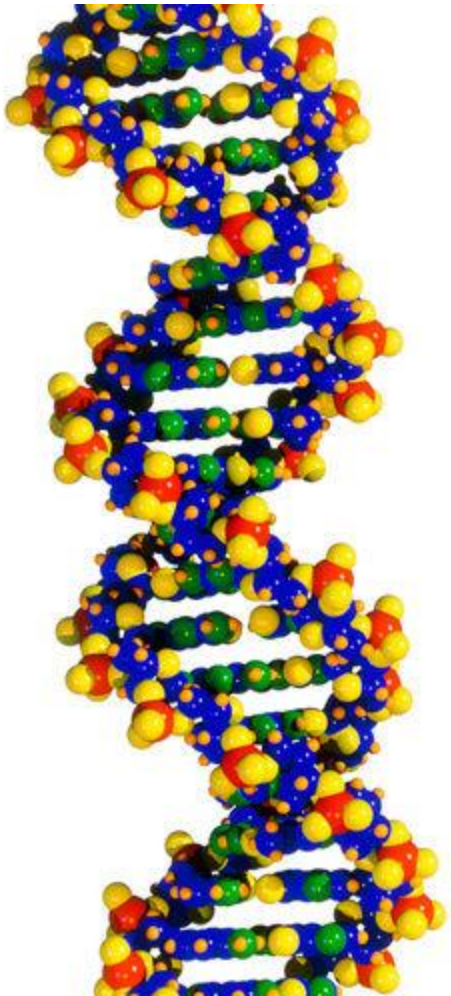
Chemistry of the Gene

- DNA structure



Discovering DNA

Bacterial Transformation & The Transformation Principle

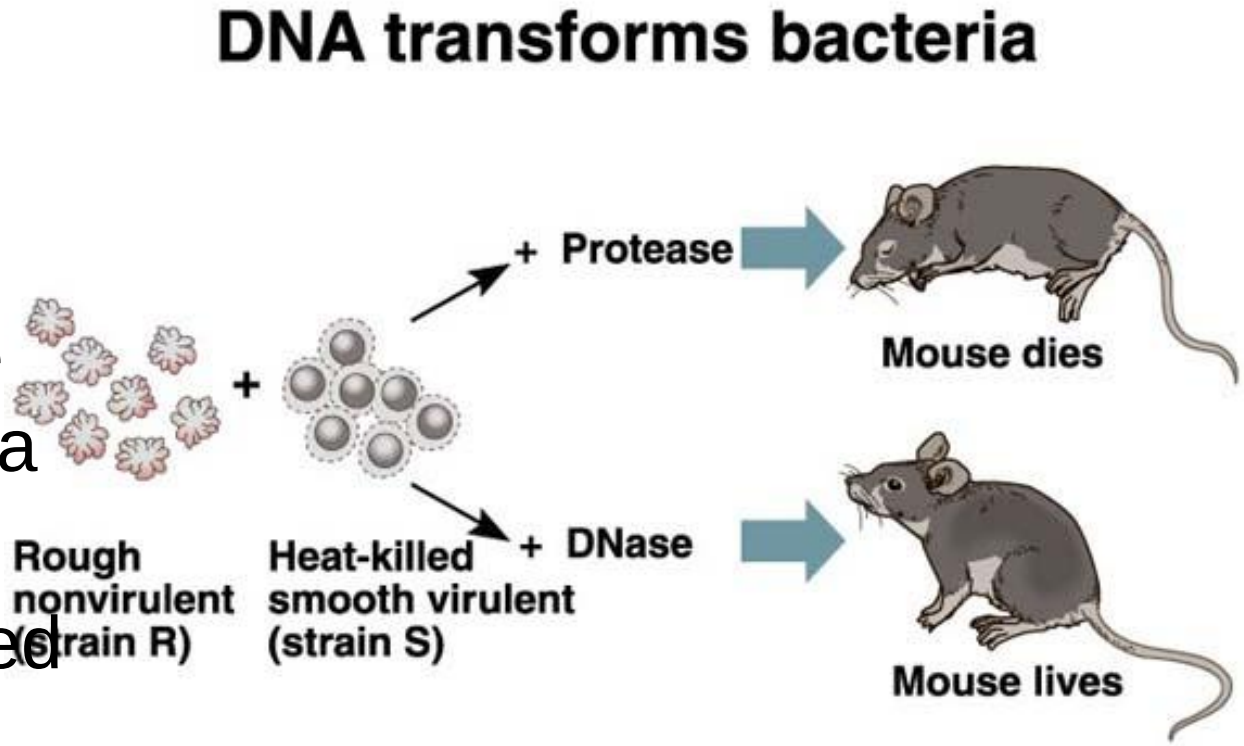
Pneumococcus is a bacterium that can cause Pneumonia.

Several strains that are genetically different

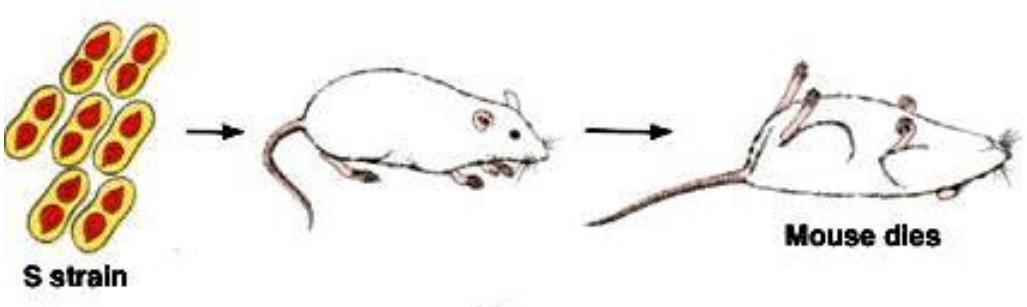
Rough & Smooth (Smooth caused Pneumonia)

Fred Griffith's Work in 1928

- Injected mice with heat killed smooth cells & live rough cells
- Thought all mice would remain healthy
- Some of the mice died of pneumonia
- Culture of dead mice blood showed smooth cells

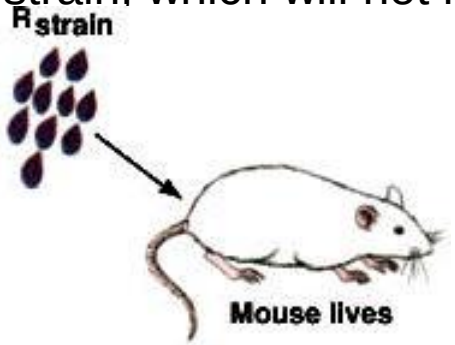


An "S" or SMOOTH coat strain, which is lethal to mice.



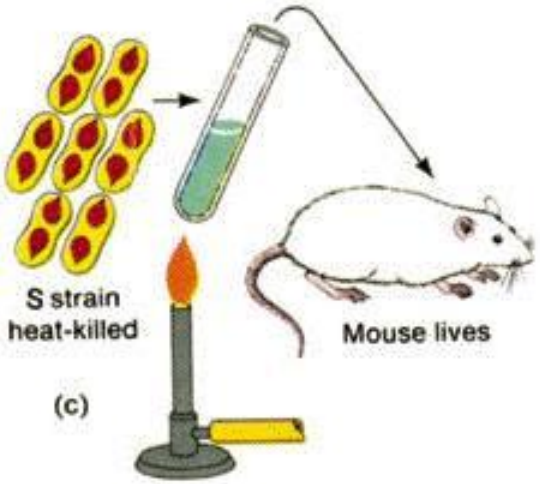
(a)

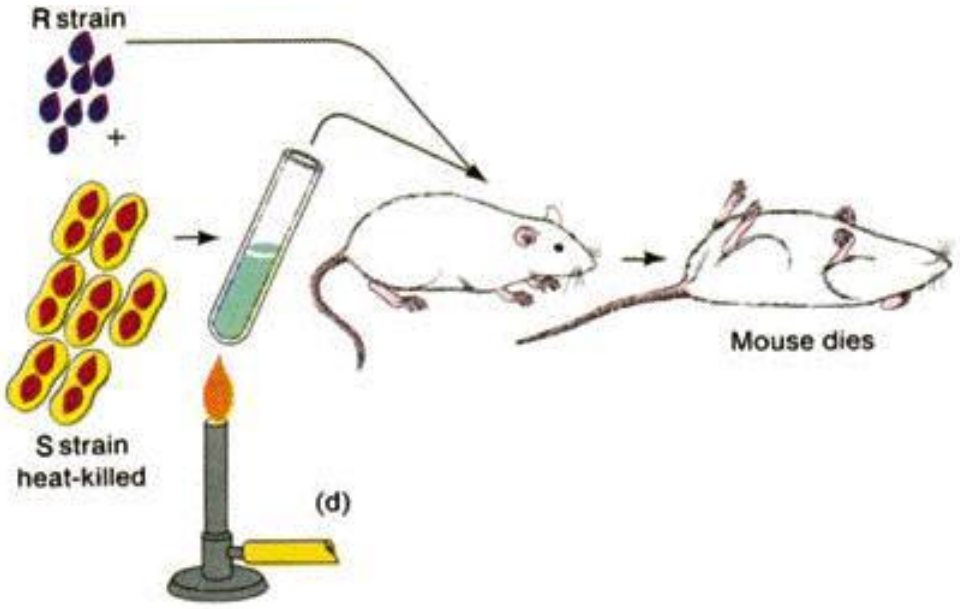
An "R" or rough strain, which will not hurt the mouse.



(b)

Griffith found that he could heat inactivate the smooth strain.





