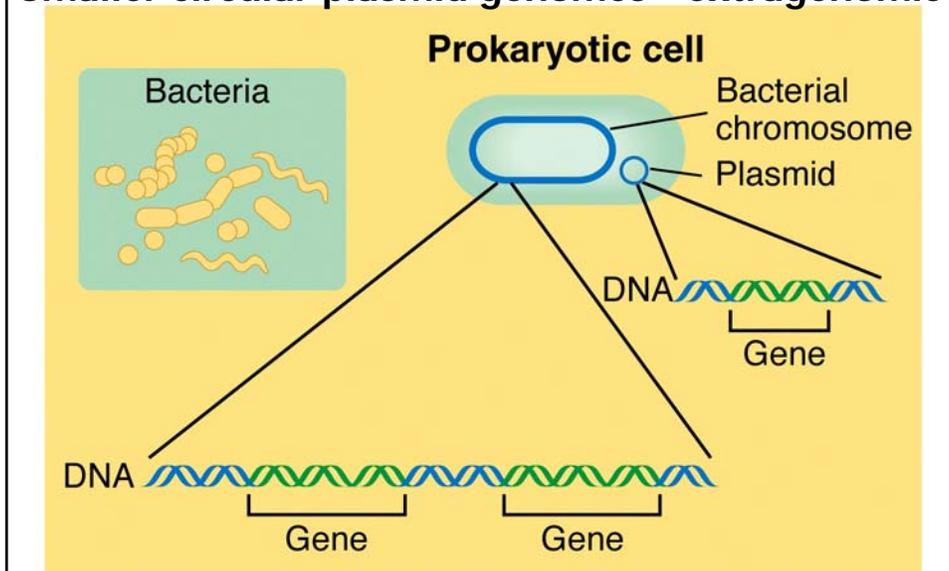
**Viruses are “nonliving” and have the greatest diversity in genome types**



### Bacterial Genomes

Single molecules, circular dsDNA

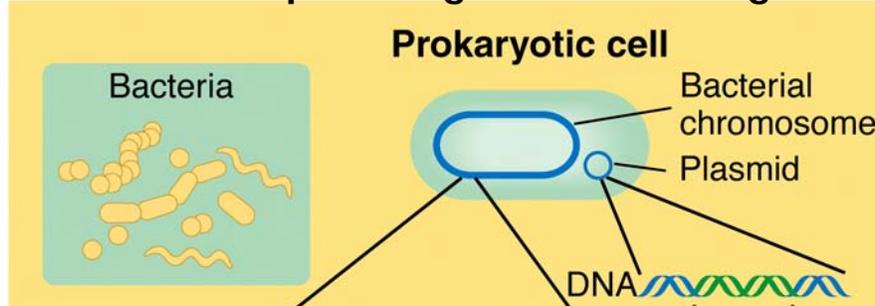
Smaller circular plasmid genomes - extragenomic



## Bacterial Genomes

Single molecules, circular dsDNA

Smaller circular plasmid genomes - extragenomic

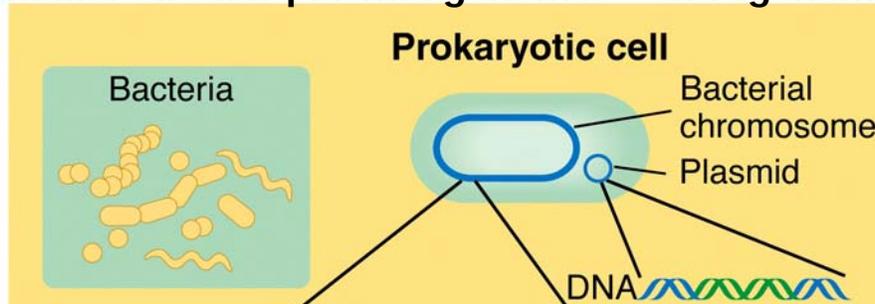


Genetic information can be exchanged between bacteria via plasmids and between the plasmid and the bacterial chromosome

## Bacterial Genomes

Single molecules, circular dsDNA

Smaller circular plasmid genomes - extragenomic



Viruses can infect bacteria and add genetic information to the bacterial host chromosome

