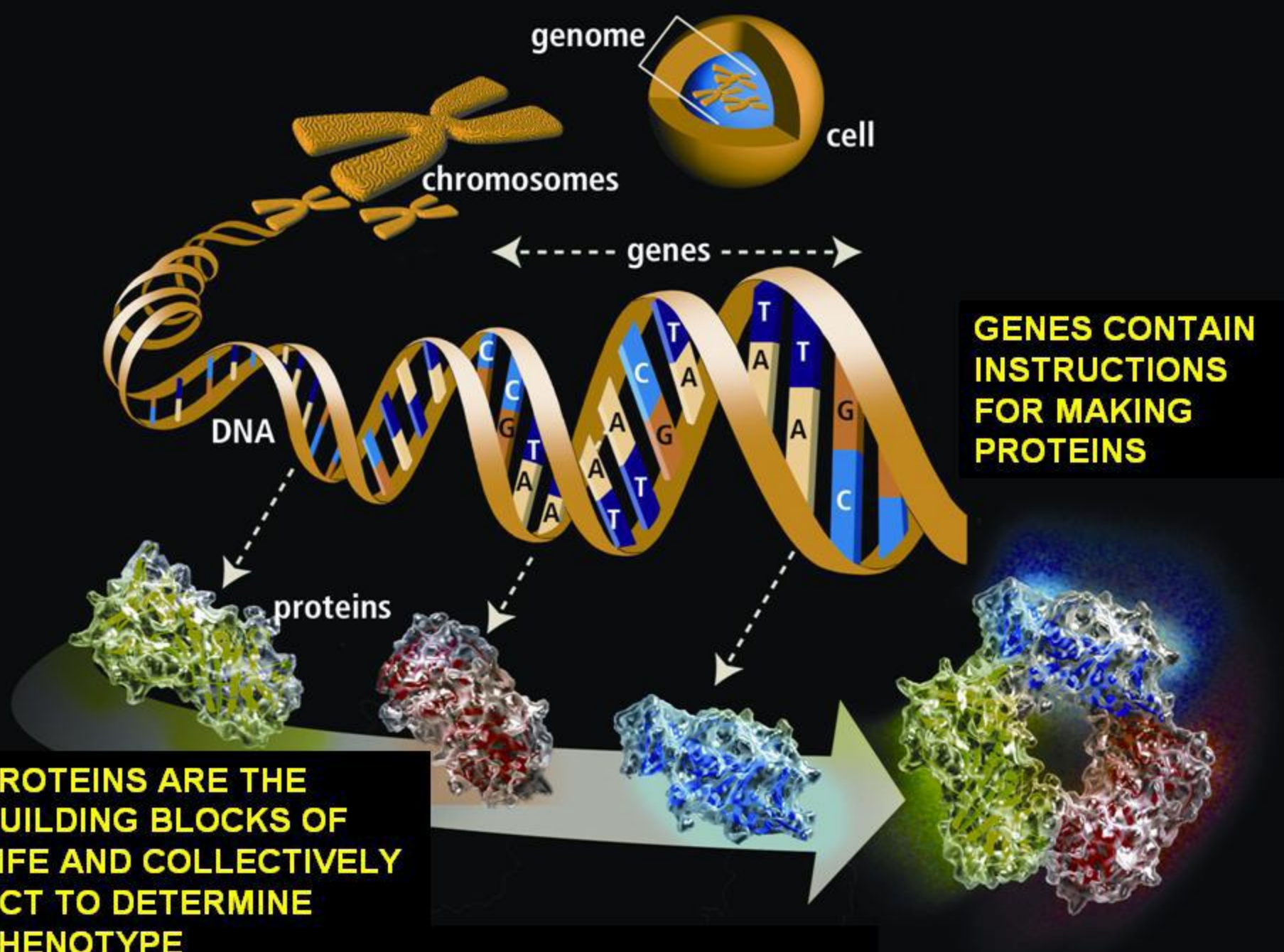




Genome and Genomics

- *Genome* adalah keseluruhan informasi genetik yang terdapat dalam suatu sel pada suatu organisme
- *Genomics* adalah ilmu pengetahuan, dan melibatkan teknologi, yang mempelajari dan menganalisis genom dengan tujuan untuk menemukan dan mengetahui peranan suatu gen
- *Gen* adalah fragmen DNA pembawa informasi genetik



genome

cell

chromosomes

genes

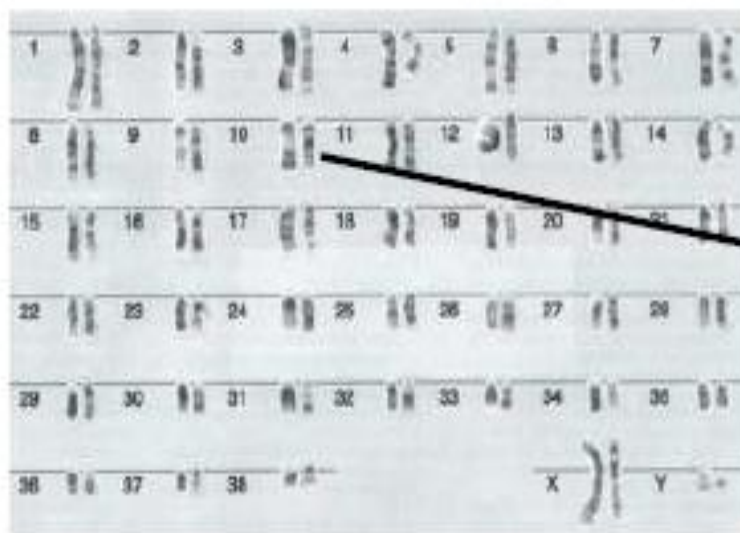
DNA

proteins

GENES CONTAIN INSTRUCTIONS FOR MAKING PROTEINS

PROTEINS ARE THE BUILDING BLOCKS OF LIFE AND COLLECTIVELY ACT TO DETERMINE PHENOTYPE

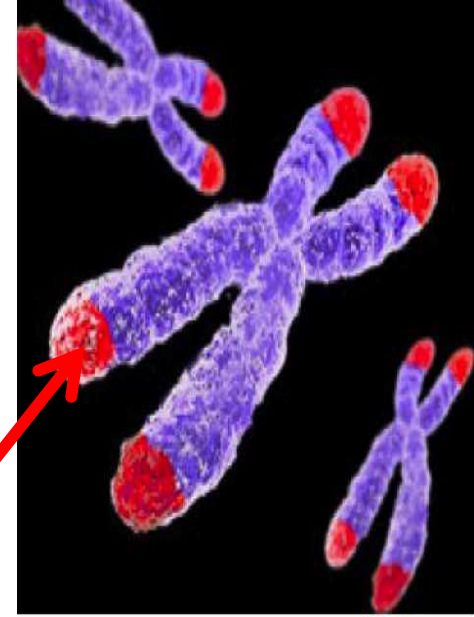
- Gene on chromosome 10 determines floppy vs. erect ears.



Gen penentu bentuk telinga pada hewan Anjing terletak pada kromosom 10

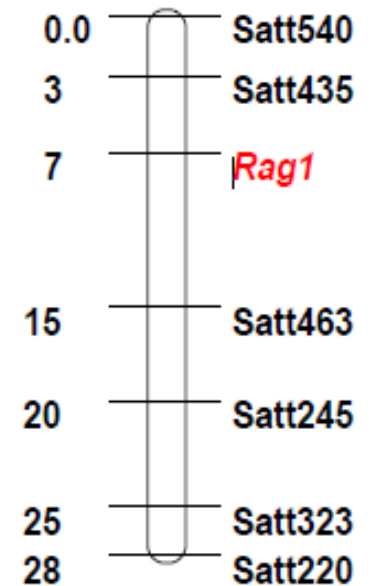


- Gene on chromosome 7 (*Rag1*) determines whether soybean plants are resistant or susceptible to soybean aphids.



Rag1 Resistant Line

rag1 Susceptible Line



PARENT 1

PARENT 2



X



=



Which ones are salt tolerant?

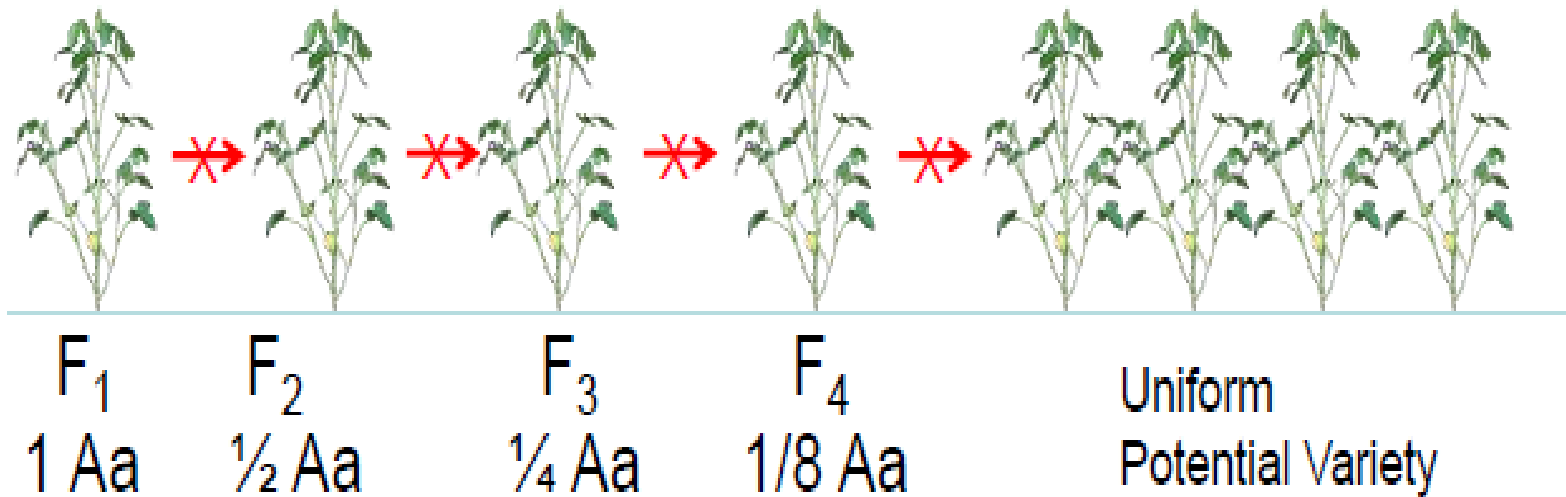
High yield
Salt sensitive

Low yield
Salt tolerant



Pemuliaan Tanaman Kedelai

- Persilangan tanaman secara manual
- Dilanjutkan *inbreeding* selama beberapa generasi