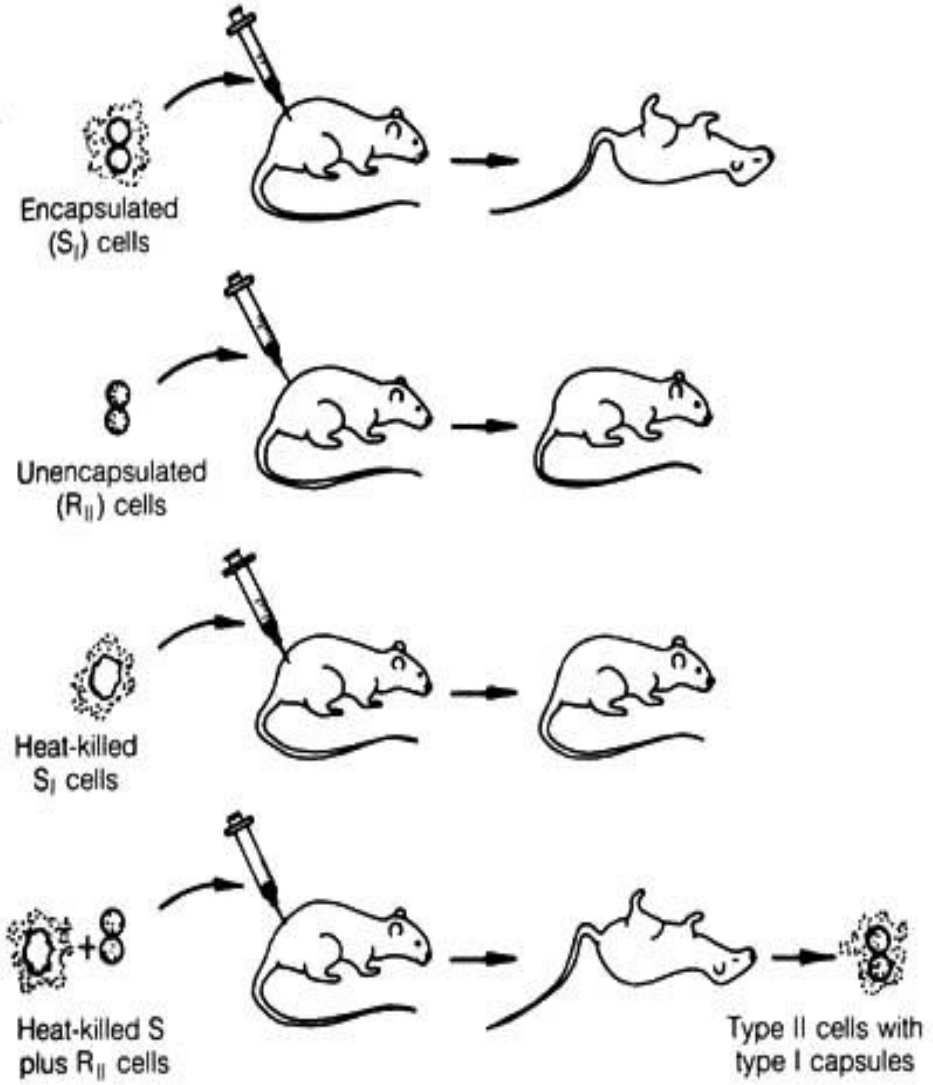
However, if he were to take a mixture of the heat-inactivated S strain, mixed with the R strain, the bacteria would die. Thus there was some Material in the heat-killed S strain that was responsible for "transforming" the R strain into a lethal form.

Bacterial transformation

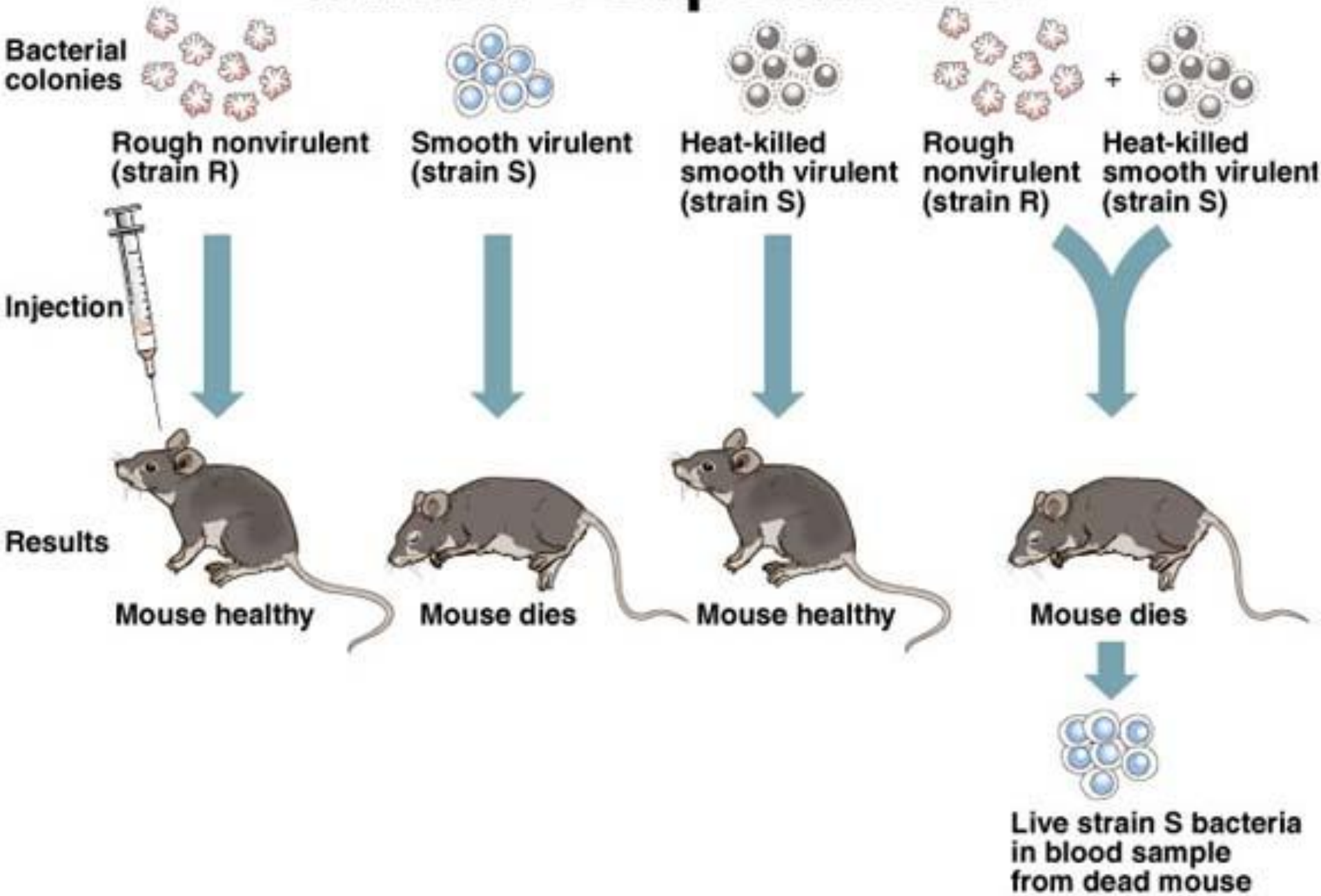
- Griffith Proved that change in heredity traits in one bacterium was caused by another bacterium that was dead

Proof of chemical causing transformation

- Smooth cells were grown & and an extract from the bacterium was removed and killed
- Extract put with culture of rough cells
- When culture observed live smooth cells were found
- Those smooth cell reproduced smooth cells



Griffith's experiments



Transforming principle

- Griffith theory was that the chemical responsible for transformation is DNA (Deoxyribonucleic acid)

*What was the major finding from the transformation experiments with Pneumococcus?**

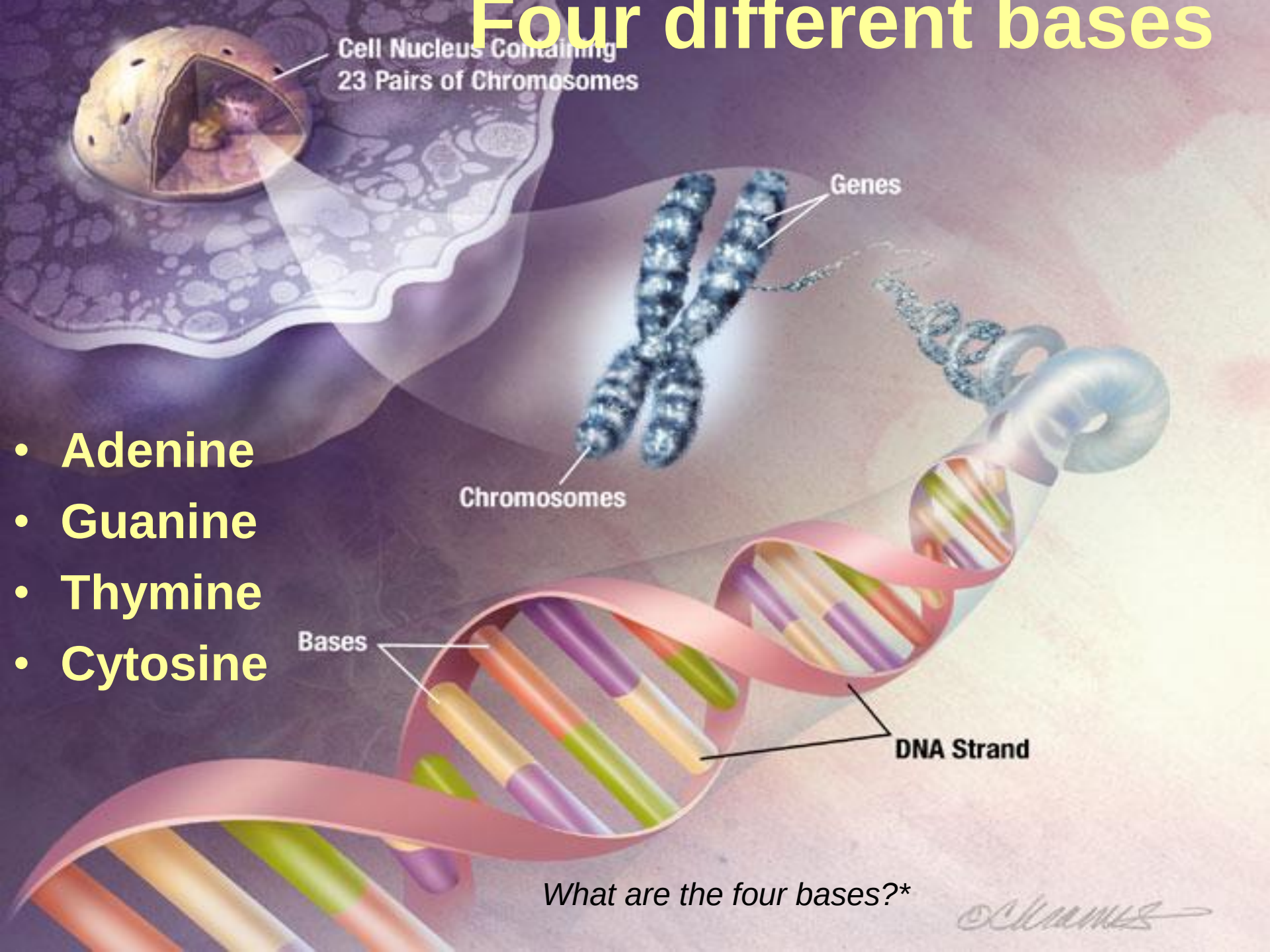
DNA Model

- DNA is a complex molecule composed of 3 smaller parts
  - Sugar (Deoxyribose)
  - Phosphate group PO_4
  - And base group (Nitrogen Compound)
- These together make up nucleotides and nucleotides together form DNA