## Bacterial Genomes

Single molecules, circular dsDNA

Smaller circular plasmid genomes - extragenomic

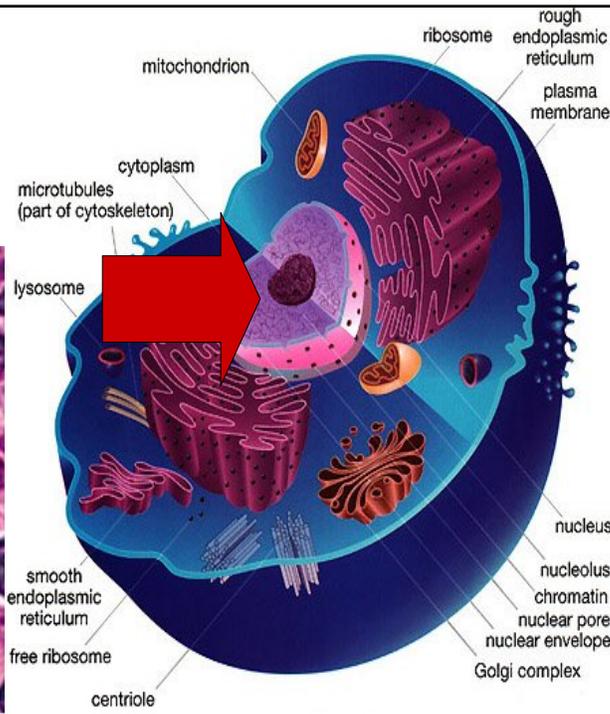
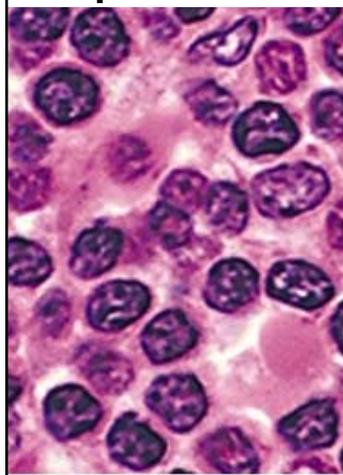