Pemuliaan Tanaman Kedelai

4000 tahun lalu



500 tahun lalu



kedelai sekarang



Pemuliaan Tanaman Jagung

Teosinte



Jagung

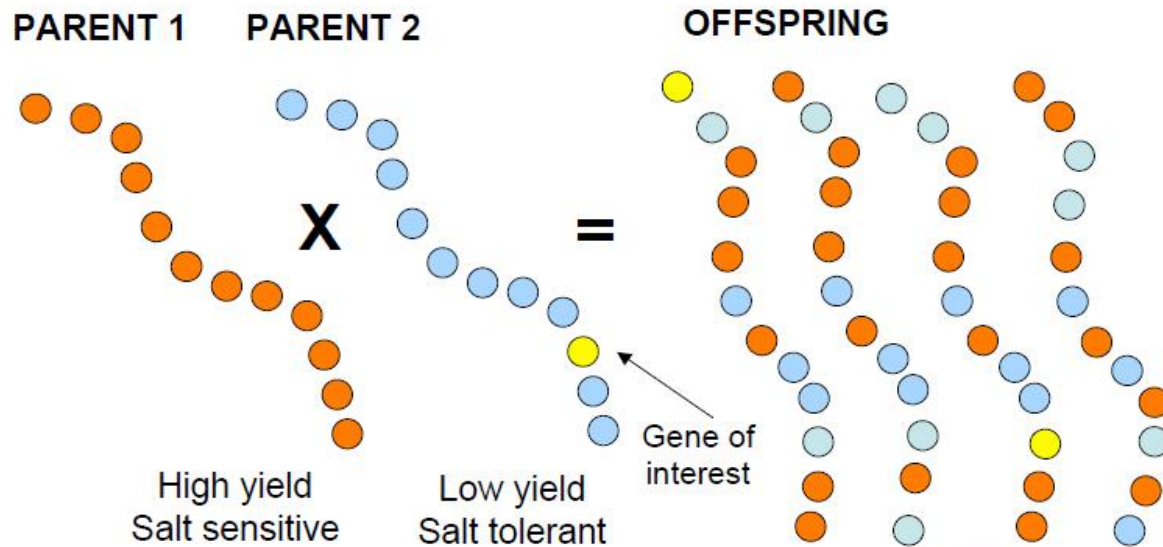


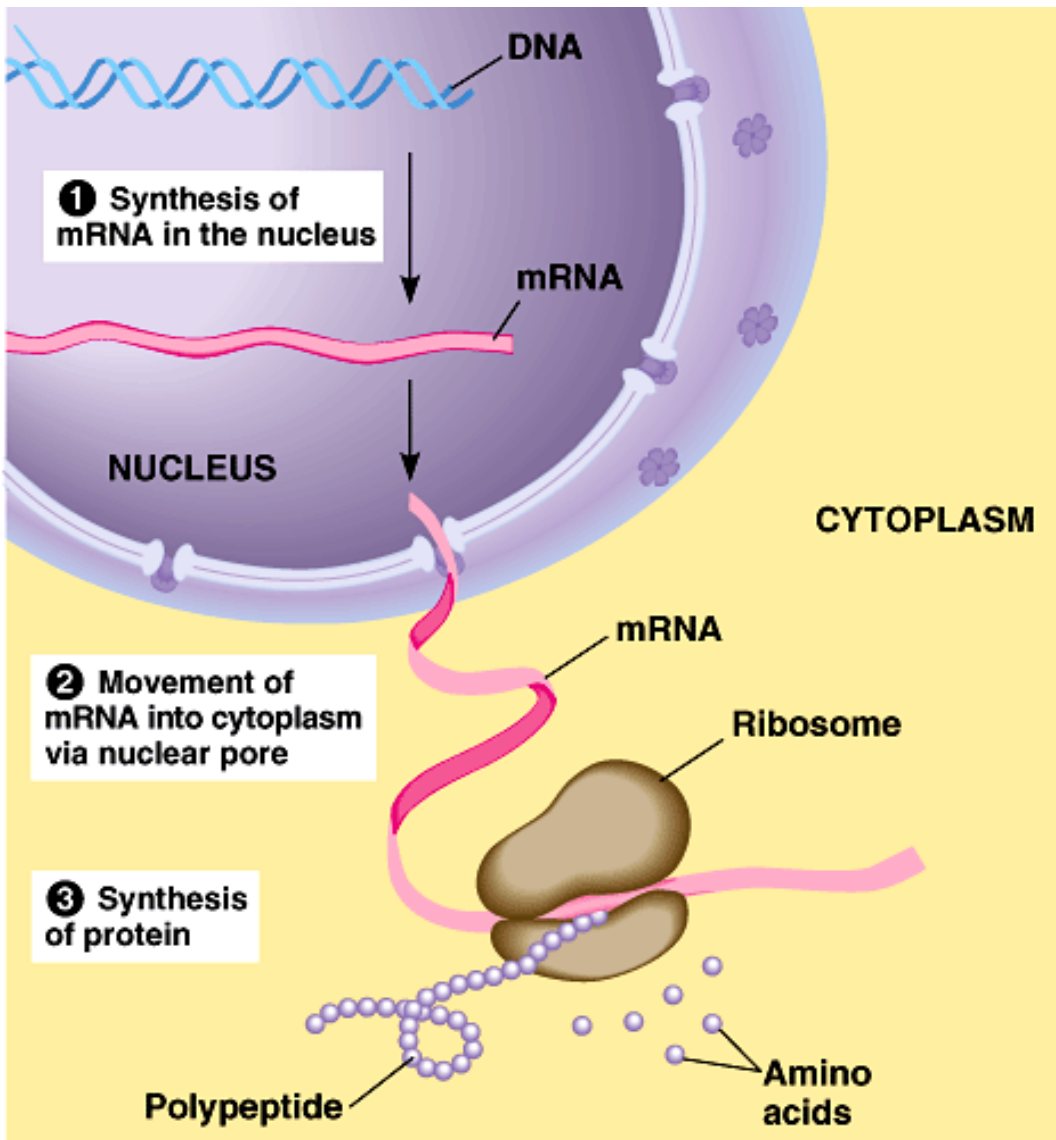


Marker-assisted Selection

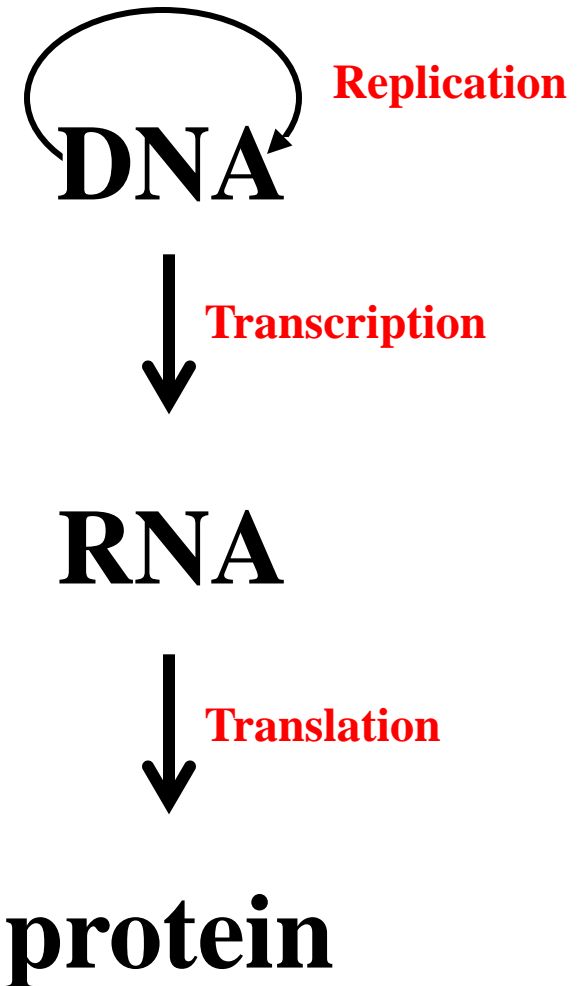


Marker assisted selection





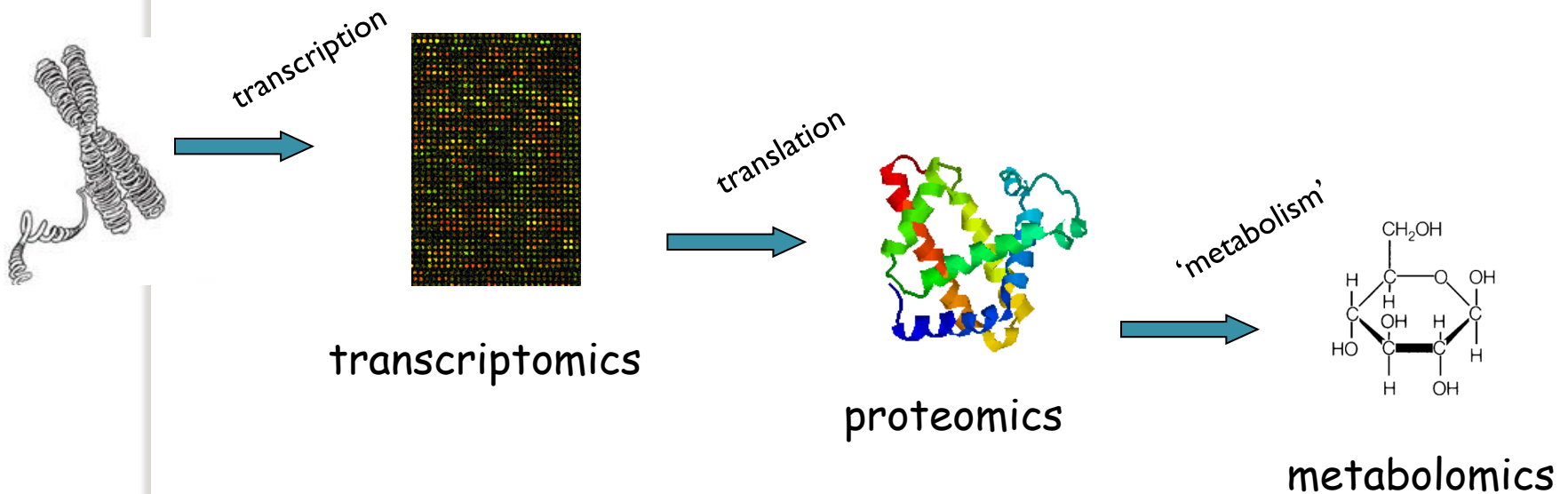
The Central Dogma



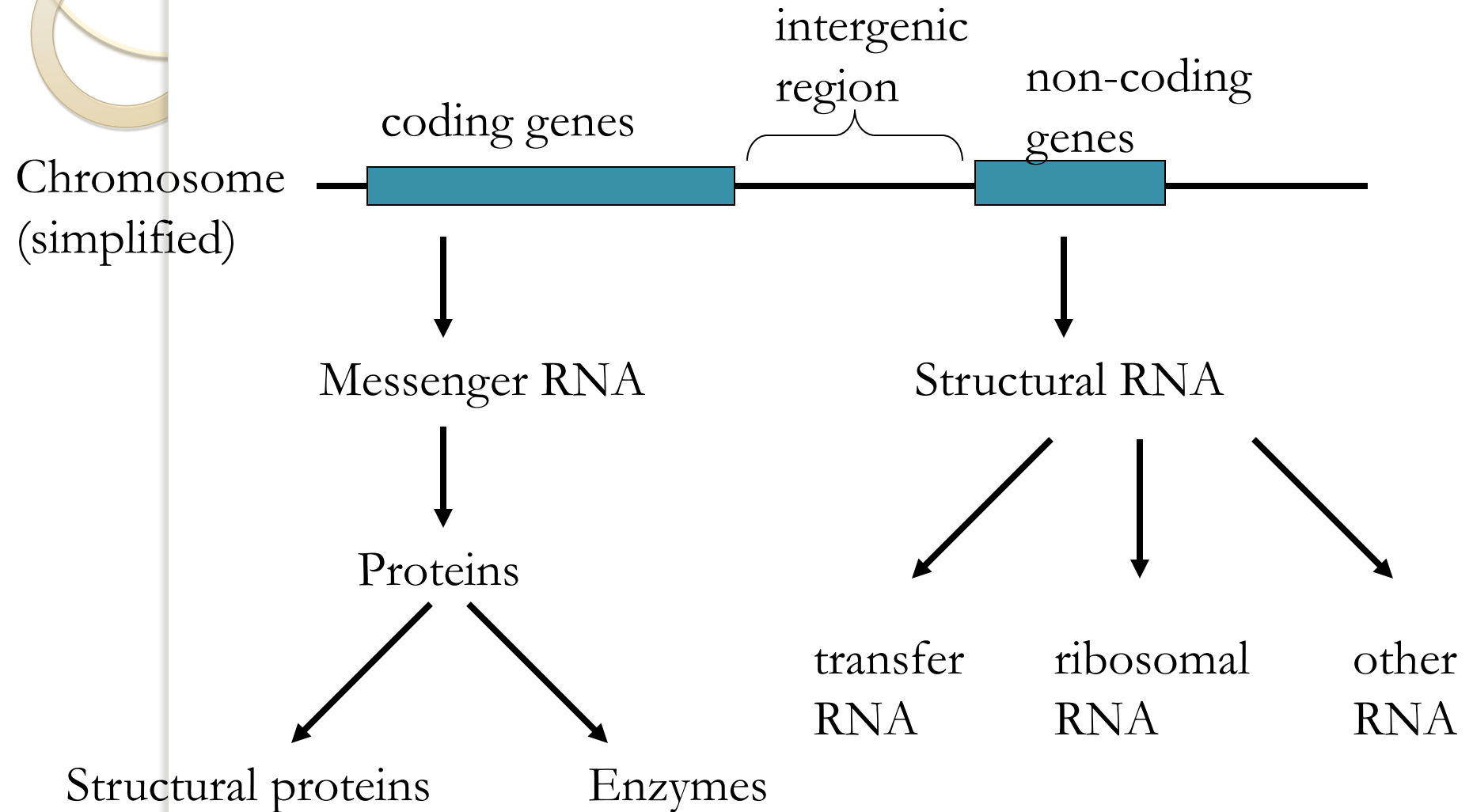
The flow of genetic information is unidirectional, from DNA to protein with messenger RNA as an intermediate.