- *What makes up the two chains that make up the DNA molecule.**

What is a nucleotide?*

Four different bases



- **Adenine**
- **Guanine**
- **Thymine**
- **Cytosine**

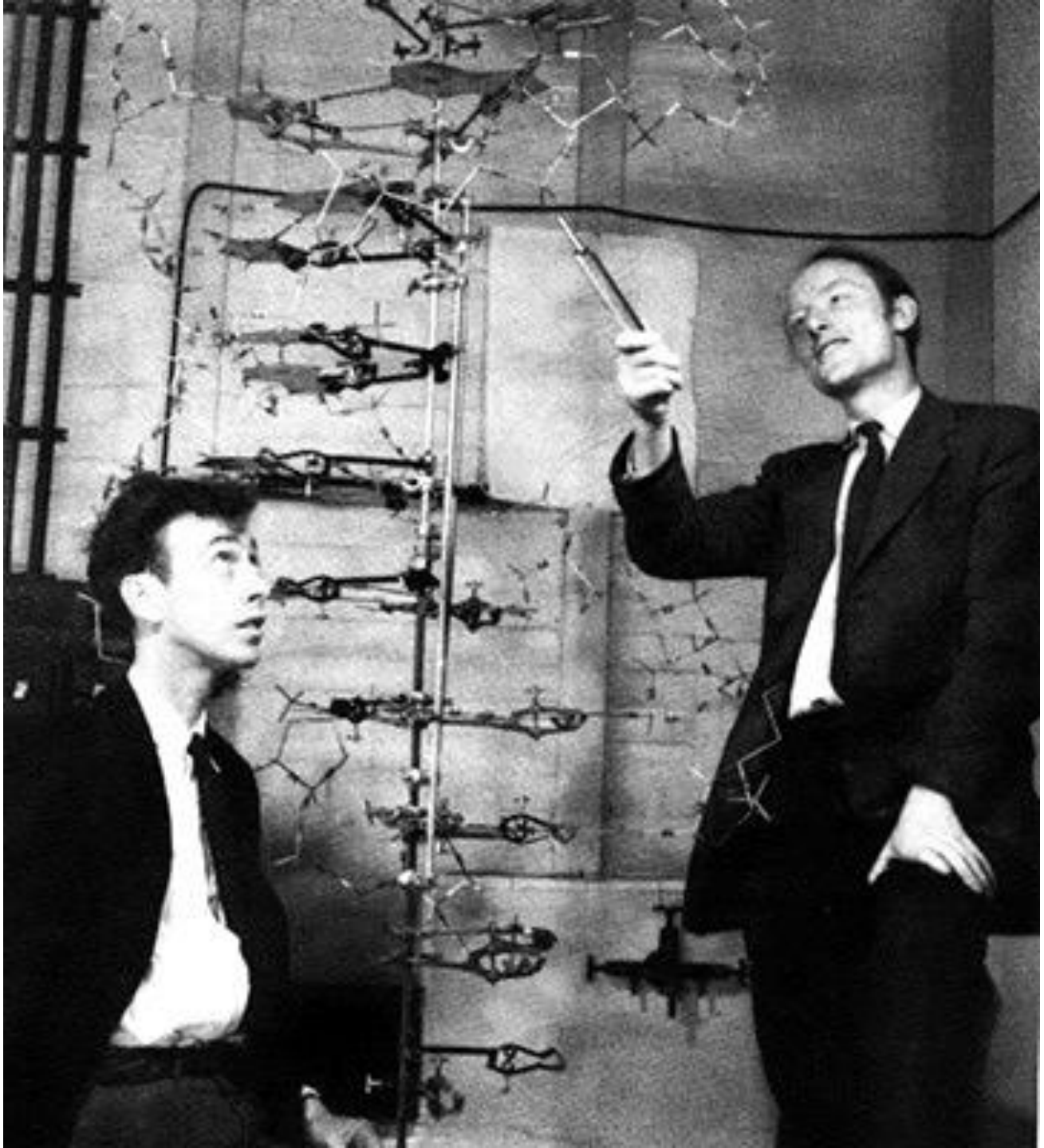
*What are the four bases?**

James Watson & Francis Crick

- **came up with the structure of DNA molecule 1953**
  - **Like a ladder**
  - **Uprights are the sugars and phosphates**
  - **Rungs are the nitrogen bases**

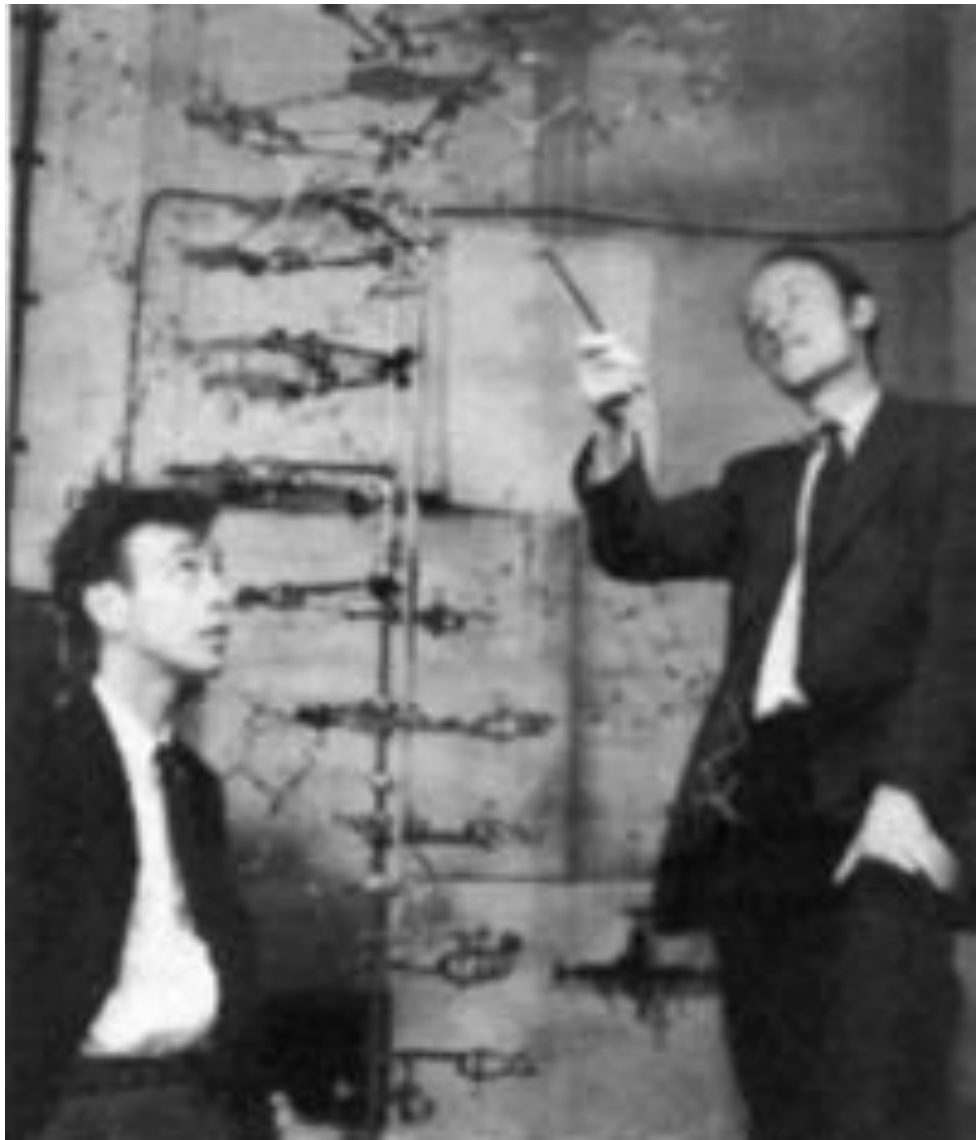
*What two scientists presented the model of DNA in 1953?**