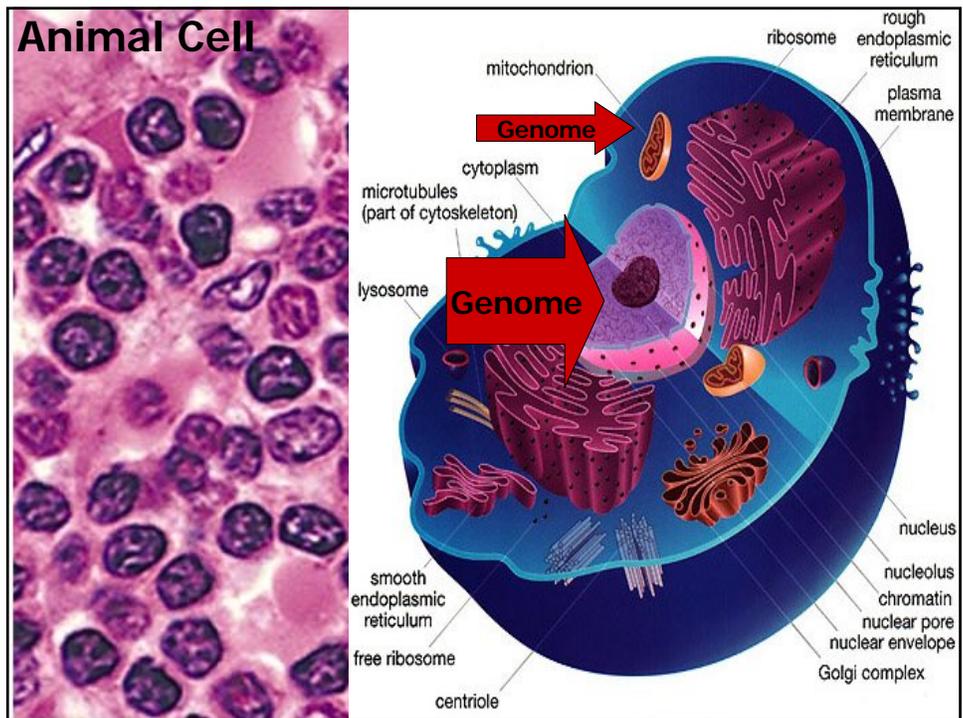
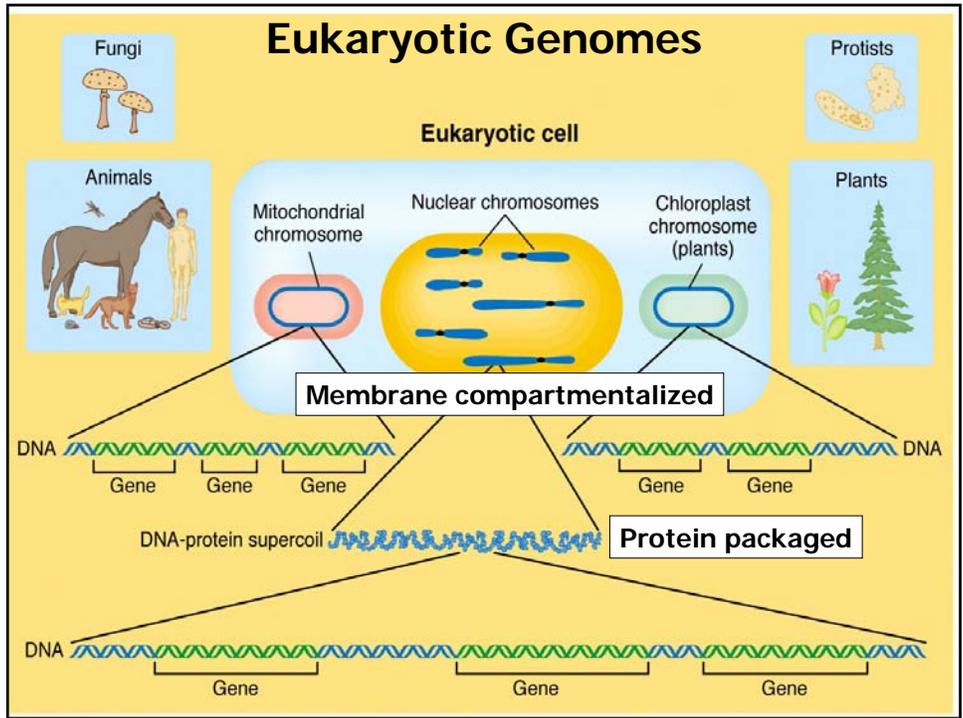
**Genome is not enclosed in a separate compartment in the prokaryotic cell**