How is it works..?

- examine the genes, transcript, protein and metabolite responses to abiotic or biotic stresses and integrate all data-sets to draw a conclusion on what is going on within the plant cells

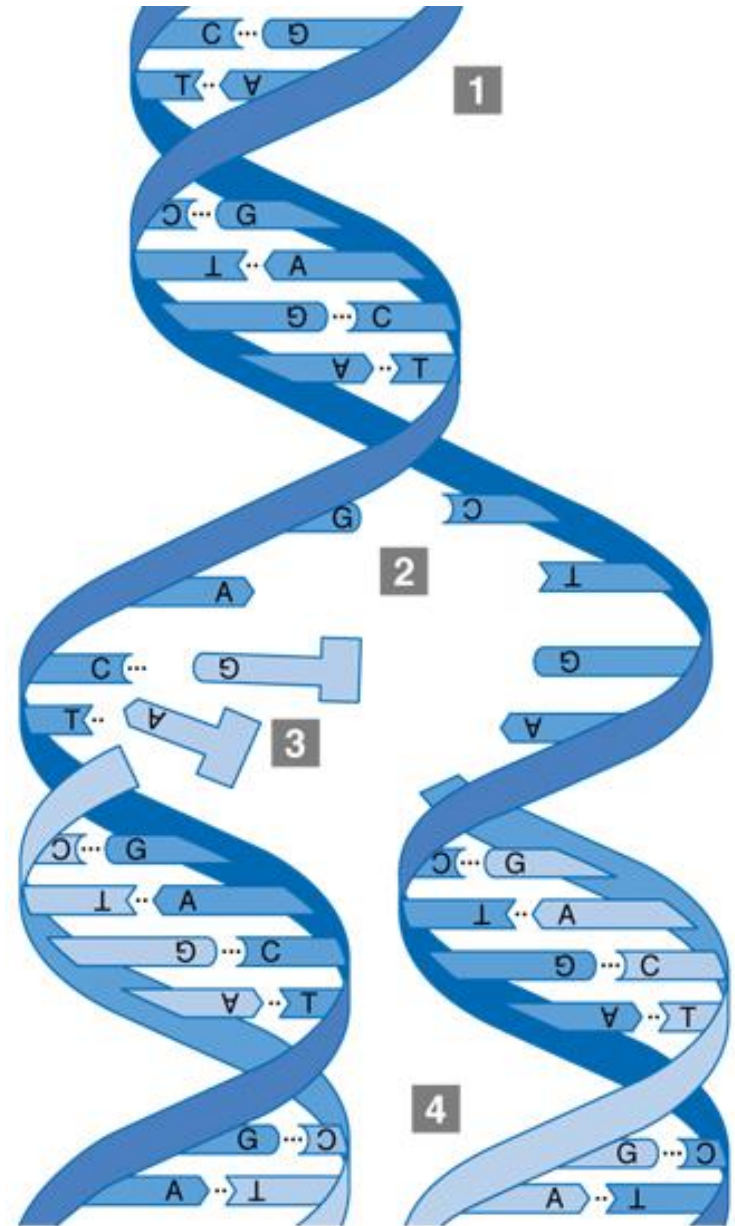


Gene classification



Replication as a process

- 1. Double-stranded DNA unwinds.**
- 2. The junction of the unwound molecules is a replication fork.**
- 3. A new strand is formed by pairing complementary bases with the old strand.**
- 4. Two molecules are made.**
Each has one new and one old DNA strand.



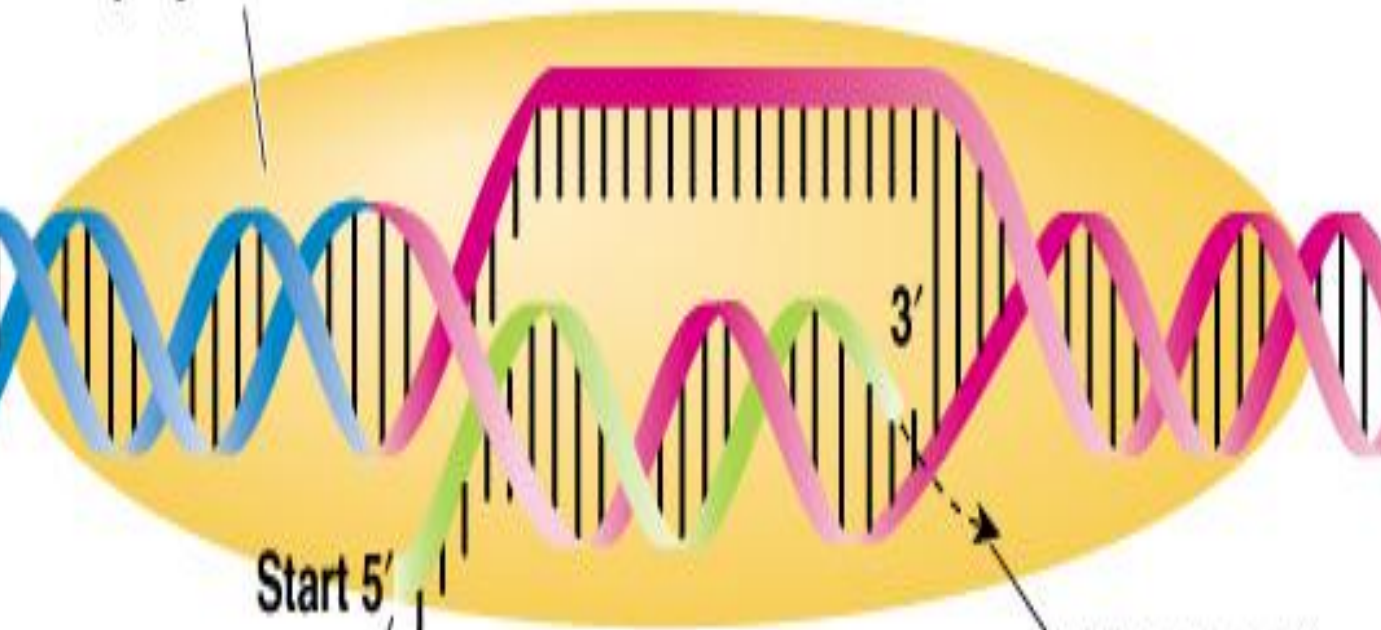
Transcription

Start of transcription

Direction of transcription



RNA polymerase



DNA strands

5'
3'

3'

3'
5'

Start 5'

Direction of RNA synthesis

RNA molecule being transcribed from the DNA

Terminology

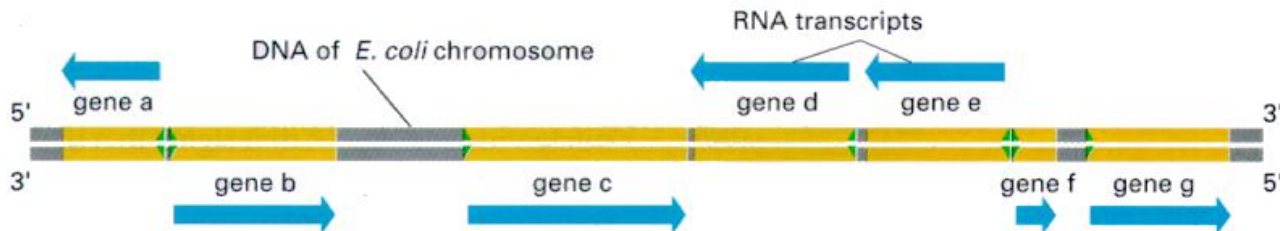
- Only one strand of DNA serves as a template for transcription.

(5') CGCTATAGCGTTT(3') DNA nontemplate (coding) strand

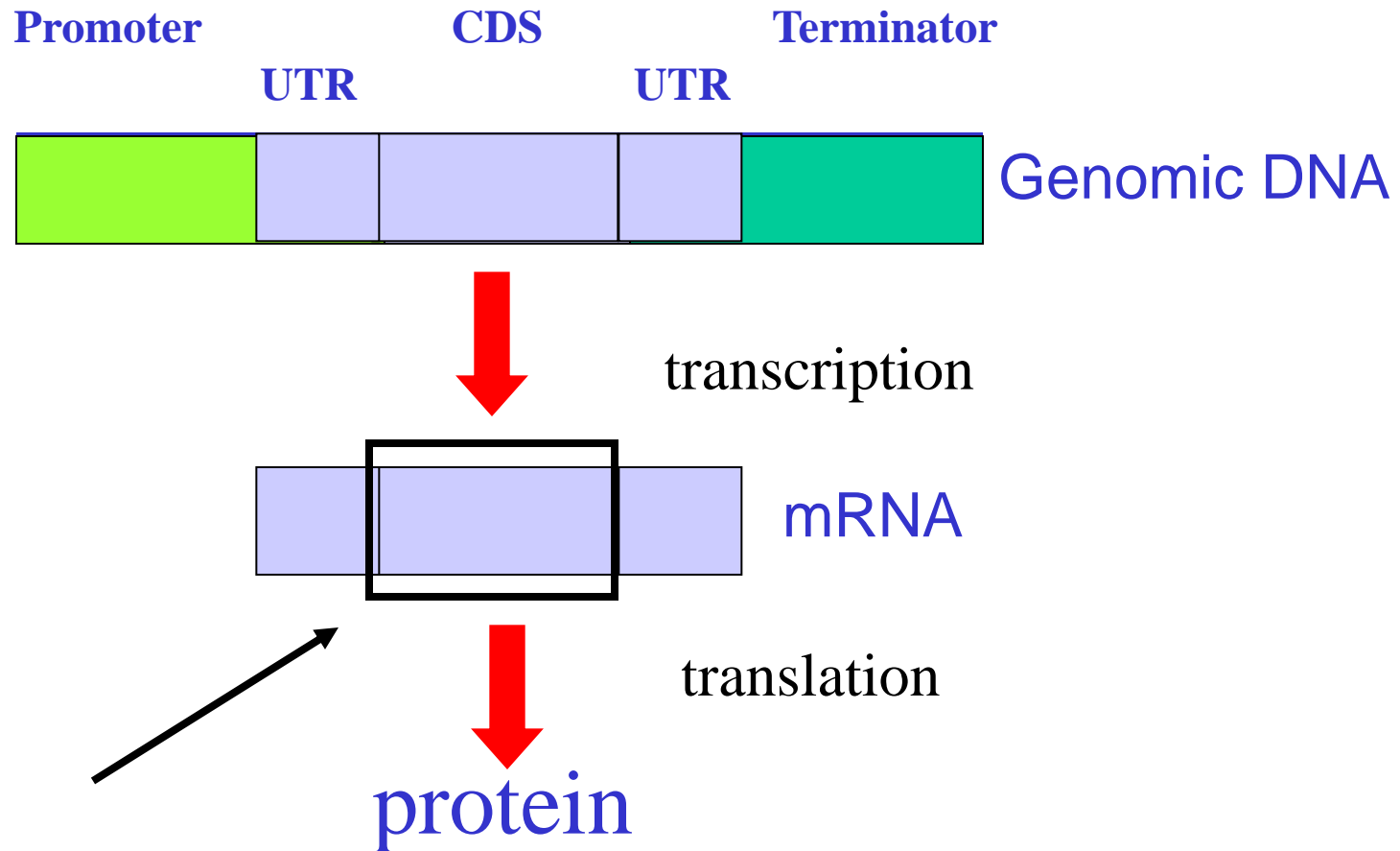
(3') GCGATATCGCAA(5') DNA template strand