*What two molecules make the uprights of the DNA ladder?**



How Bases Fit Together

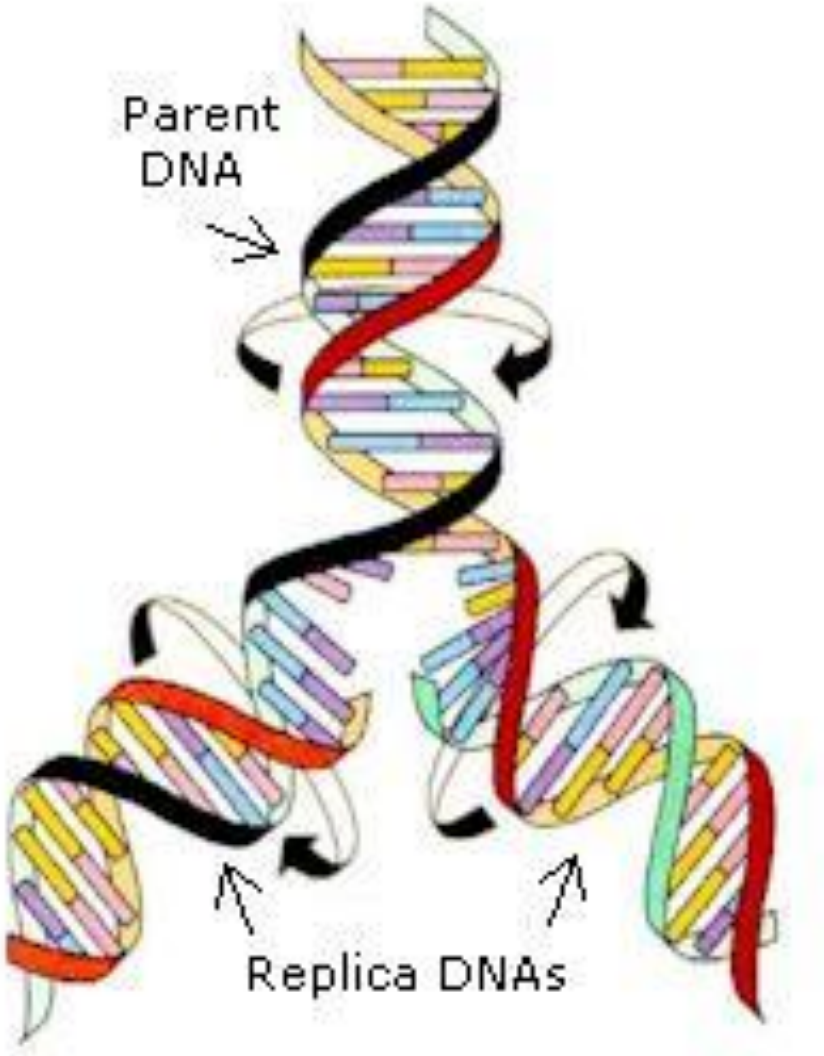
- The bases fit together in certain ways
  - Adenine with Thymine
  - Cytosine with Guanine
- Double helix - a twisted ladder
- The twisting makes it more stable



*Which nitrogen bases fit together in DNA?**

DNA Replication

- DNA molecule unwinds and then unzips when it is ready to replicate
- Weak hydrogen bonds hold the bases together are broken and the two strands separate
- Bases become exposed to contents of the nucleus
- New nucleotides join with exposed bases only in certain ways A-T, G-C

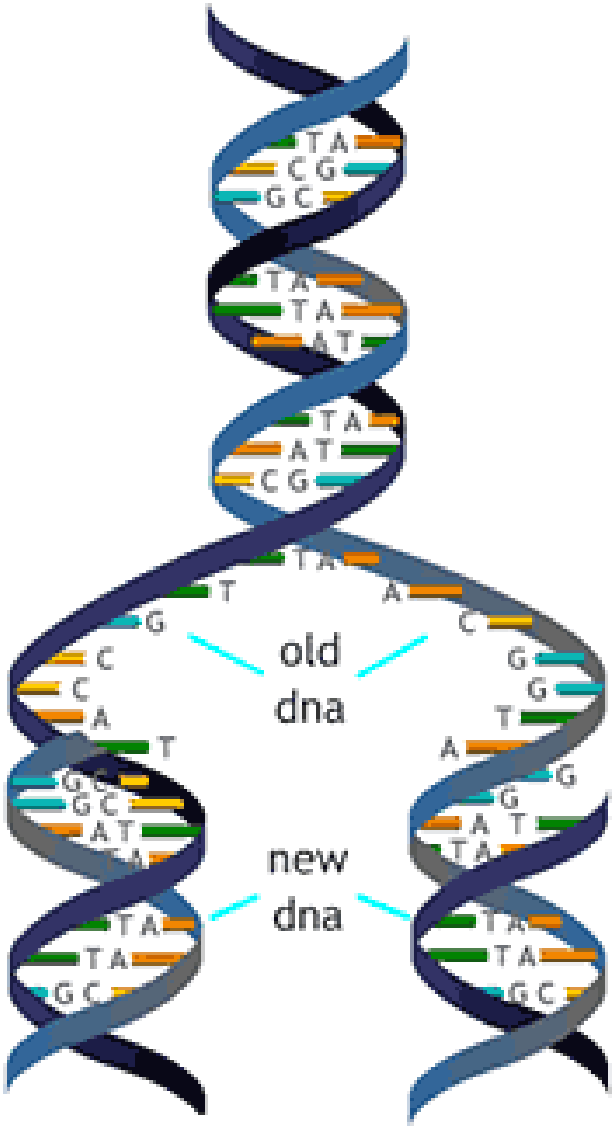


DNA Replication

DNA Replication Continued

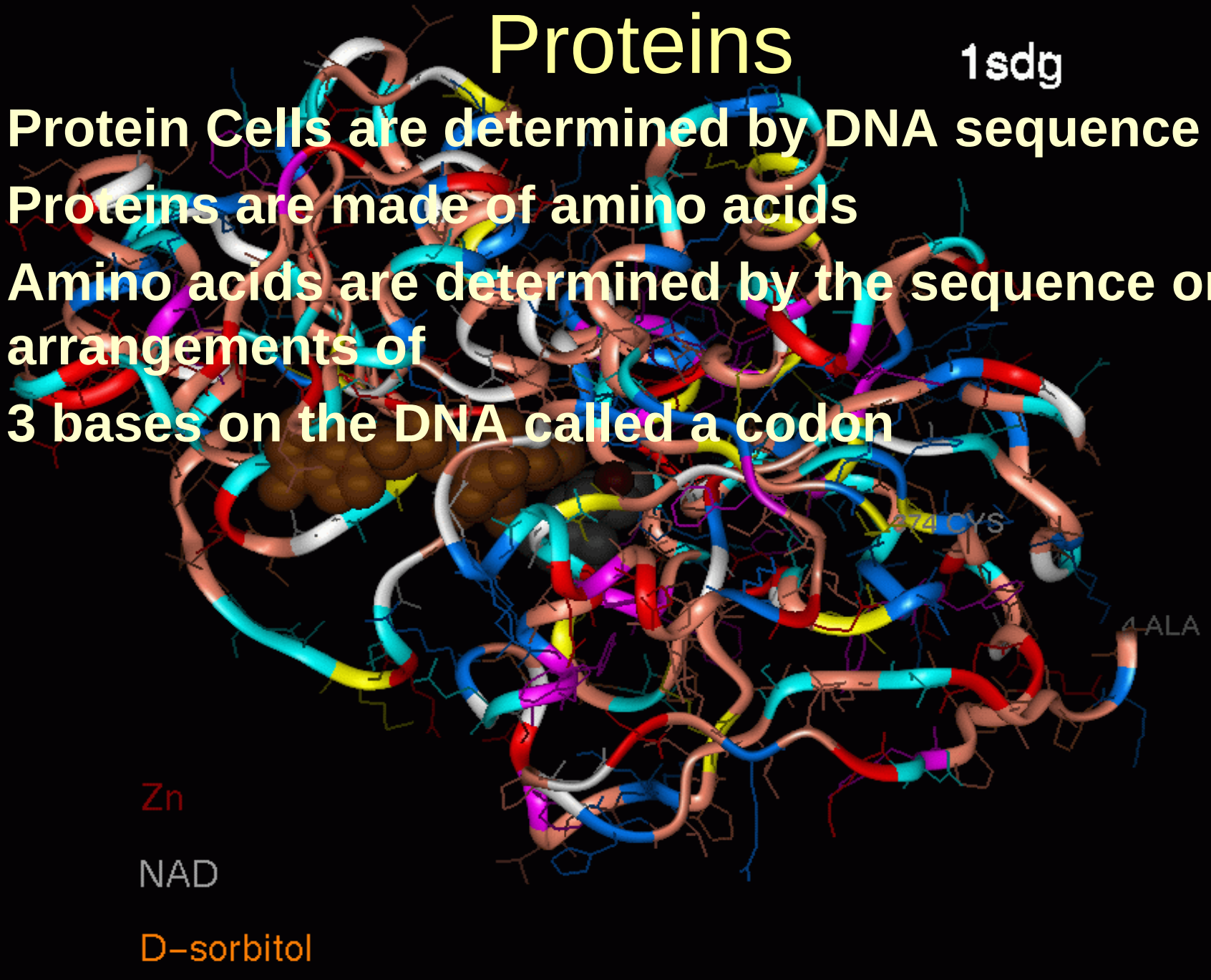
- Nucleotides added to each strand from a sequence exactly like the original strand
- Nucleotides are joined together by phosphates
- Results in two DNA molecules exactly like the original
- Fits with the process of mitosis & meiosis