**Genomic DNA is not protein packaged**

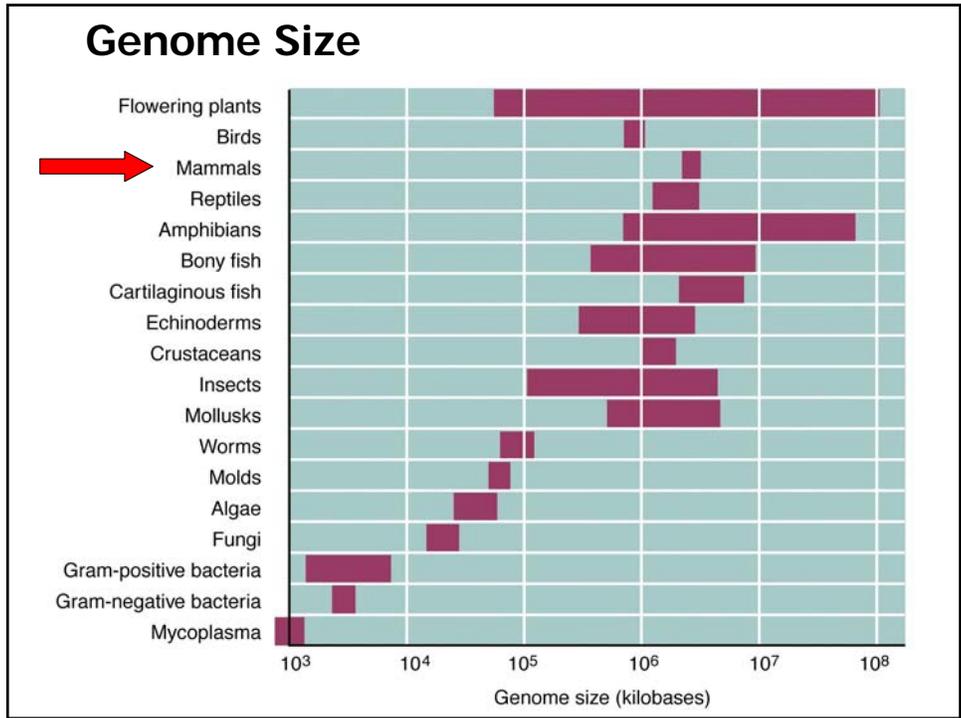
## Eukaryotic Cell:

Genome is contained in separate cell compartment









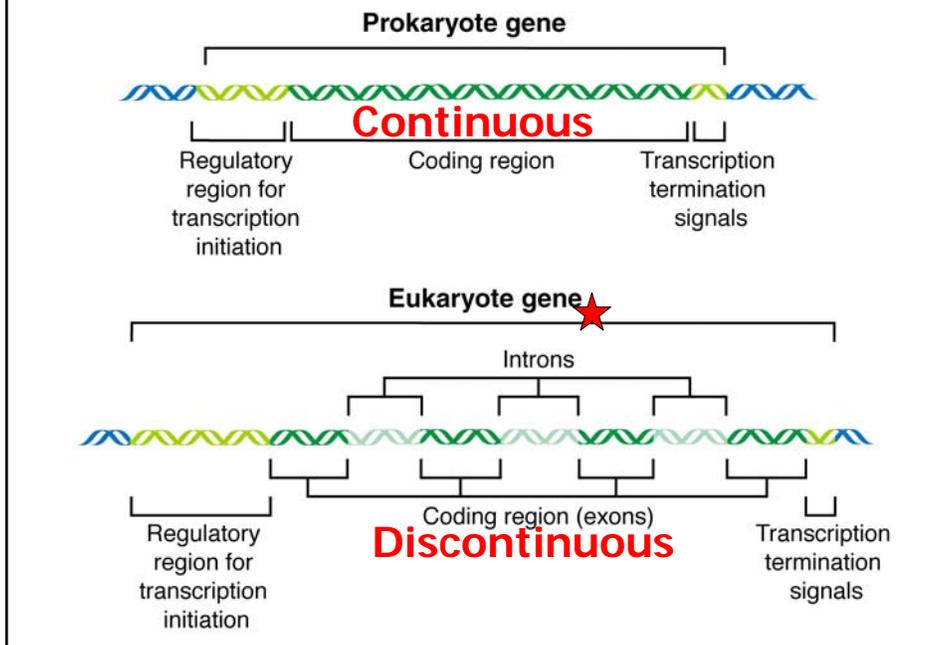
## Genome Size and Number of Genes

Genome	Group	Size (kb)*	Number of Genes
<b>Eukaryotic nucleus</b>			
<i>Saccharomyces cerevisiae</i>	Yeast	13,500 (L)	6,000
<i>Caenorhabditis elegans</i>	Nematode	100,000 (L)	13,500
<i>Arabidopsis thaliana</i>	Plant	120,000 (L)	25,000
<i>Homo sapiens</i>	Human	3,000,000 (L)	30,000–100,000
<b>Prokaryote</b>			
<i>Escherichia coli</i>	Bacterium	4,700 (C)	4,000
<i>Hemophilus influenzae</i>	Bacterium	1,830 (C)	1,703
<i>Methanococcus jannaschii</i>	Bacterium	1,660 (C)	1,738
<b>Viruses</b>			
T4	Bacterial virus	172 (L/C)	300
HCMV (herpes group)	Human virus	229 (L)	200
<b>Eukaryotic organelles</b>			
<i>S. cerevisiae</i> mitochondria	Yeast	78 (C)	34
<i>H. sapiens</i> mitochondria	Human	17 (C)	37
<i>Marchantia polymorpha</i> chloroplast	Liverwort	121 (C)	136
<b>Plasmids</b>			
F plasmid	In <i>E. coli</i>	100 (C)	29
Kalilo	In the fungus <i>Neurospora</i>	9 (L)	2

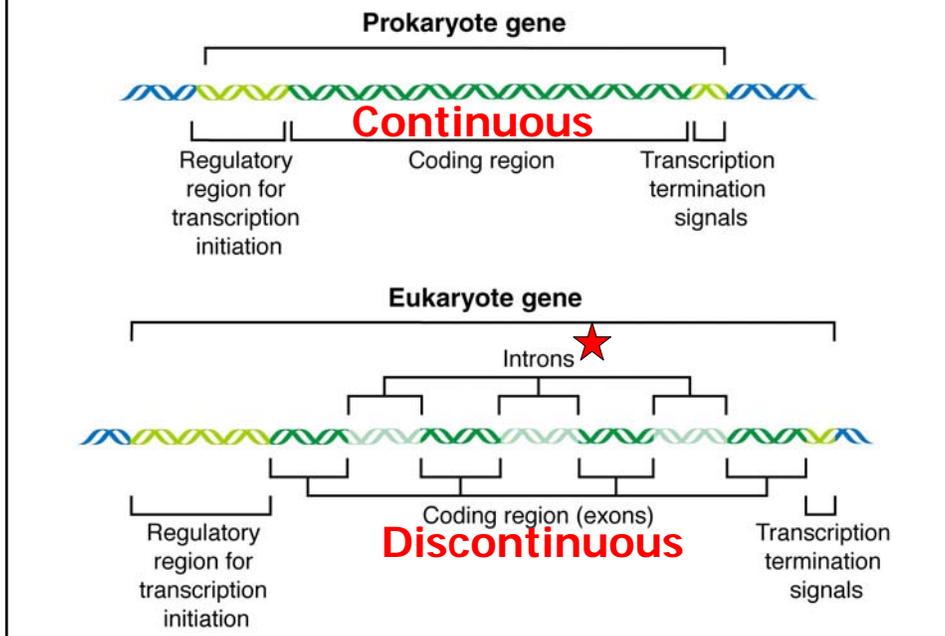
\*C = circular DNA molecule; L = linear DNA molecule; L/C = linear in free virus, circular in cell.