(5') CGCUAUAGCGUUU(3') RNA transcript

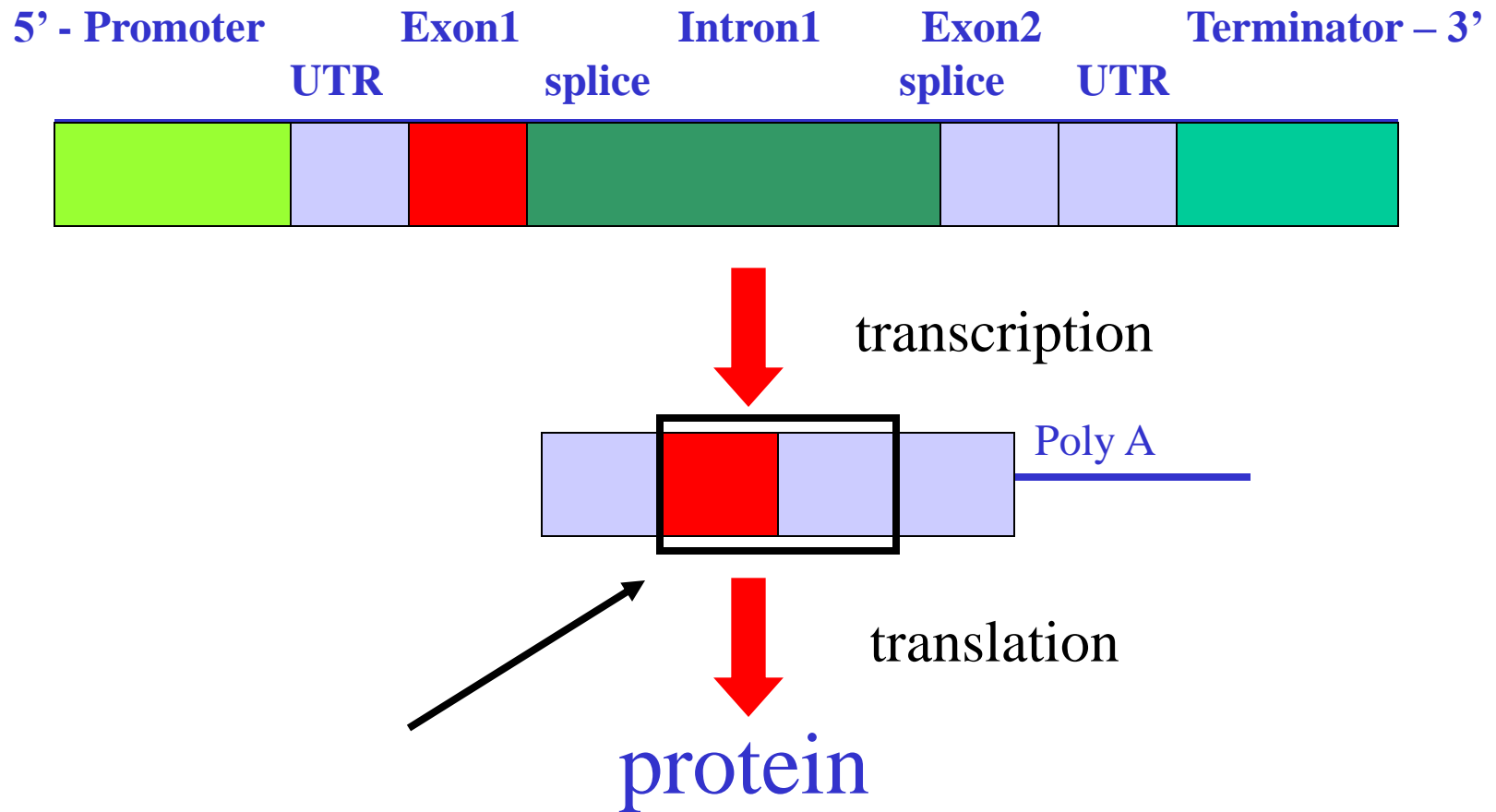
- Different genes are transcribed from different strands



Prokaryotic Gene Structure

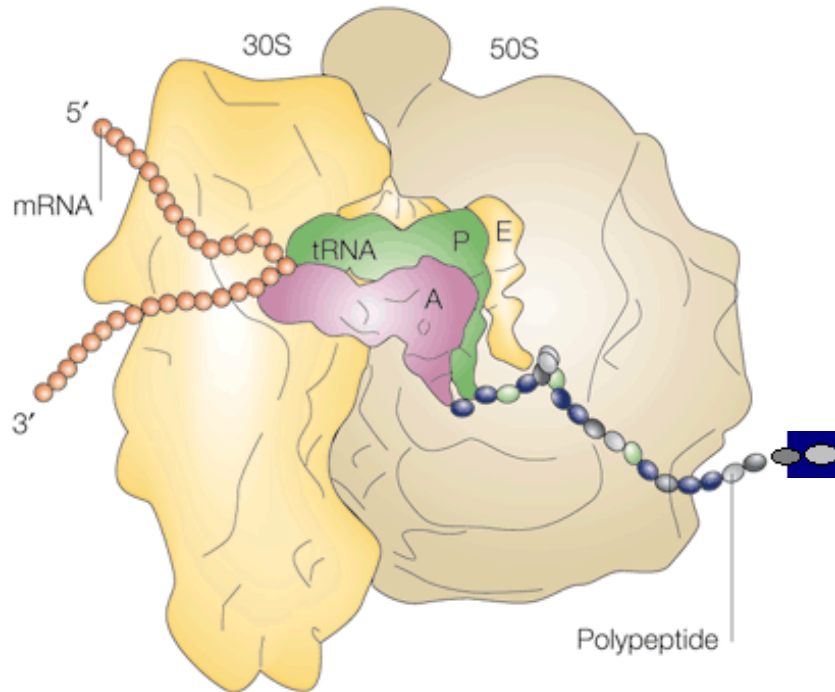


Eukaryotic Gene Structure



Translation

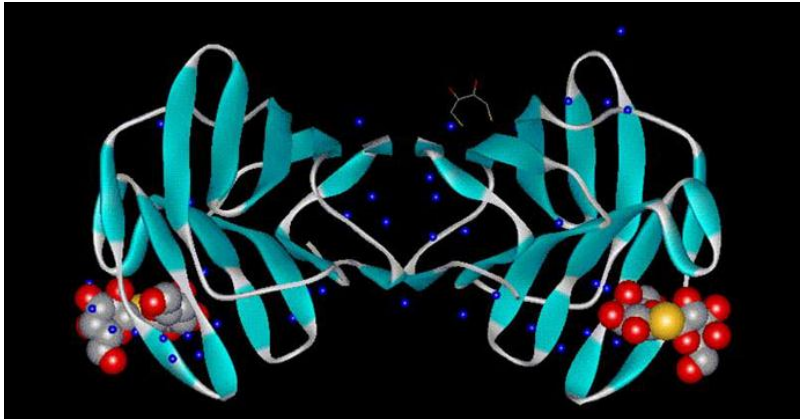
Ribosomes and Protein Synthesis



Ribosomes are cytoplasmic organelles which translate mRNA into proteins (chains of amino acids), amplifying the signal in the process.

What are Proteins?

- basic building blocks - amino acids - 20
- acidic / basic / uncharged polar / nonpolar



The structure of toad ovary galectin complexed with thio-digalactose

- **peptide bond**

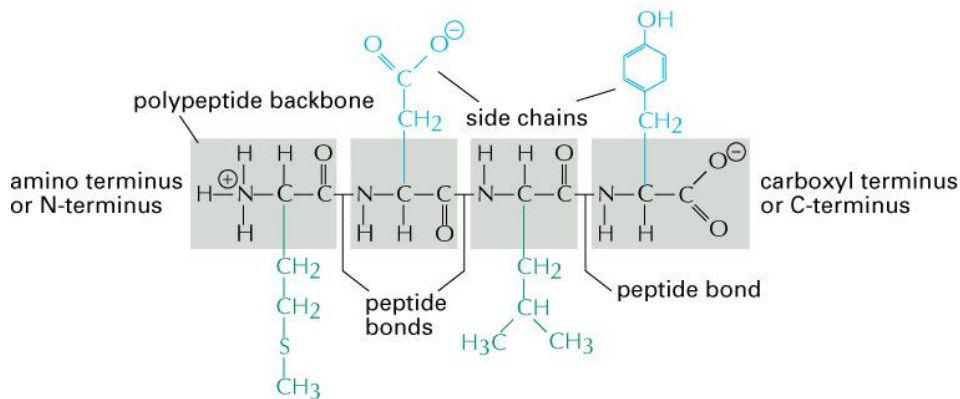
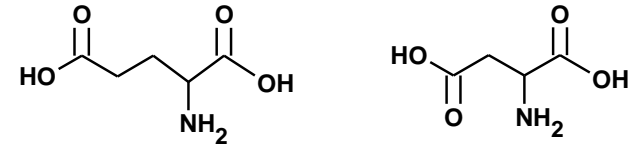


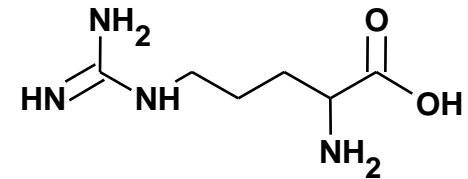
Figure 3-2 part 2 of 3. Molecular Biology of the Cell, 4th Edition.