*Explain how DNA replicates itself.**



DNA unzipping

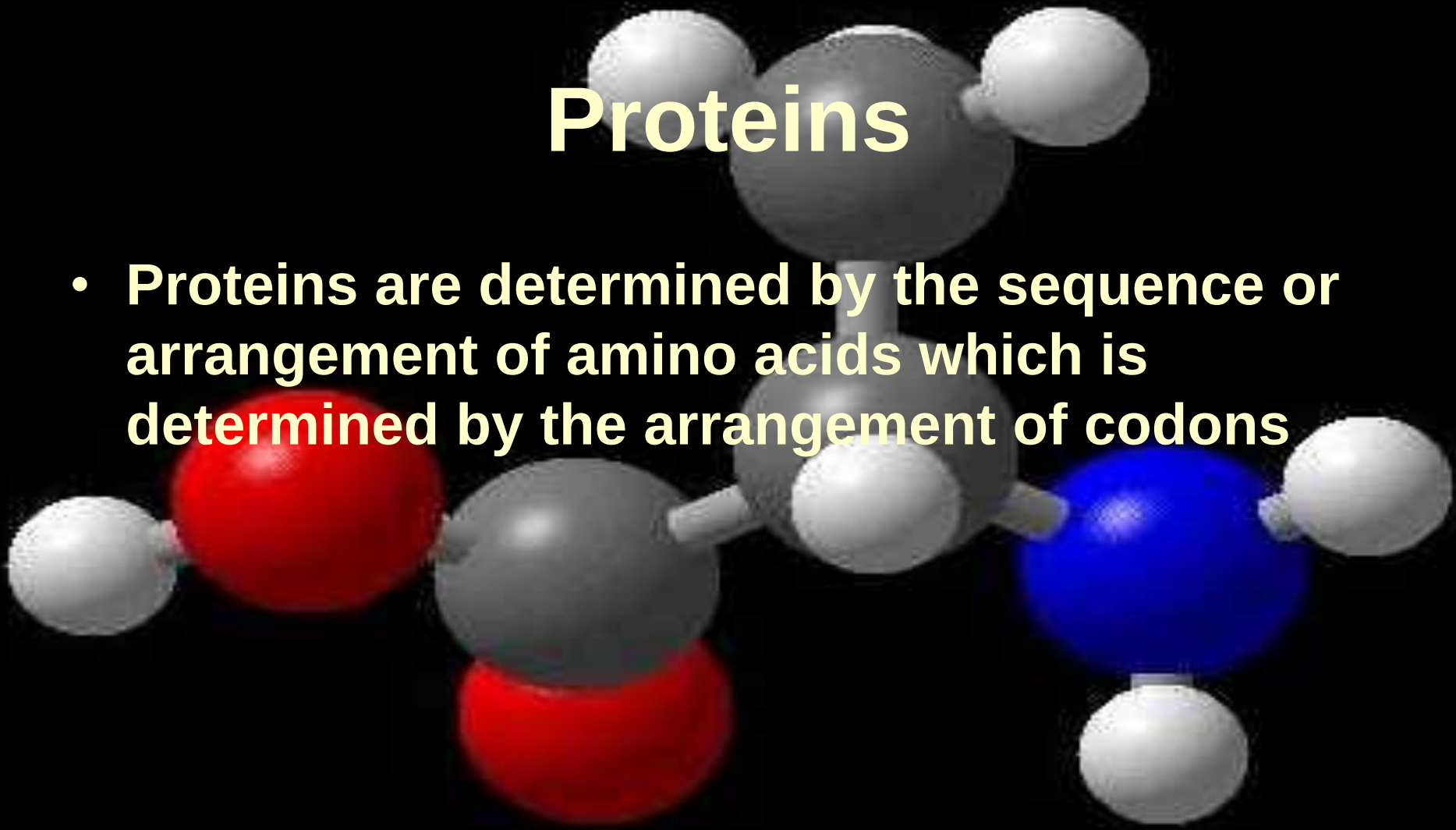
Proteins



- **Protein Cells are determined by DNA sequence**
- **Proteins are made of amino acids**
- **Amino acids are determined by the sequence or arrangements of**
- **3 bases on the DNA called a codon**

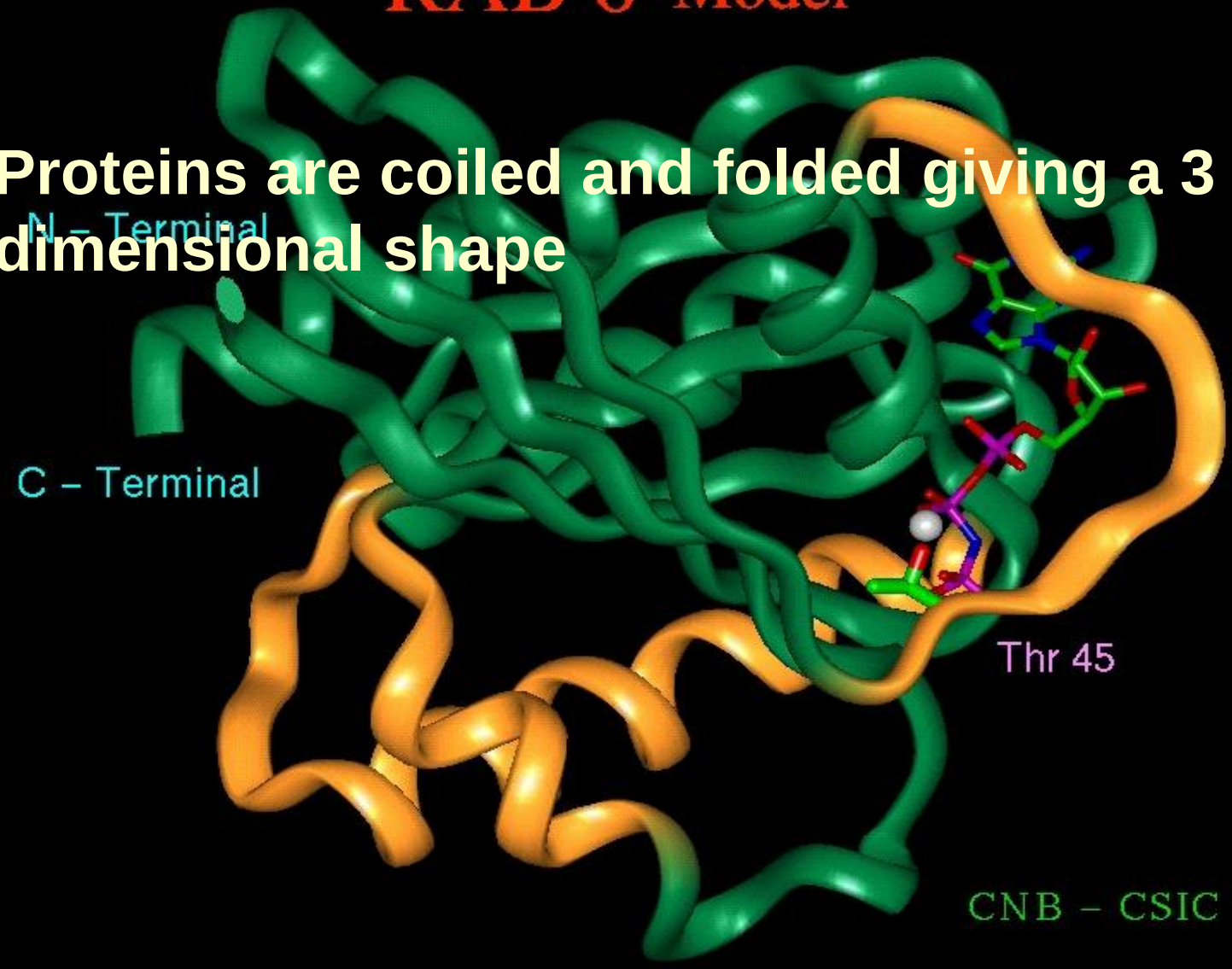
Proteins

- **Proteins are determined by the sequence or arrangement of amino acids which is determined by the arrangement of codons**