### Human Genome: 3.4 billion nucleotides

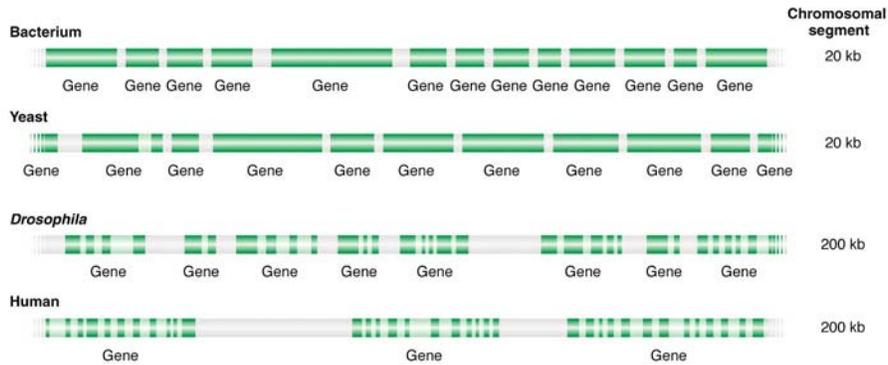
## Differences in Gene structure



## Exons produce message; introns do not

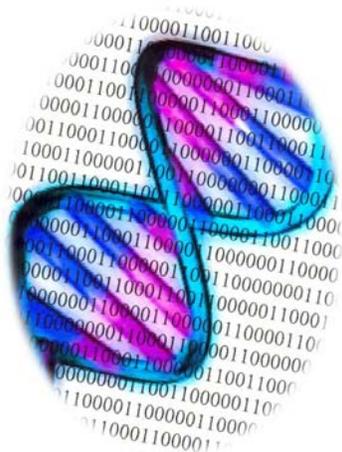


## Eukaryotic Genes are interrupted by noncoding intronic sequence

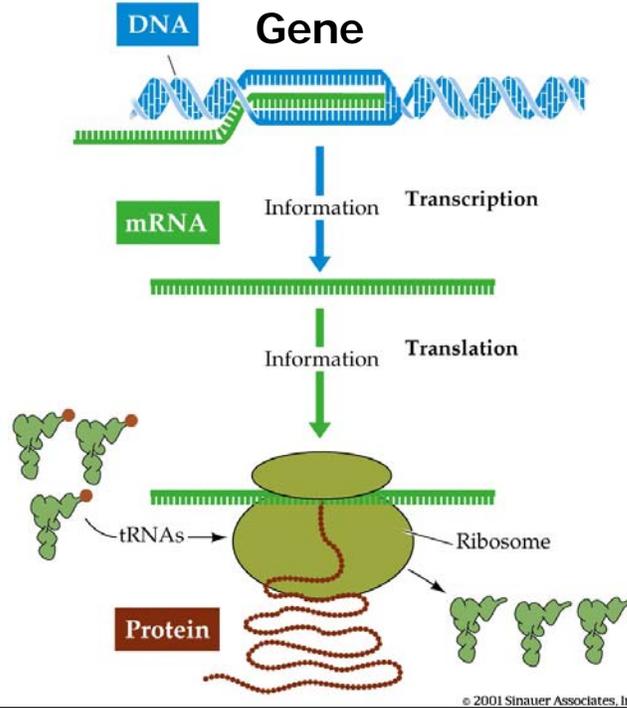


**Genes of mammals have more intronic sequence than flies, yeast and bacteria**

## GENES

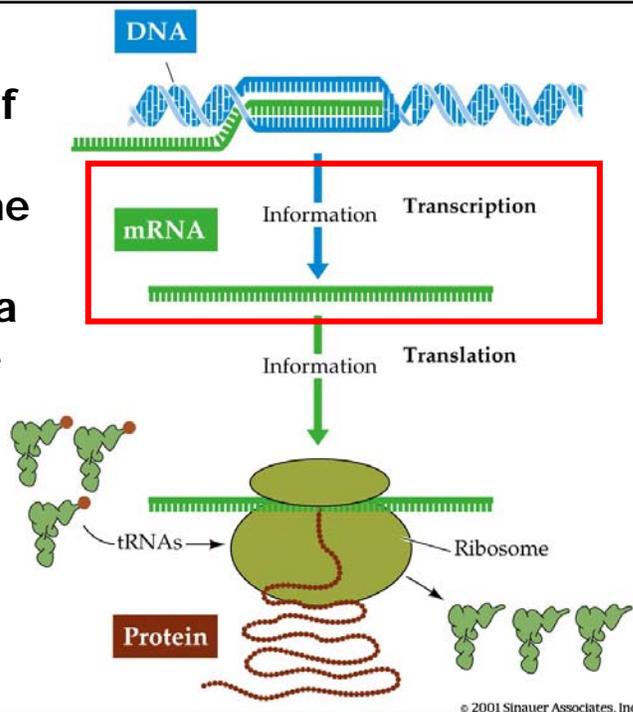


Certain Information in the DNA sequence is processed to result in proteins that can carry out an essential cell function



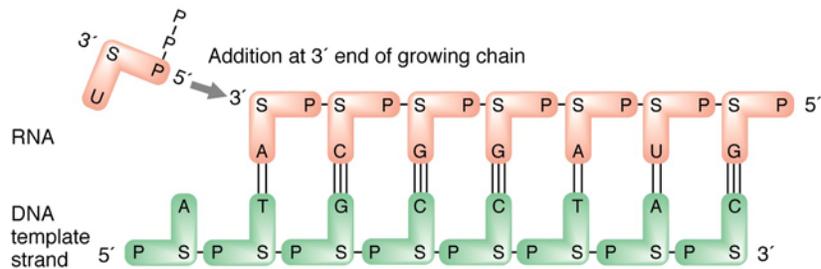
One strand of the DNA sequence (the template) is written into a intermediate message

Messenger RNA



One strand of the DNA sequence  
(the template) is written into a  
intermediate message