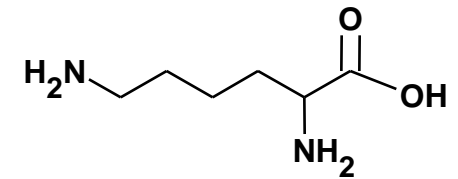
Glutamic Acid (Glu)

Aspartic Acid (Asp)

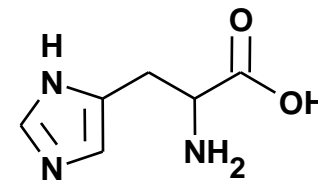
Acidic Amino Acids



Arginine (Arg)



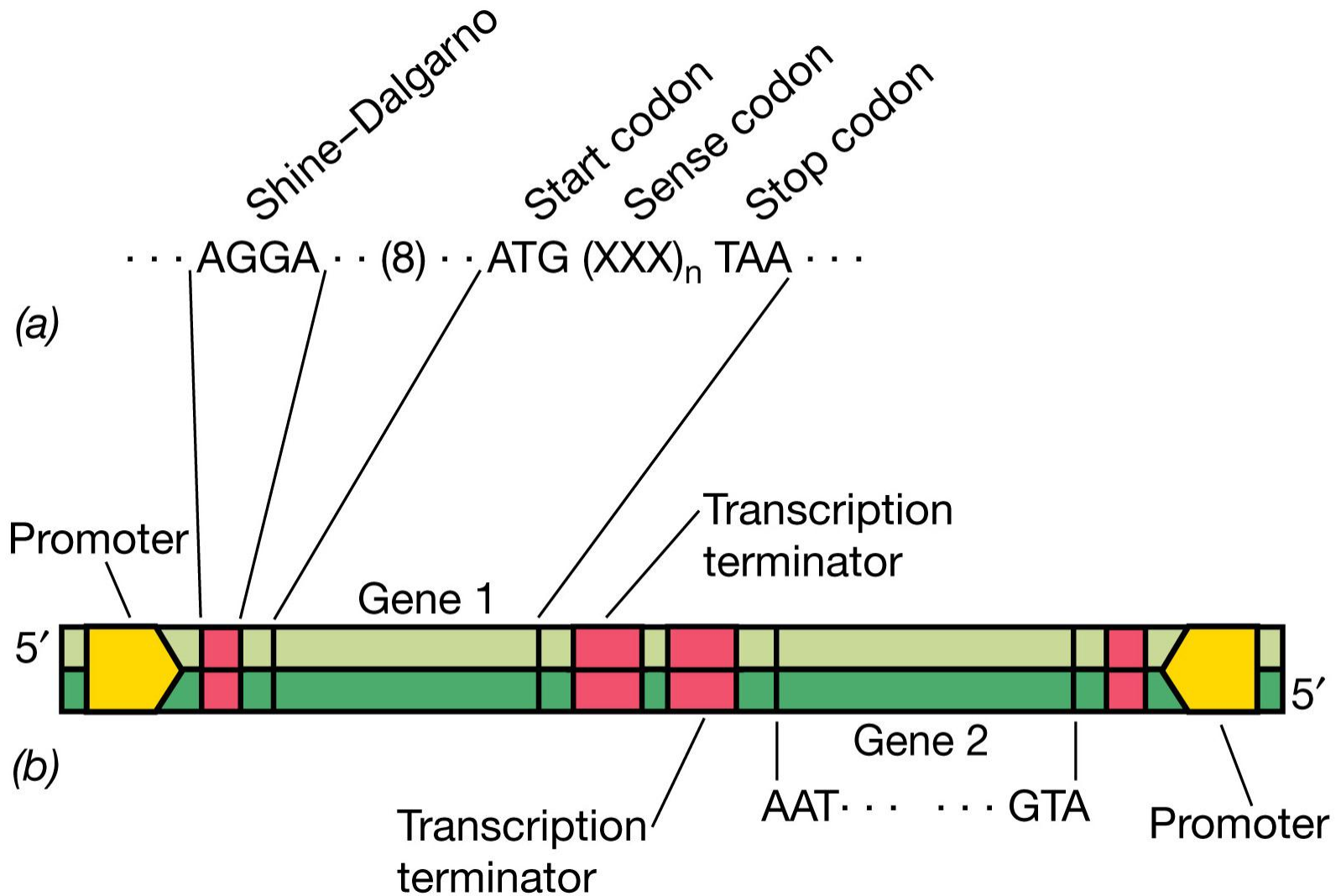
Lysine (Lys)



Histidine (His)

Basic Amino Acids

Open Reading Frames (ORF)

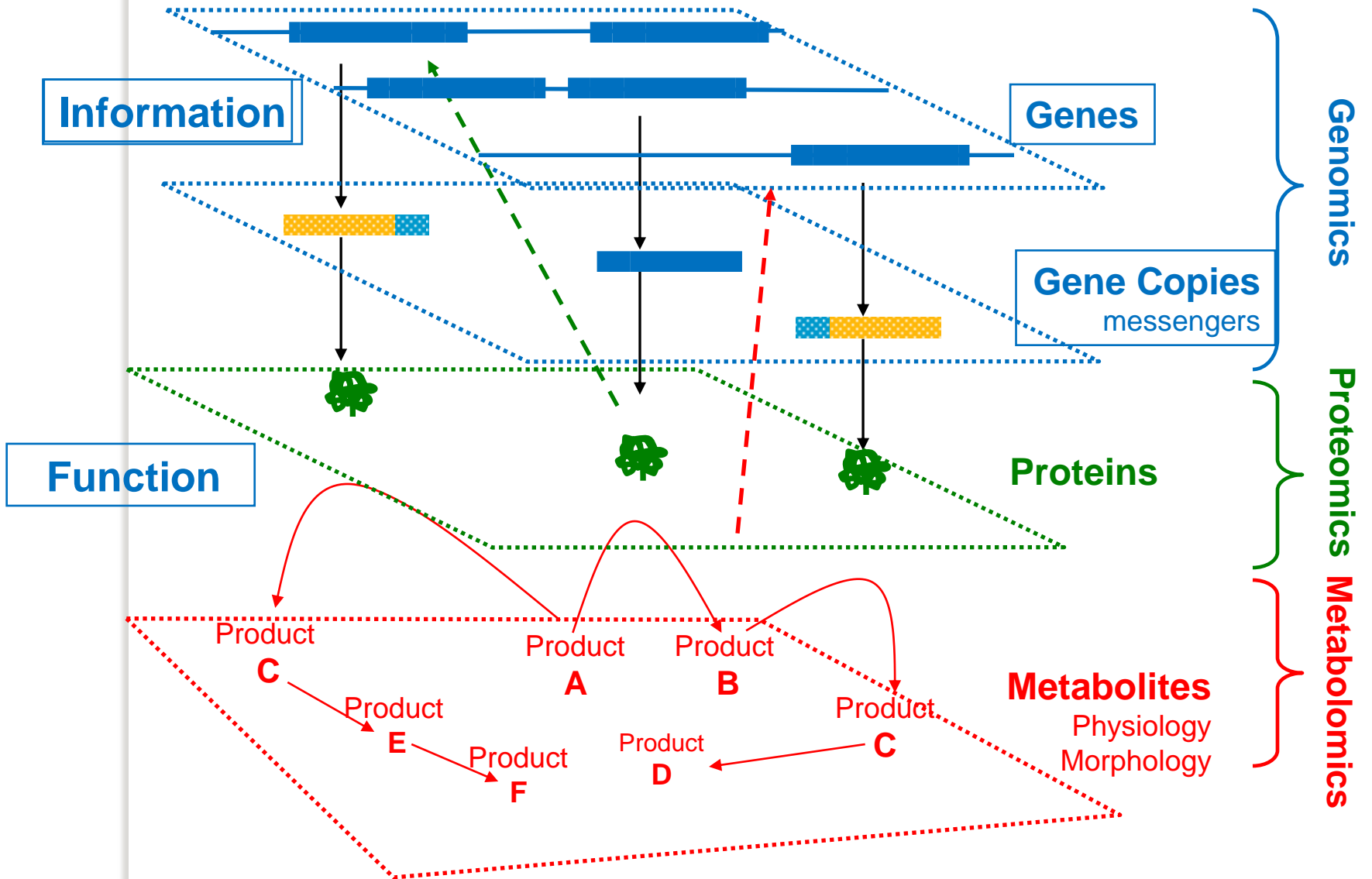


The Codon

- mRNA sequence is decoded in sets of three nucleotides.
- Since there are 64 possible tri-nucleotide combinations and only 20 amino acids, there must be some redundancy (a.k.a degenerate code).

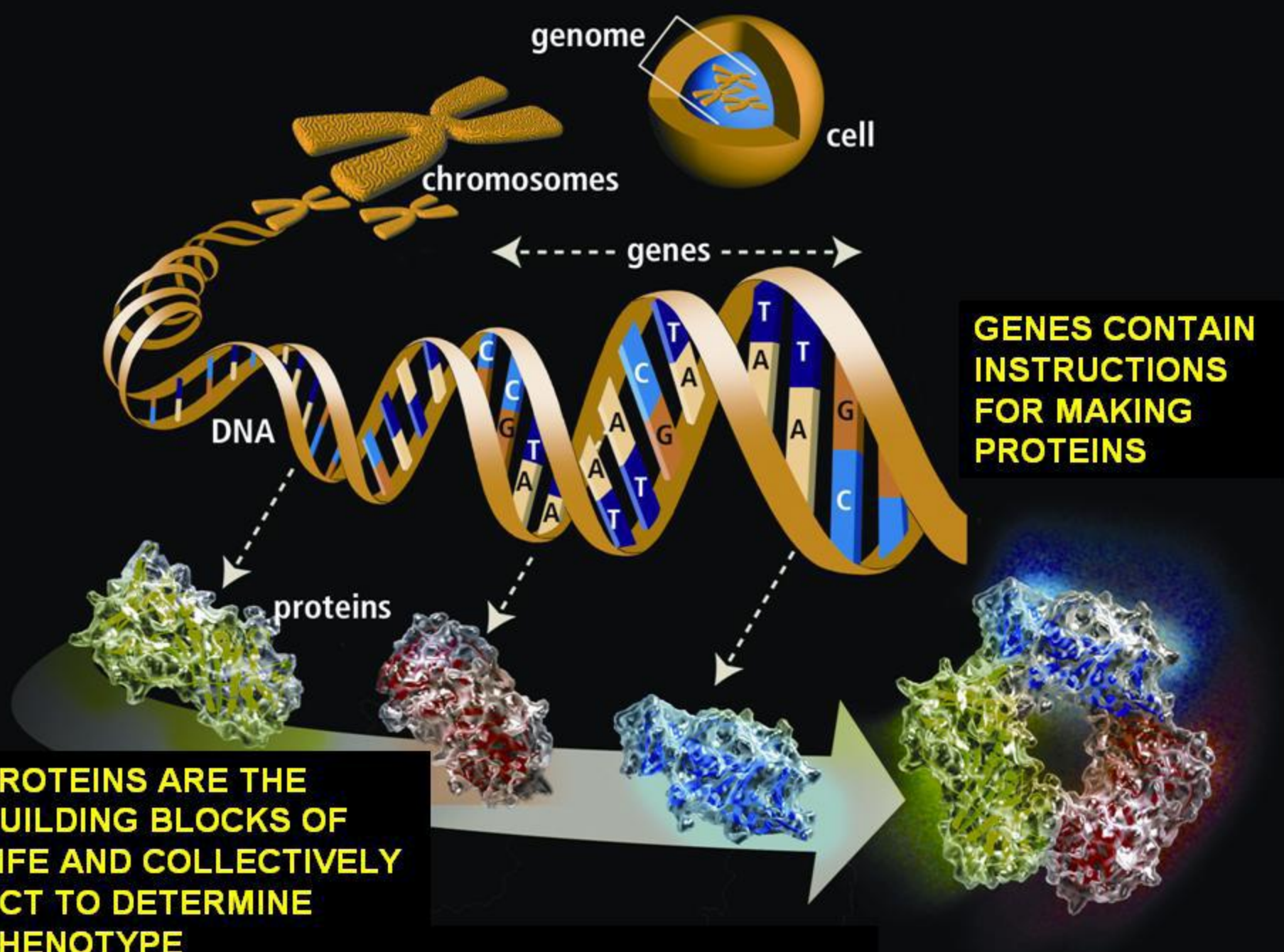
GCA	AGA									UUA					AGC										
GCC	AGG									UUG					AGU										
GCG	CGA					GGA			AUA	CUA				CCA	UCA	ACA							GUA		
GCU	CGC					GGC			AUC	CUC				CCC	UCC	ACC							GUC		UAA
	CGG	GAC	AAC	UGC	GAA	CAA	GGG	CAC	AUC	CUG	AAA			CCG	UCG	ACG						GUG		UAG	
	CGU	GAU	AAU	UGU	GAG	CAG	GGU	CAU	AUU	CUU	AAG	AUG	UUU	CCU	UCU	ACU	UGG	UAU				GUU		UGA	
Ala	Arg	Asp	Asn	Cys	Glu	Gln	Gly	His	Ile	Leu	Lys	Met	Phe	Pro	Ser	Thr	Trp	Tyr	Val					stop	
A	R	D	N	C	E	Q	G	H	I	L	K	M	F	P	S	T	W	Y	V						