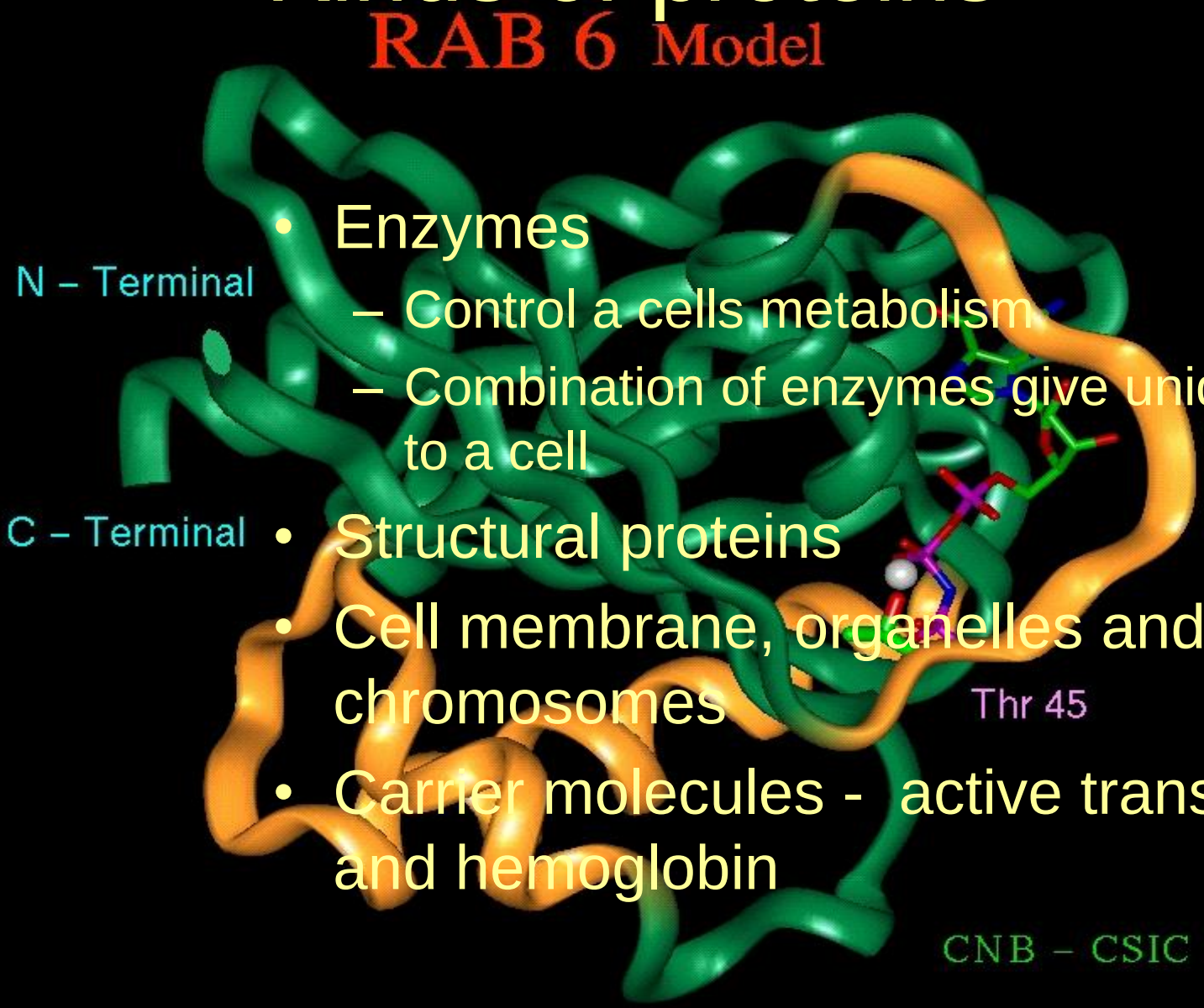


Proteins

- **Proteins are coiled and folded giving a 3 dimensional shape**



Kinds of proteins

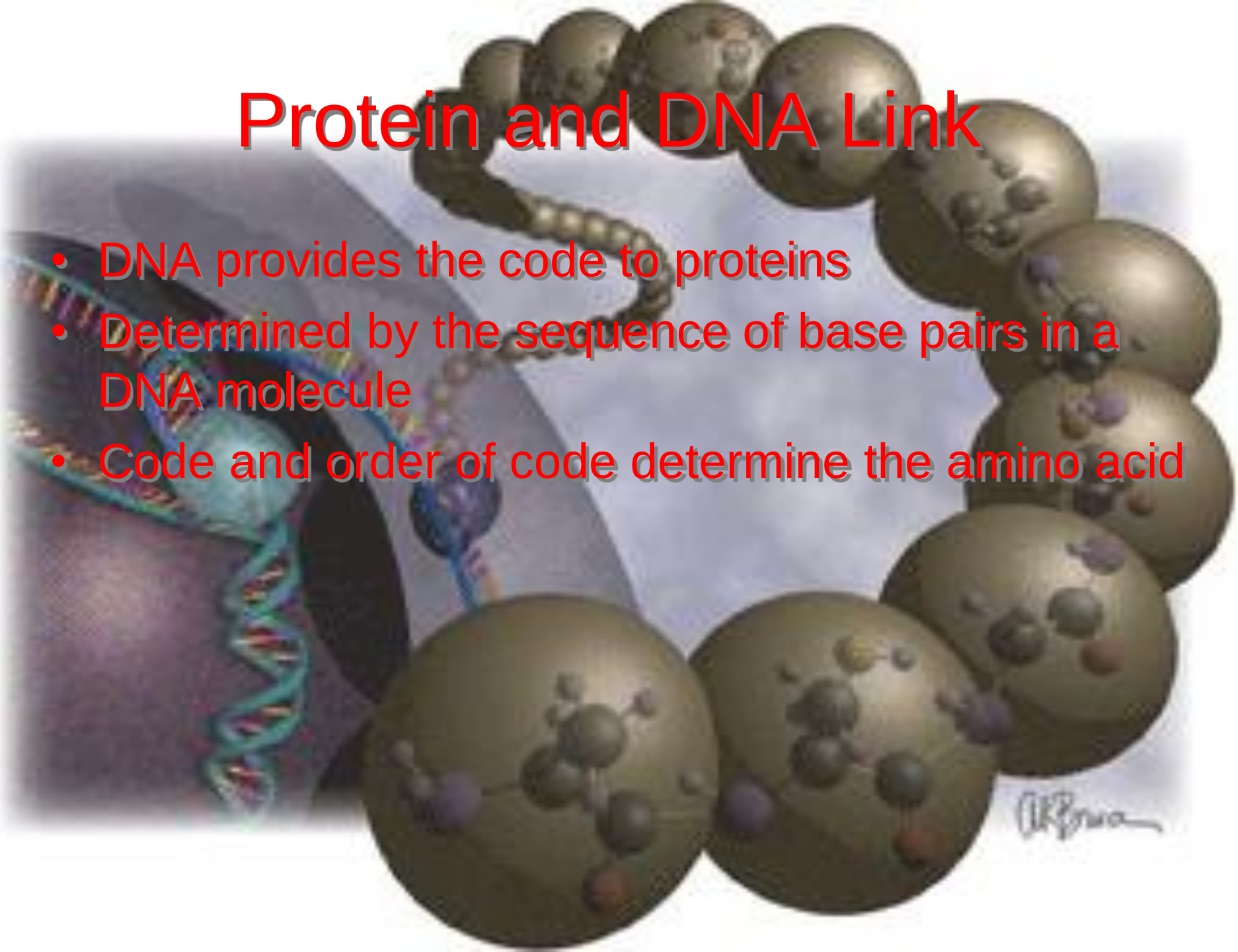


- Enzymes
  - Control a cells metabolism
  - Combination of enzymes give uniqueness to a cell
- Structural proteins
- Cell membrane, organelles and chromosomes
- Carrier molecules - active transport and hemoglobin

Genes & Proteins

- Theory of relationship of genes to proteins 1941 Beadle & Tatum provide evidence to the DNA protein link with bread mold experiments which lead them to the one gene-one enzyme hypothesis, which states that one gene codes for one enzyme

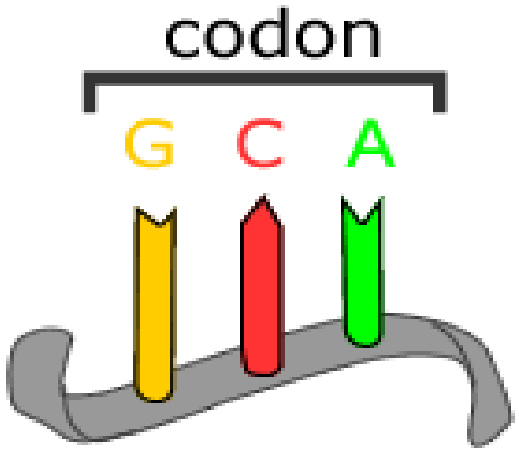
Protein and DNA Link



- DNA provides the code to proteins
- Determined by the sequence of base pairs in a DNA molecule
- Code and order of code determine the amino acid

From DNA to Amino Acids

- There are more than 20 amino acids
- 3 base pairs act as the code for the amino acid
- Codon - are three base pairs that determine what the amino acid is page 241



1 codon = 1 amino acid

Combining Baes 1 at a Time:

A	C	G	T

Combining Bases 2 at a Time:

AA	CA	GA	TA
AC	CC	GC	TC
AG	CG	GG	TG
AT	CT	GT	TT

Combining Bases 3 at a Time:

AAA	CAA	GAA	TAA
AAC	CAC	GAC	TAC
AAG	CAG	GAG	TAG
AAT	CAT	GAT	TAT
ACA	CCA	GCA	TCA
ACC	CCC	GCC	TCC
ACG	CCG	GCG	TCG
ACT	CCT	GCT	TCT
AGA	CGA	GGA	TGA
AGC	CGC	GGC	TGC
AGG	CGG	GGG	TGG
AGT	CGT	GGT	TGT
ATA	CTA	GTA	TTA
ATC	CTC	GTC	TTC
ATG	CTG	GTG	TTG
ATT	CTT	GTT	TTT