### Messenger RNA (mRNA)

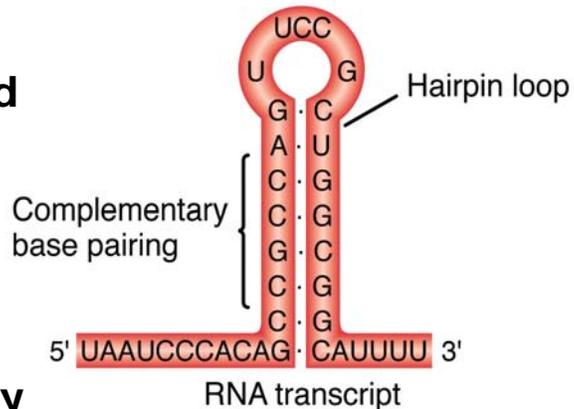


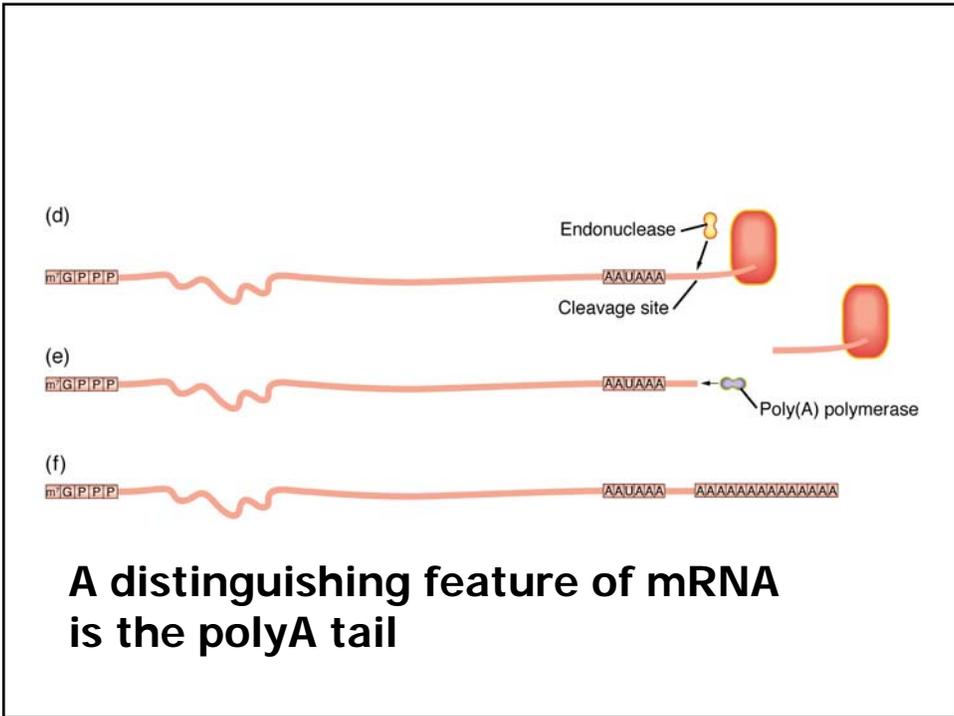
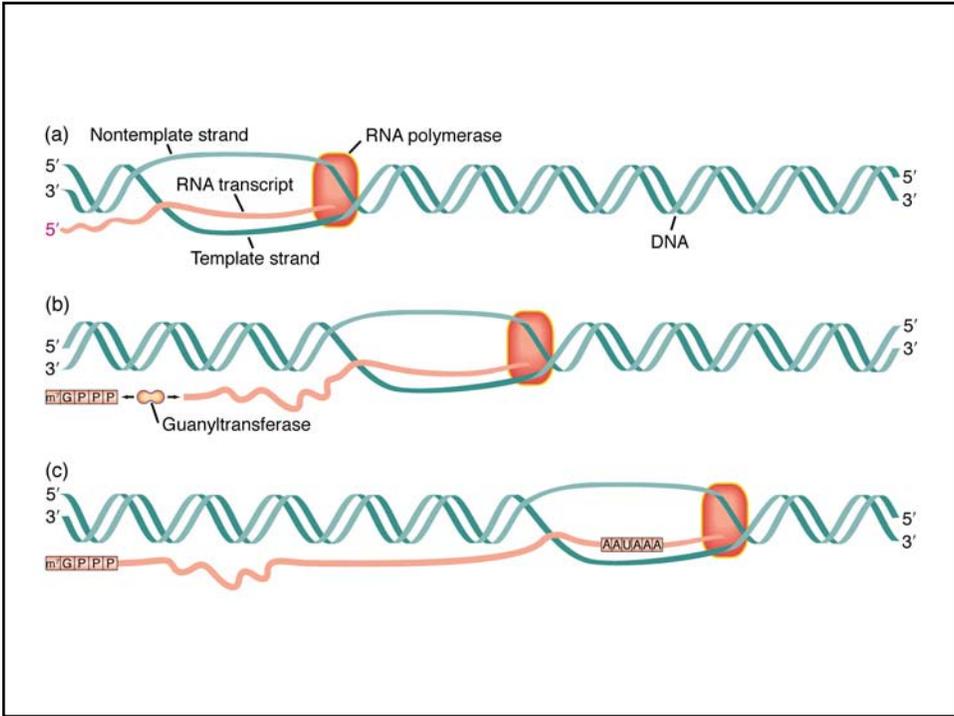
### mRNA