FIRST BASE	SECOND BASE OF A CODON				THIRD BASE
	U	C	A	G	
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	STOP	STOP	A
	leucine	serine	STOP	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	methionine (or START)	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G



Pengaturan Genom dalam Kromosom

- ✓ The nuclear genome is organized into chromosome
- ✓ Chromosomes consist of essentially one long DNA helix wound around nucleosome
- ✓ At metaphase, when the genome is relatively inactive, the chromosome are most condensed and therefore most easily observed cytologically, counted or separated



genome

cell

chromosomes

genes

DNA

proteins

GENES CONTAIN INSTRUCTIONS FOR MAKING PROTEINS

PROTEINS ARE THE BUILDING BLOCKS OF LIFE AND COLLECTIVELY ACT TO DETERMINE PHENOTYPE



Genomics Era

- Ditandai dengan keberhasilan mendapatkan *complete genome sequence* pada manusia, binatang, tanaman dan berbagai mikrobia
- Rerata jumlah gen pada berbagai eukariot berkisar 30.000 genes, namun fungsi dari 40-60% gen gen tersebut belum diketahui



Functional Genomics

- Paradigma lama bahwa 1 gen = 1 protein sudah tidak berlaku lagi
- *Human genome* mempunyai 35.000 gen tapi jumlah protein berkisar 200X lipatnya karena adanya proses translasi dan post-translasional
- Ada sekitar 40 tipe sel pada tanaman, semua dengan genome yang sama tapi transcriptome, proteome dan metabolome bervariasi sesuai dengan jenis sel, laju pertumbuhan, stimuli internal dan eksternal semacam biotik dan abiotik stress

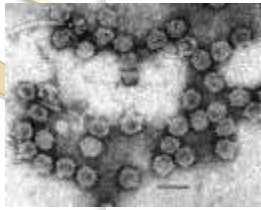


Genome Information

S. cerevisiae *C. elegans* *A. thaliana* *H. sapiens*

# Cells	1	~1000	>1x10⁶	>1x10⁶
Size	12Mbp	97Mbp	125Mbp	3.2 Gbp
Chromosomes	16	6	5	23
Predicted ORFs	~6,000	~19,000	~28,000	~35,000
%Coding	72%	27%	50%	1.5%

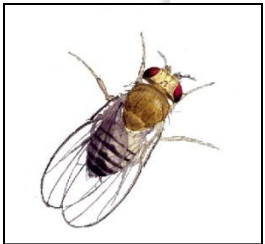
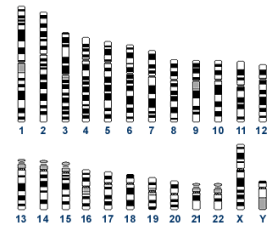
Sekuensing Genom



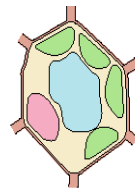
Year	Organism	Significance	Genome size (bp)	Number of genes
1977	Bacteriophage fX174	First genome	5,386	11
1981	Human mitochondria	First organelle	16,500	37
1995	<i>Haemophilus influenzae</i> Rd	First free-living organism	1,830,137	~3,500
1996	<i>Saccharomyces cerevisiae</i>	First eukaryote	12,086,000	~6,000

Sekuensing Genom

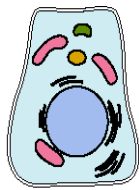
Year	Organism	Significance	Genome size (bp)	Number of genes
1998	<i>Caenorhabditis elegans</i>	First multi-cellular organism	97,000,000	~19,000
1999	Human chromosome 22	First human chromosome	49,000,000	673
2000	<i>Drosophila melanogaster</i>	First insect	150,000,000	~14,000
2000	<i>Arabidopsis thaliana</i>	First plant genome	150,000,000	~25,000



Ukuran Genom



Plant cells



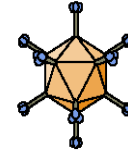
Animal cells



Bacteria



Poxvirus



Viruses
Ribosomes

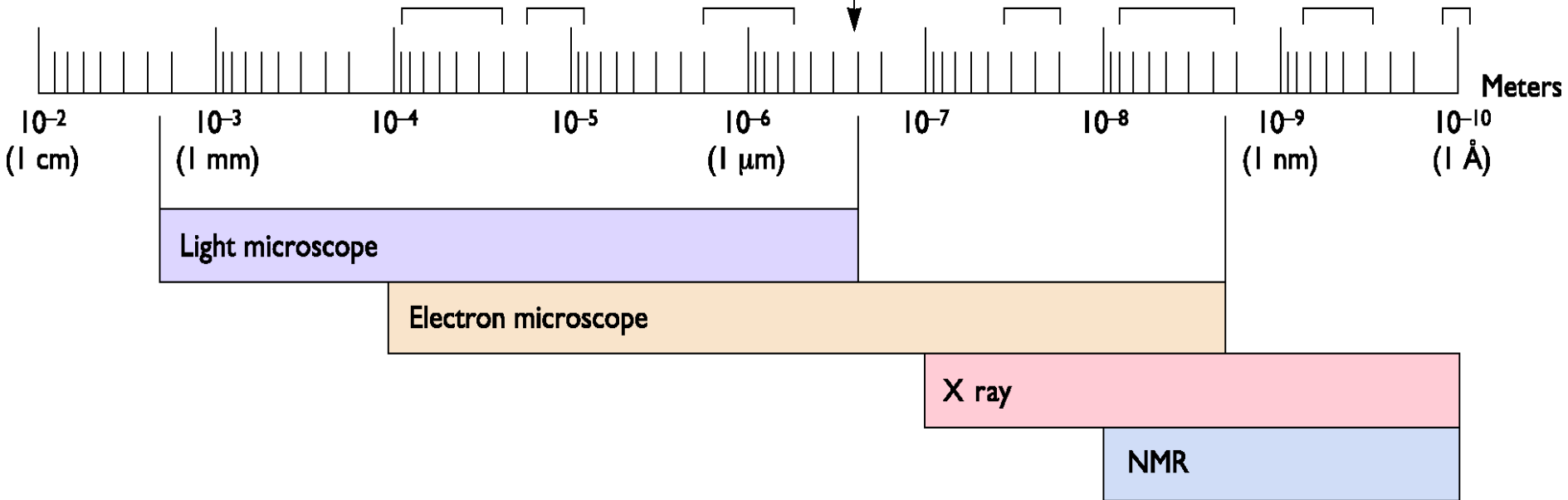
Proteins



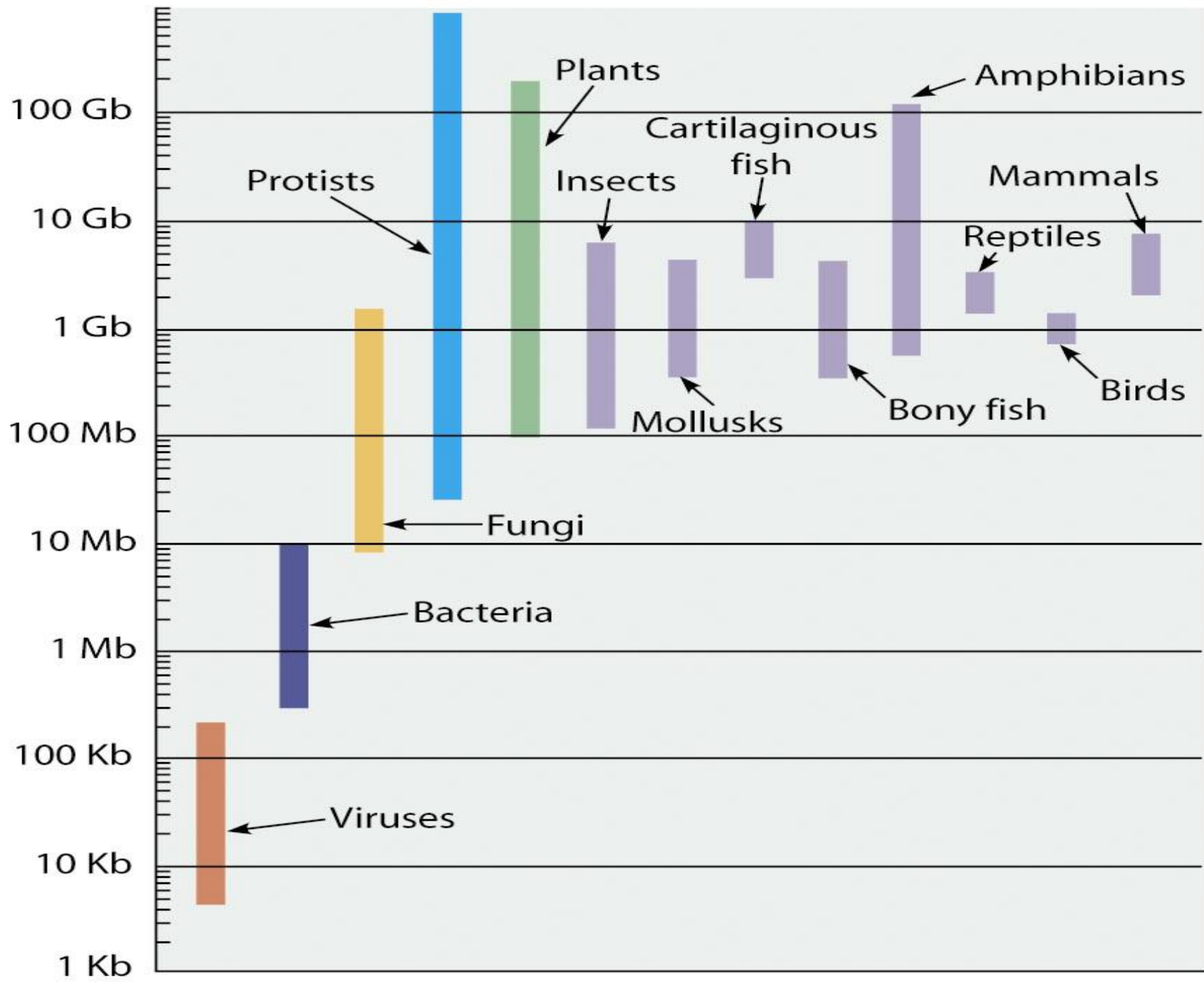
Small molecules



Atoms

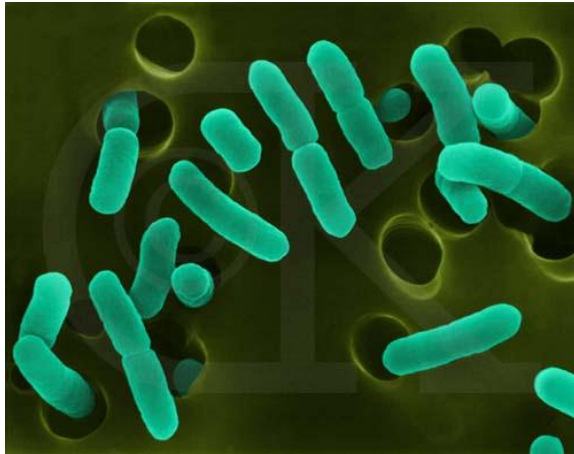


Genome size (number of base pairs per haploid genome)