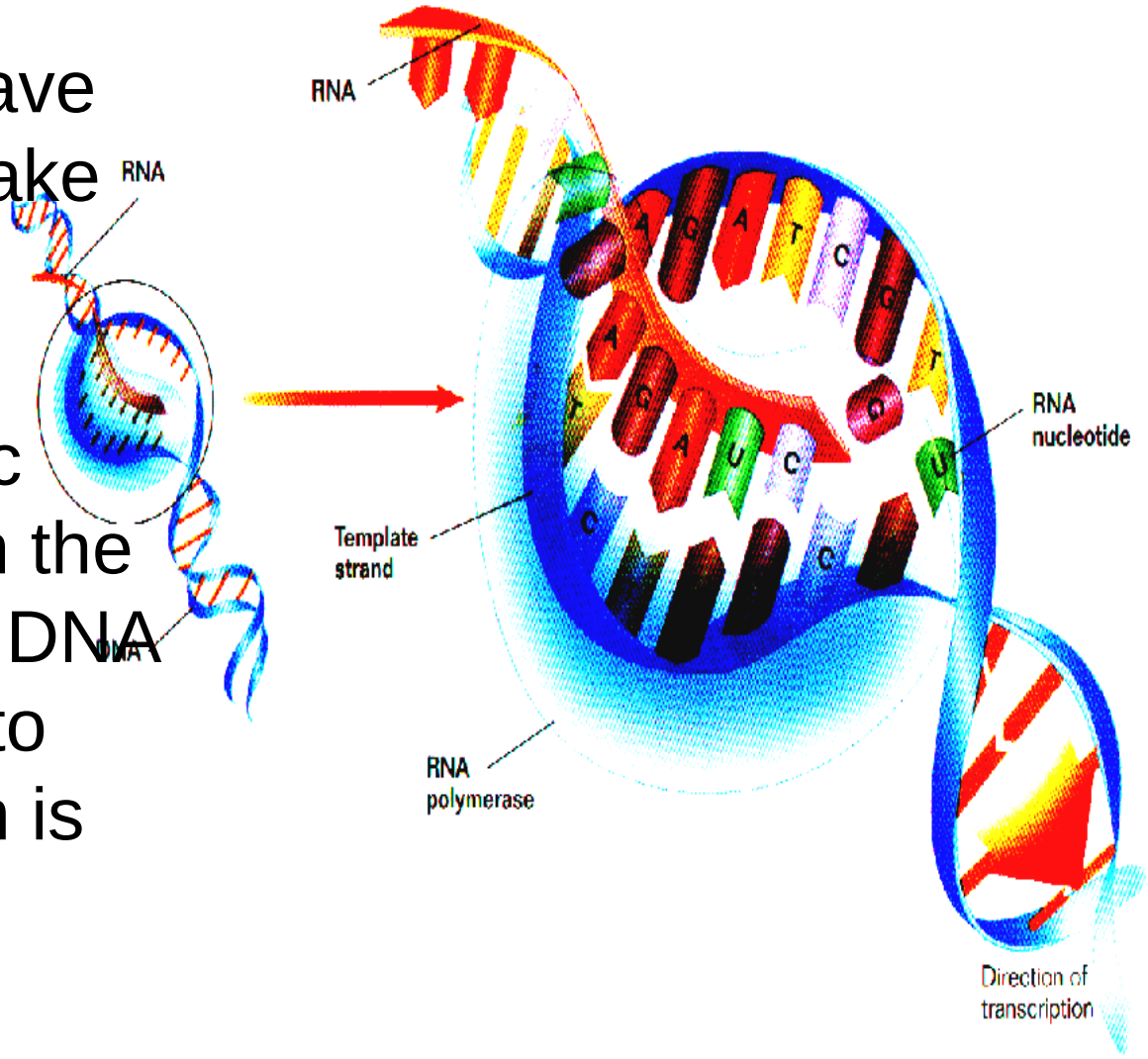
mRNA

The Genetic Code

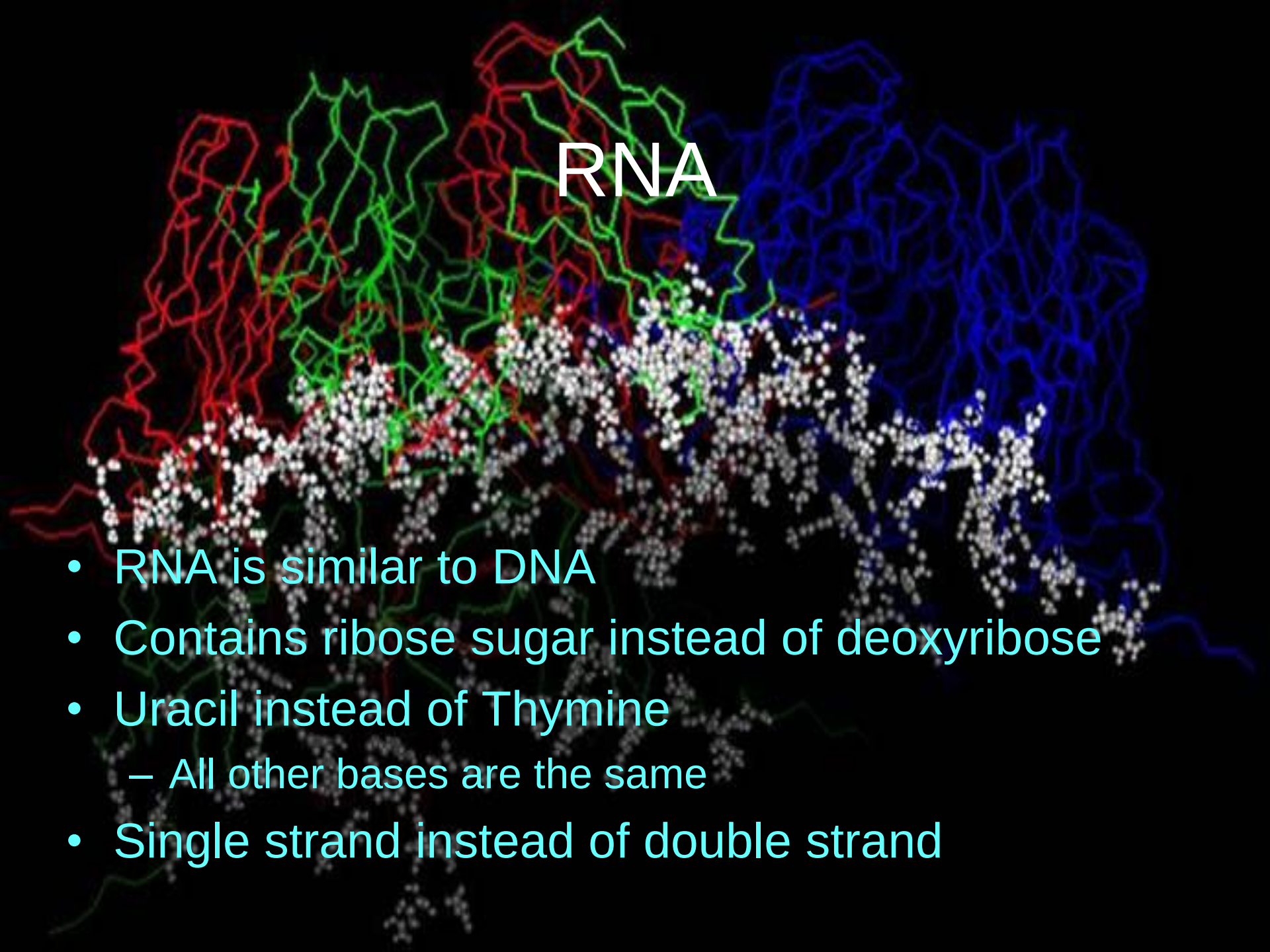
	U	C	A	G	
U	UUU Phenyl alanine UUC UUG Leucine UUA	UCU Serine UCC UCA UCG	UAU Tyrosine UAC UAA Stop UAG	UGU Cysteine UGC UGA Stop UGG Tryptophan	U C A G
C	CUU Leucine CUC CUA CUG	CCU Proline CCC CCA CCG	CAU Histidine CAC CAA Glutamine CAG	CGU Arginine CGC CGA CGG	U C A G
A	AUU Isoleucine AUC AUA AUG Methionine	ACU Threonine ACC ACA ACG	AAU Asparagine AAC AAA Lysine AAG	AGU Serine AGC AGA Arginine AGG	U C A G
G	GUU Valine GUC GUA GUG	GCU Alanine GCC GCA GCG	GAU Aspartic acid GAC GAA Glutamic acid GAG	GGU Glycine GGC GGA GGG	U C A G

DNA to RNA

- DNA does not leave the nucleus to make proteins at the ribosome
- RNA (Ribonucleic Acid) is formed in the nucleus from the DNA to take the code to where the protein is made



RNA



- RNA is similar to DNA
- Contains ribose sugar instead of deoxyribose
- Uracil instead of Thymine
  - All other bases are the same
- Single strand instead of double strand

Protein Synthesis

- Protein Synthesis (The making of proteins)

Three types of RNA*

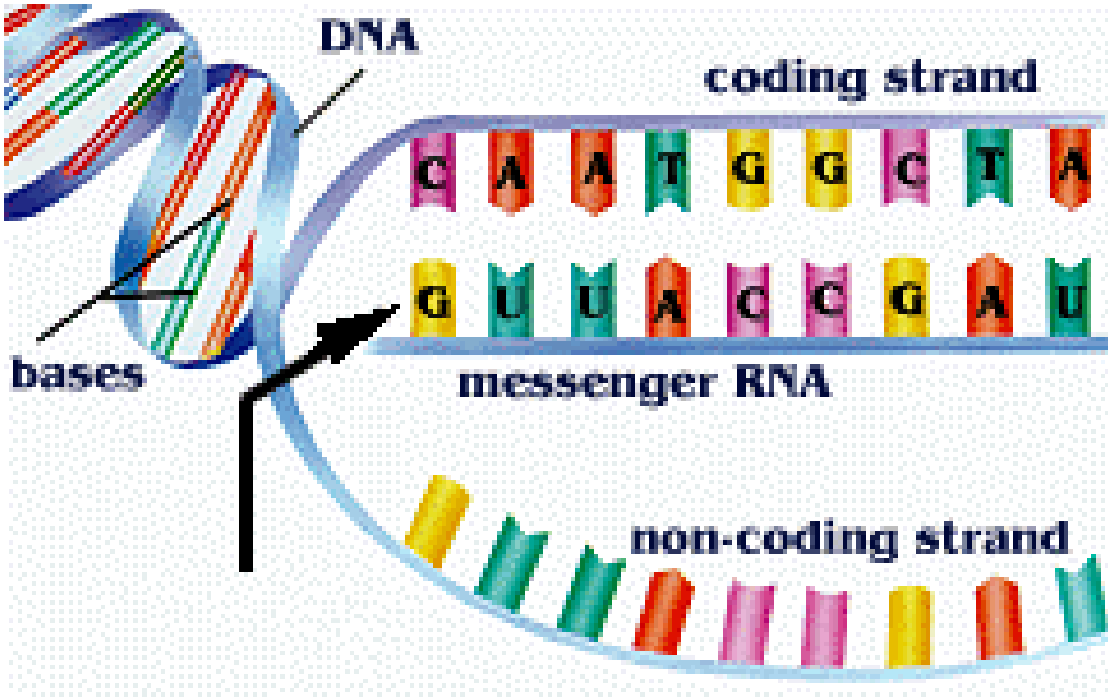
- Types of RNA involved in protein synthesis
  - Messenger RNA (mRNA)
  - Transfer RNA (tRNA)
  - Ribosomal RNA (rRNA)