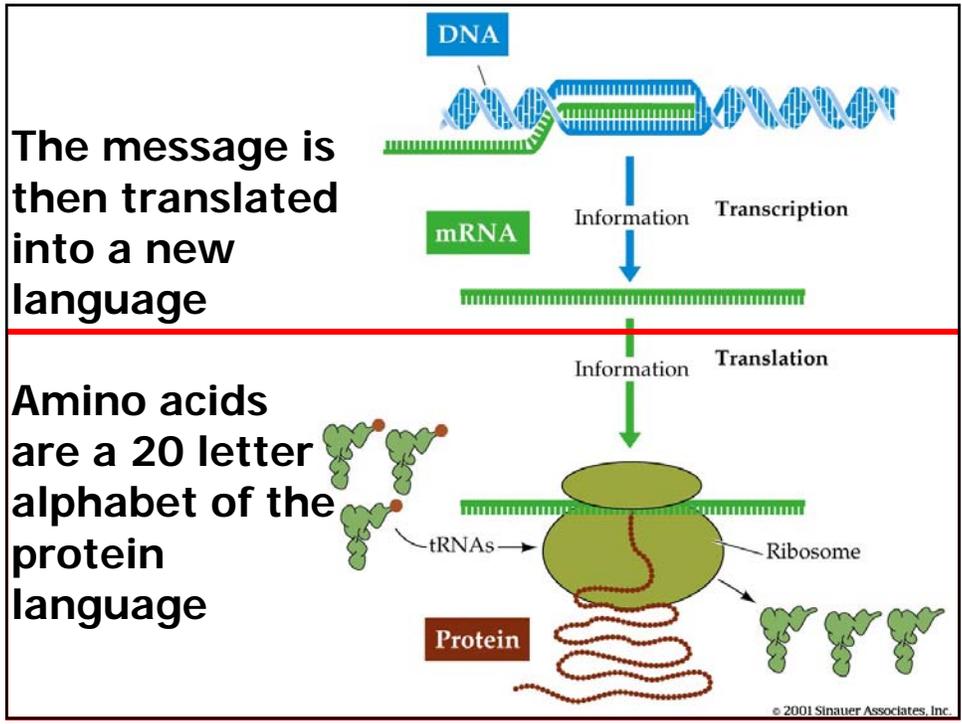
- Single stranded

- Complex secondary structure

- Complementary sequence shows hydrogen bonding







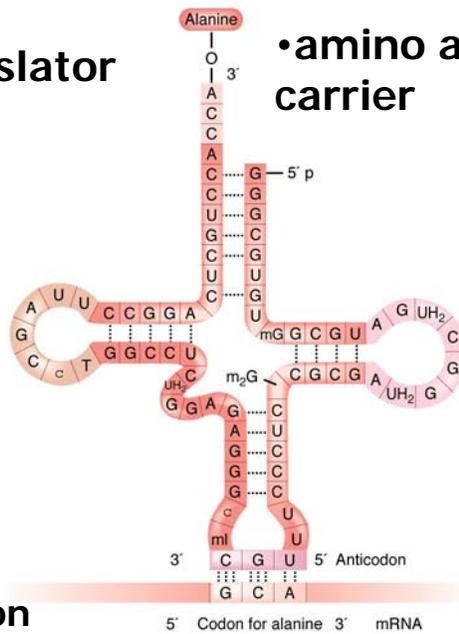
One code used to translate from nucleic acid to protein sequence

		Second letter					
		U	C	A	G		
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G	
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G	
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G	
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G	

Each codon will be translated to an amino acid

**tRNA is the translator**

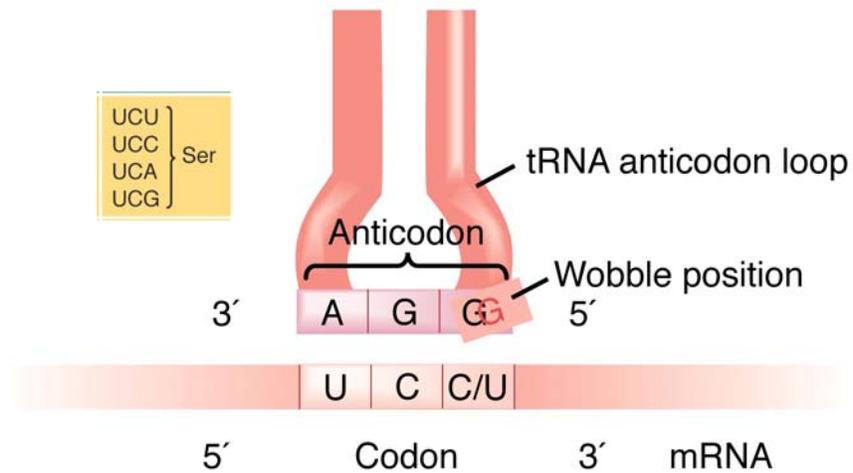
**•amino acid carrier**



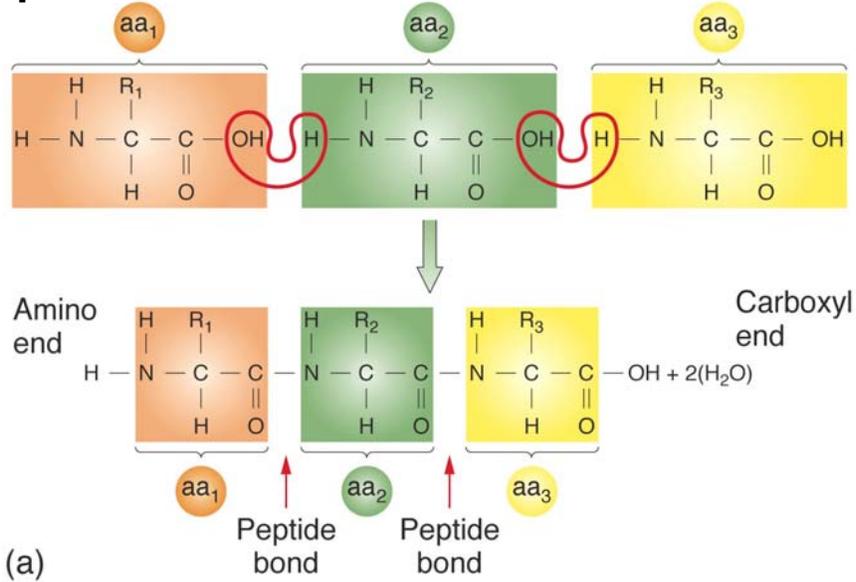
**•Carries the anticodon**

**The anticodon is complementary to the codon**

### Site of translation on the t-RNA



## Amino acids are linked together in a protein chain



## Overview of the key players in translation