Prokariotik dan Eukariotik

- Sel adalah unit paling kecil dari organisme yang memisahkan dengan lingkungannya

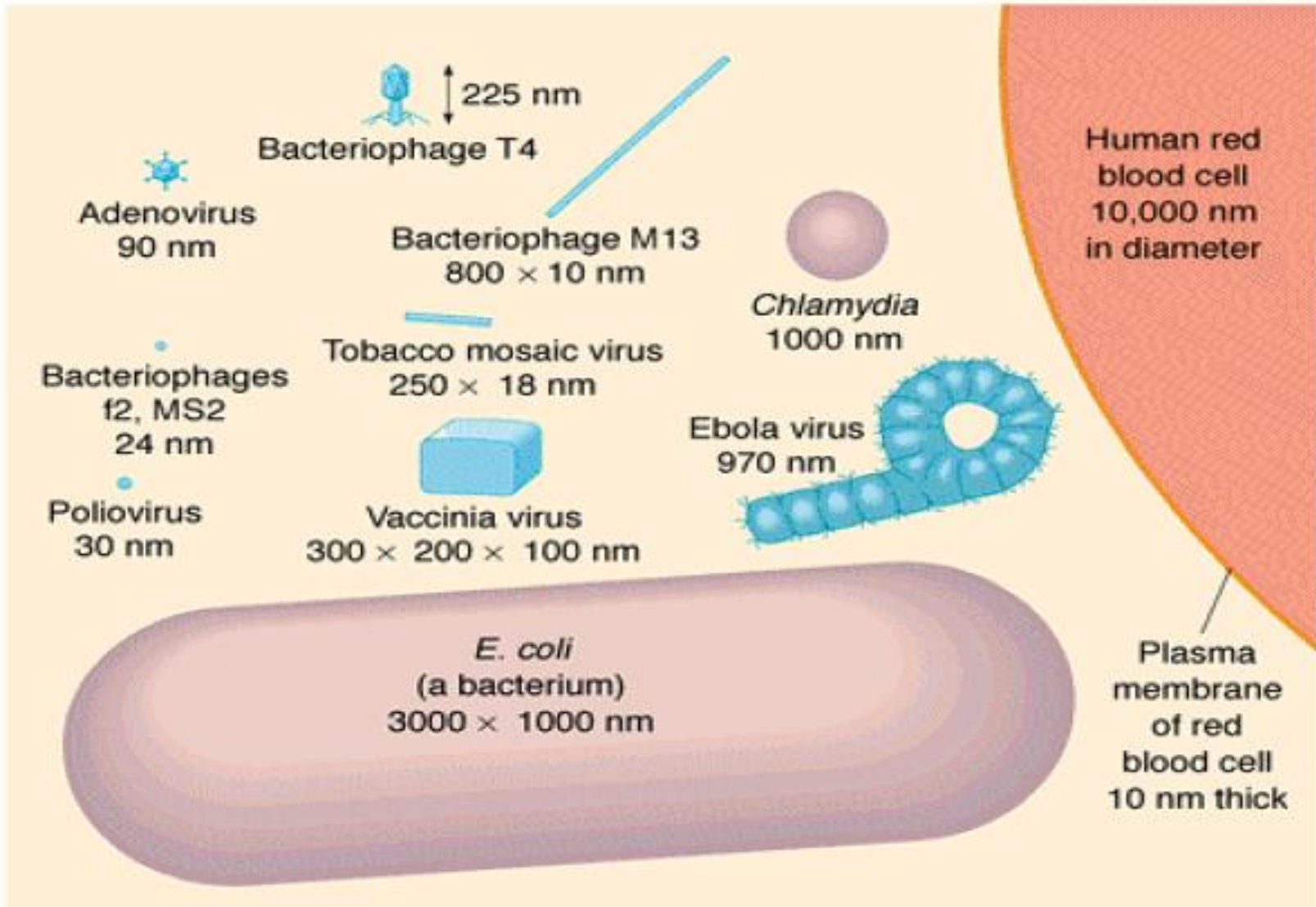


- Ada yang bersel tunggal (I) ada yang lebih dari satu
- Makhluk hidup paling sederhana adalah yang bersel tunggal
- Sel sel merupakan gugus fungsional dari makhluk hidup multiseluler

Prokaryotic versus Eukaryotic Cells

<u>Feature</u>	<u>Prokaryotic</u>	<u>Eukaryotic</u>
Organisms	Bacteria	All others (animals, plants, fungi, and protozoa)
Nucleus	Absent	Present
DNA	One chromosome	Multiple chromosomes
Size	Small (1-10 um)	Large (10 or more um)
Membrane Bound Organelles	Absent	Present (mitochondria, golgi, chloroplasts, etc.)
Division	Rapid process (Binary fission)	Complex process (Mitosis)

Ukuran Relatif Sel Prokariotik, Eukariotik dan Virus



Prokariotik

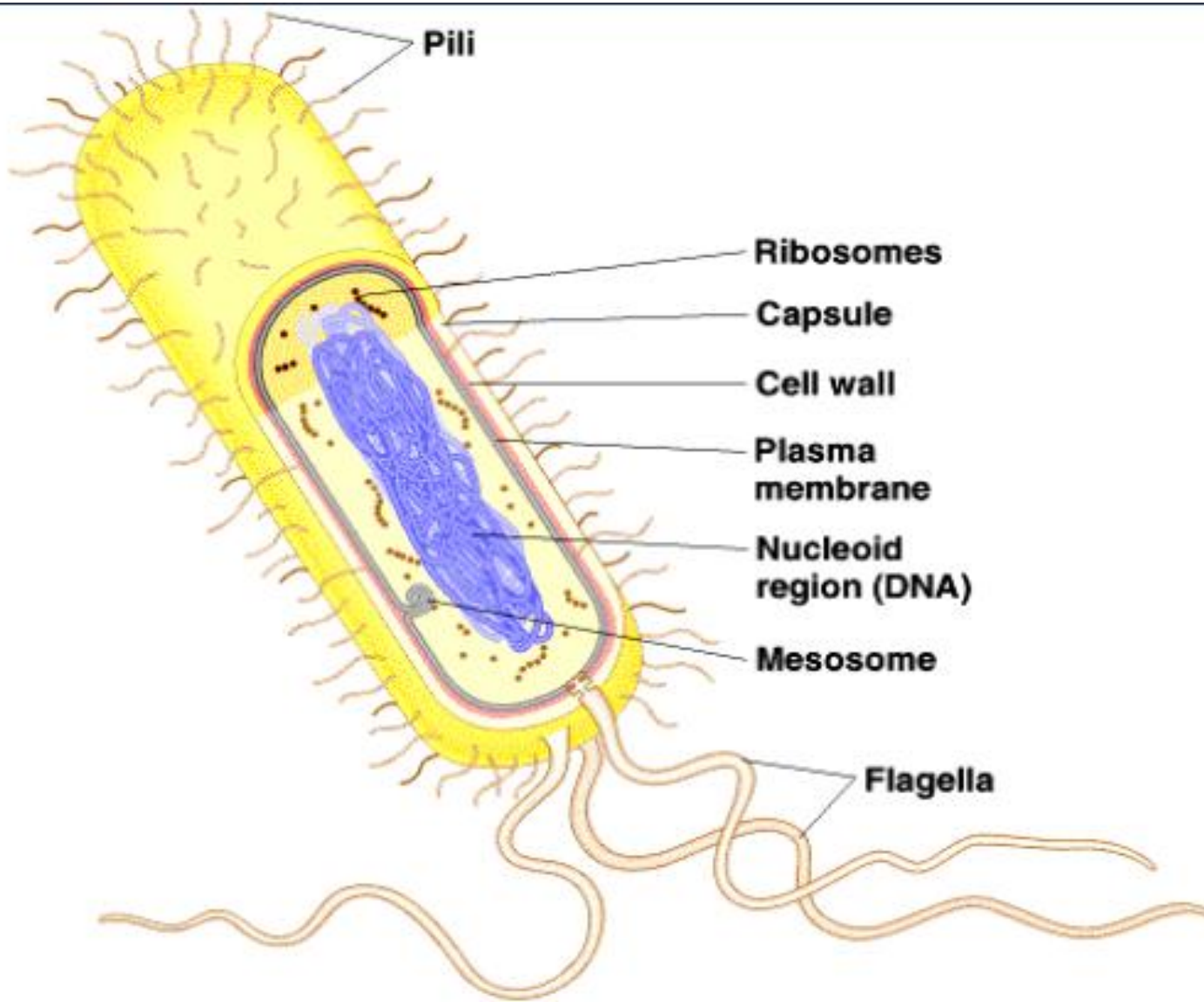
- **Bakteri dan Blue Green Algae**
- **Ukuran: 1 – 10 μ m (1/10 sel eukariotik)**
- **Tidak mempunyai Nukleus (DNA`ada di sitoplasma)**
- **Ribosom berfungsi untuk sintesis protein**
- **Dinding sel mengelilingi membran**
- **Struktur lainnya:**
 - ❑ **Kapsul: lapisan luar untuk perlindungan diri atau penempelan**
 - ❑ **Pili: untaian seperti rambut di luar sel**
 - ❑ **Flagela: Seperti pili untuk bergerak**

Genom Prokariot

- ✓ Generally 1 circular chromosome (dsDNA)
- ✓ Usually without introns
- ✓ Relatively high gene density (~2500 genes per mm of *E. coli* DNA)
- ✓ Often indigenous **plasmids** are present

1. Eschericia coli

2. Agrobacterium tumefaciens



Plasmids

✓ Naturally Extra chromosomal circular DNAs

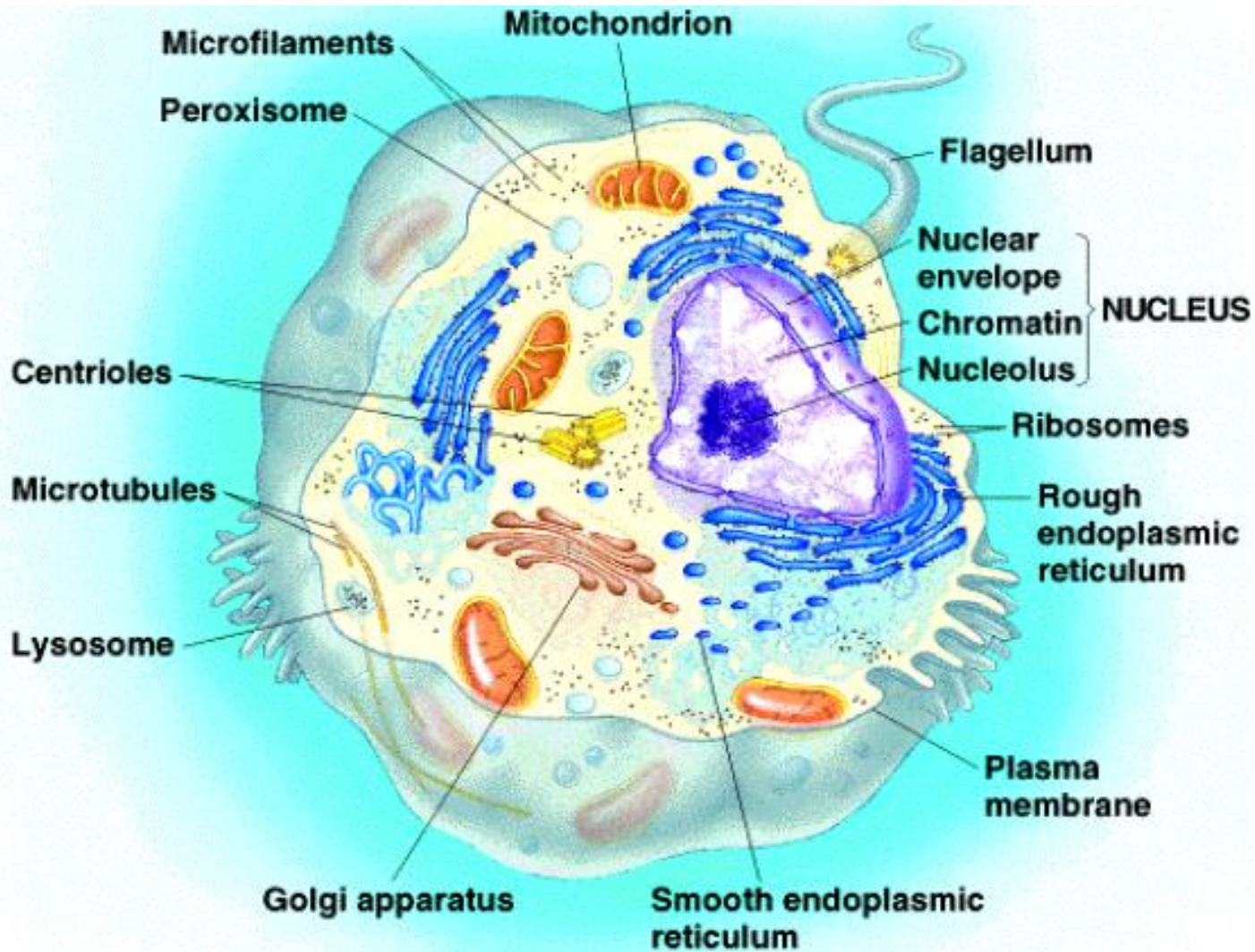
- ✓ They exist separate from the main chromosome
- ✓ They replicate within the host cells
- ✓ Their size vary form $\sim 1,000$ to 250,000 base pairs
- ✓ They can be divided into two broad groups according to how tightly their replication in regulated:
 1. stringent plasmids (low copy number plasmids: 1-2 plasmids/cell)
 - only replicate along with the main bacterial chromosome
 - and so exist as single copy, or at most several copies within the cell
 2. Relaxed plasmid (multi copy number plasmids)
 - replicate autonomously of the main chromosome and have copy numbers
 - of 10 - 500 per cells



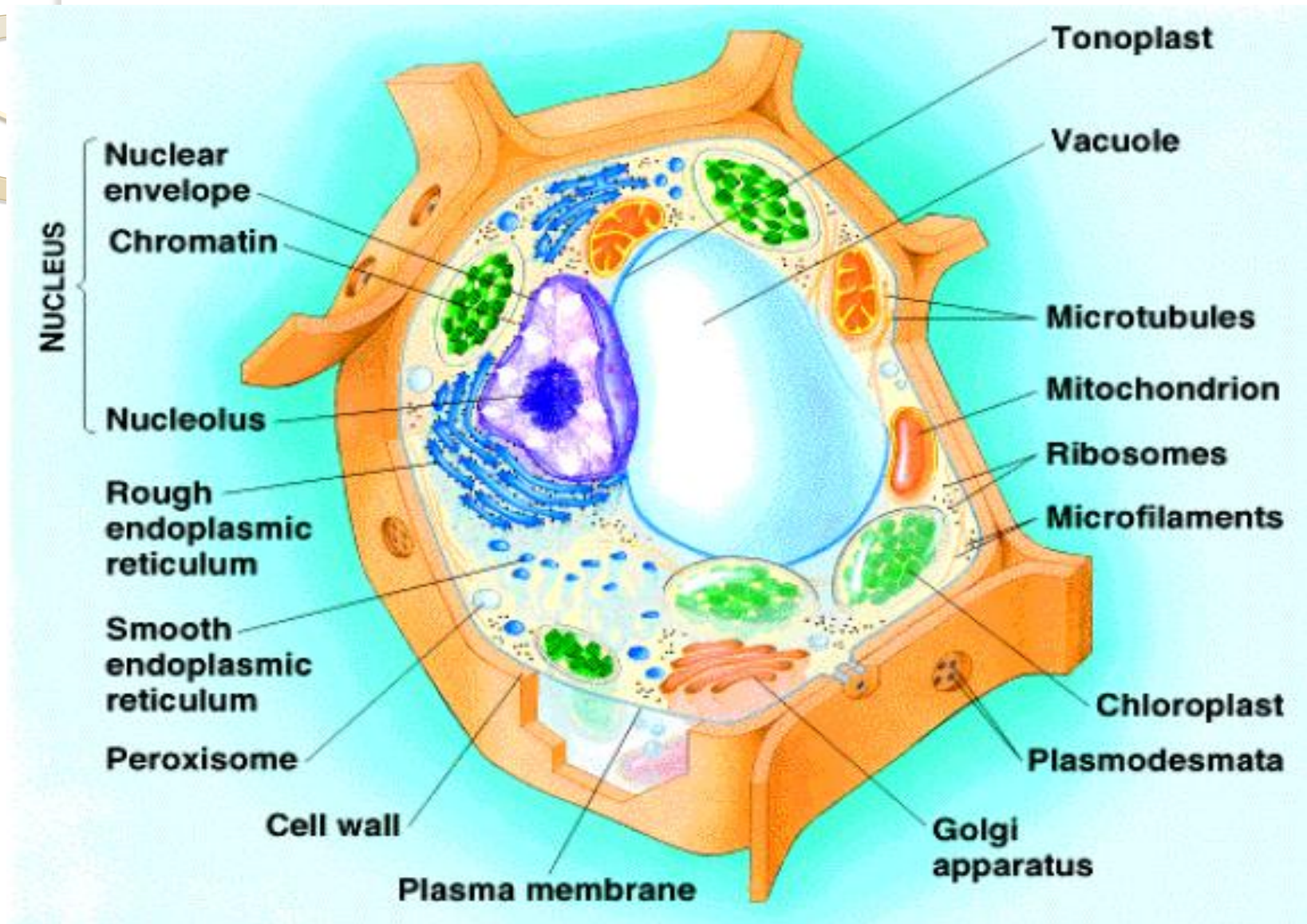
Sel Eukariotik

- **Termasuk Fungi, Tanaman dan Sel Hewan**
- **Mempunyai Nukleus untuk mewadahi dan melindungi DNA**
- **Organela terikat membran dengan fungsi spesifik termasuk disini:**
 1. **Nukleus**
 2. **Retikulum Endoplasma**
 3. **Golgi**
 4. **Lysosome**
 5. **Kloroplas**
 6. **Mitokondria**
 7. **Vakuola**

Sel Hewan



Sel Tanaman



Nukleus

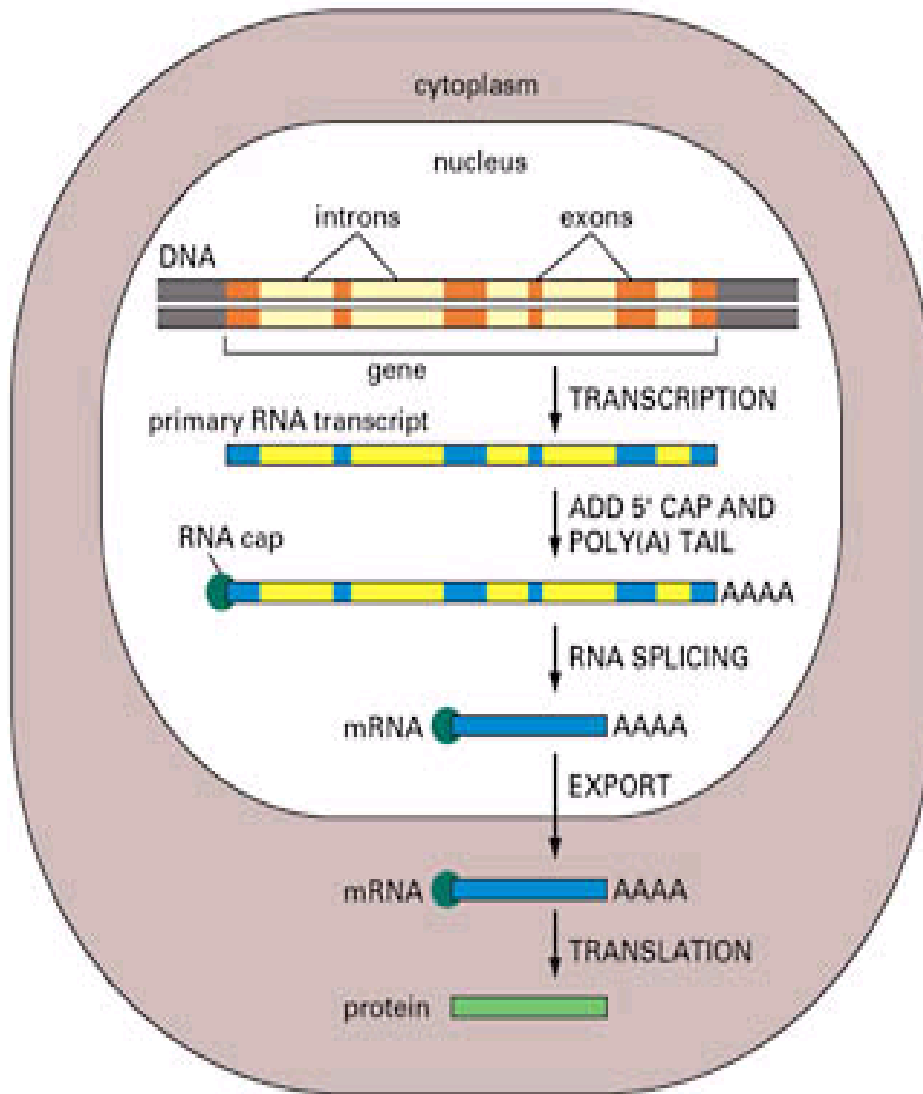
Structure

- **Double nuclear membrane (envelope)**
- **Large nuclear pores**
- **DNA (genetic material) is combined with histones and exists in two forms:**
 - **Chromatin (Loose, threadlike DNA, most of cell life)**
 - **Chromosomes (Tightly packaged DNA. Found only during cell division)**
- **Nucleolus: Dense region where ribosomes are made**

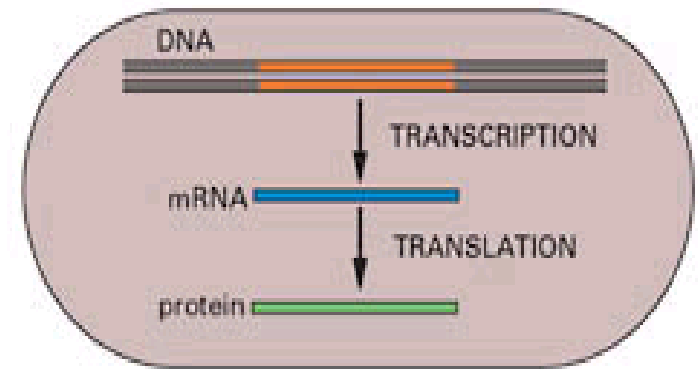
Functions

- **House and protect cell's genetic information (DNA)**
- **Ribosome synthesis**

(A) EUCARYOTES



(B) PROCARYOTES



Protein Coding Genes

Segment of DNA which can be transcribed and translated to