*Explain 3 differences between DNA & RNA.**

Actin Protein

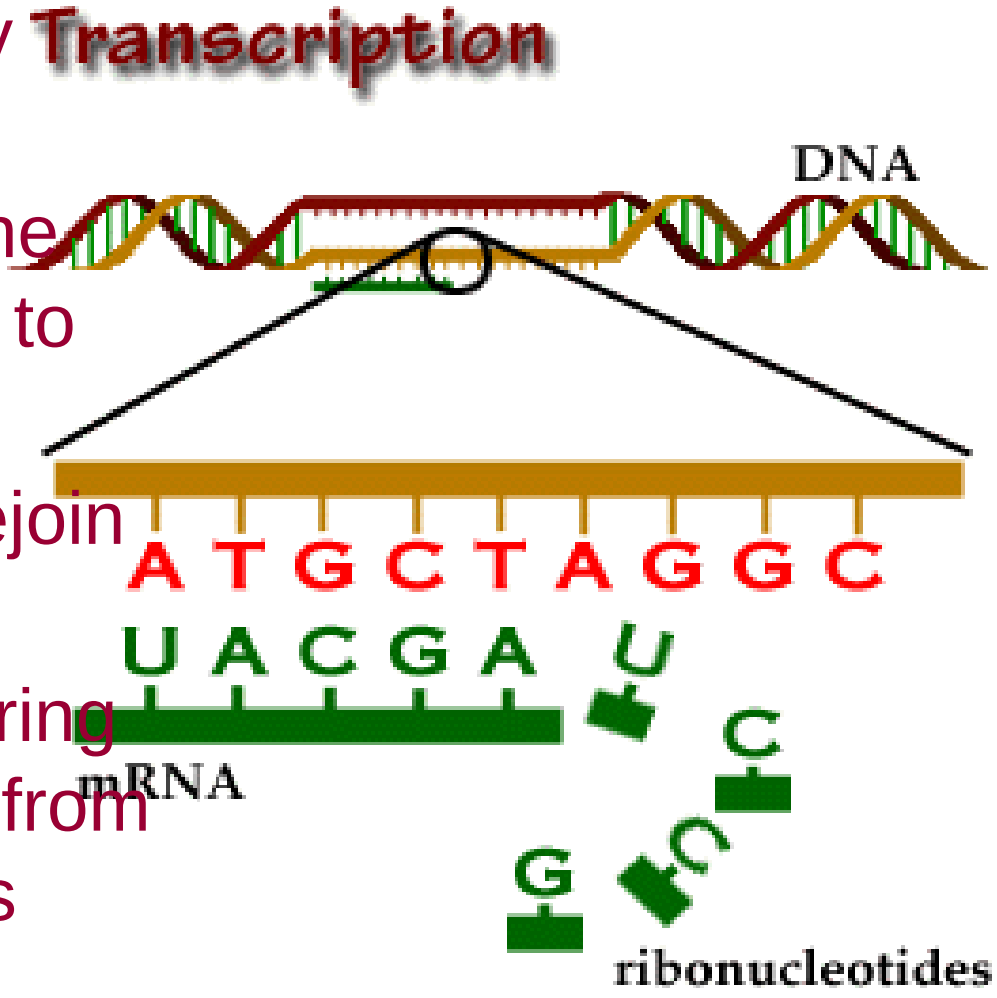
*Transcription**

- Protien synthesis begins with the DNA code order of codons being transferred to the mRNA
- The DNA molecule unzips
- Transcription continued The mRNA copies the base codons (3bases together) from the DNA
- The specific sequence of the mRNA bases are determine by DNA bases



Transcription Continued *

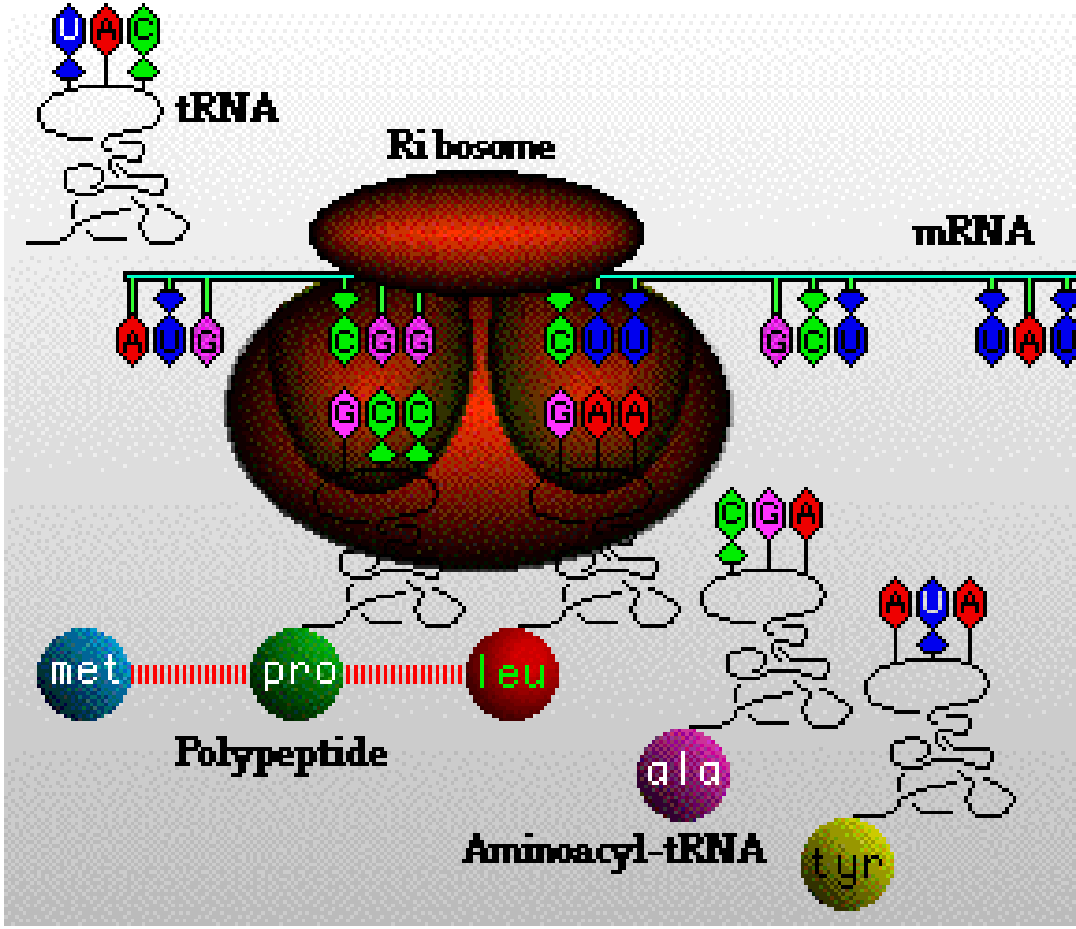
- After mRNA molecule is complete it breaks away from the DNA
- The mRNA goes from the nucleus through the ER to the ribosomes
- The two DNA strands rejoin and recoil
- This process of transferring the order of the codons from the DNA to the mRNA is called *Transcription*

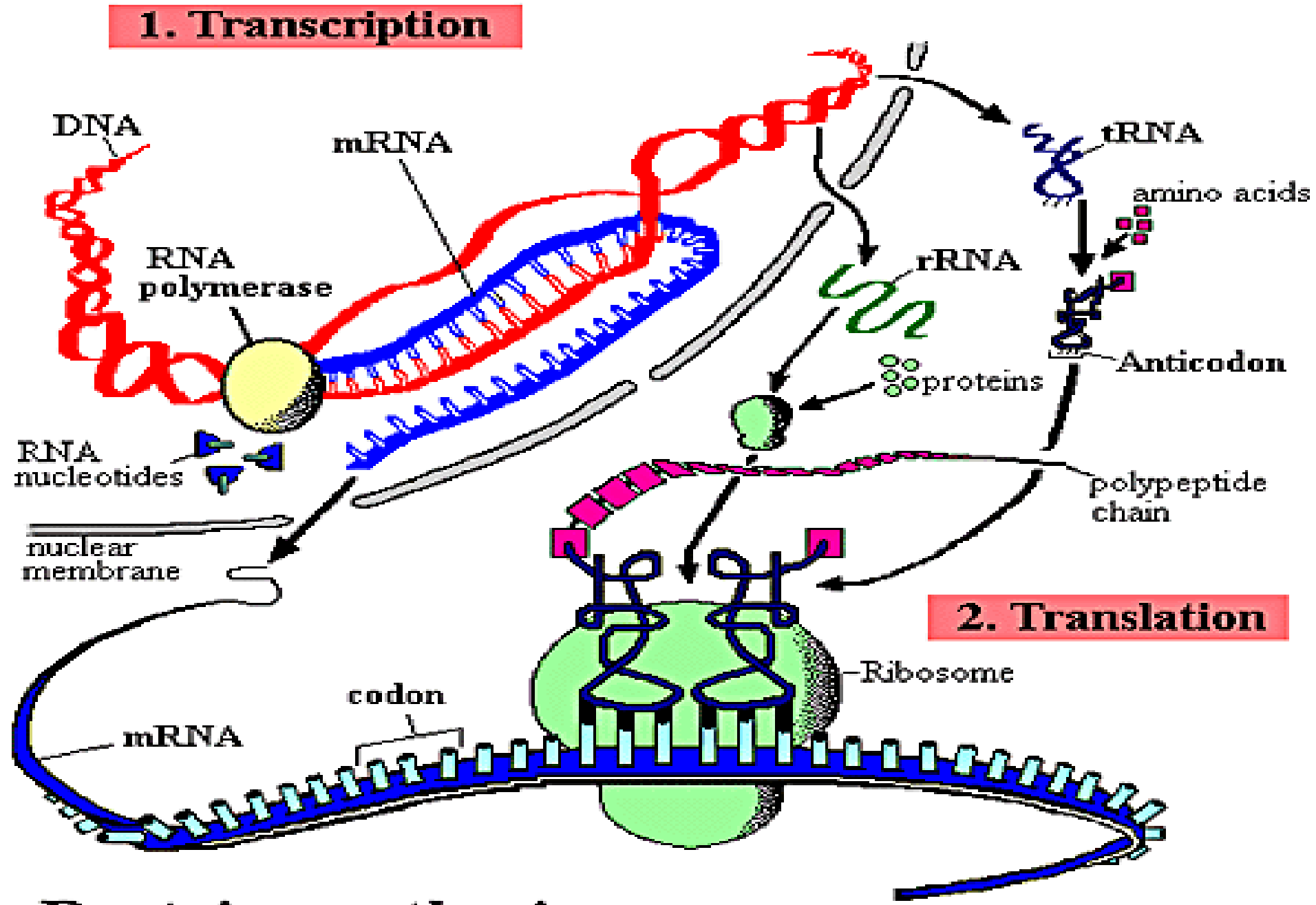


*What is transcription and what molecules are involved?**

Translation*

- *Translation* – the process of the tRNA bringing the amino acids (AA) to the mRNA to be put in the correct order
- The tRNA are already in the cytoplasm
- There are many different kinds of tRNA to match the mRNA codons



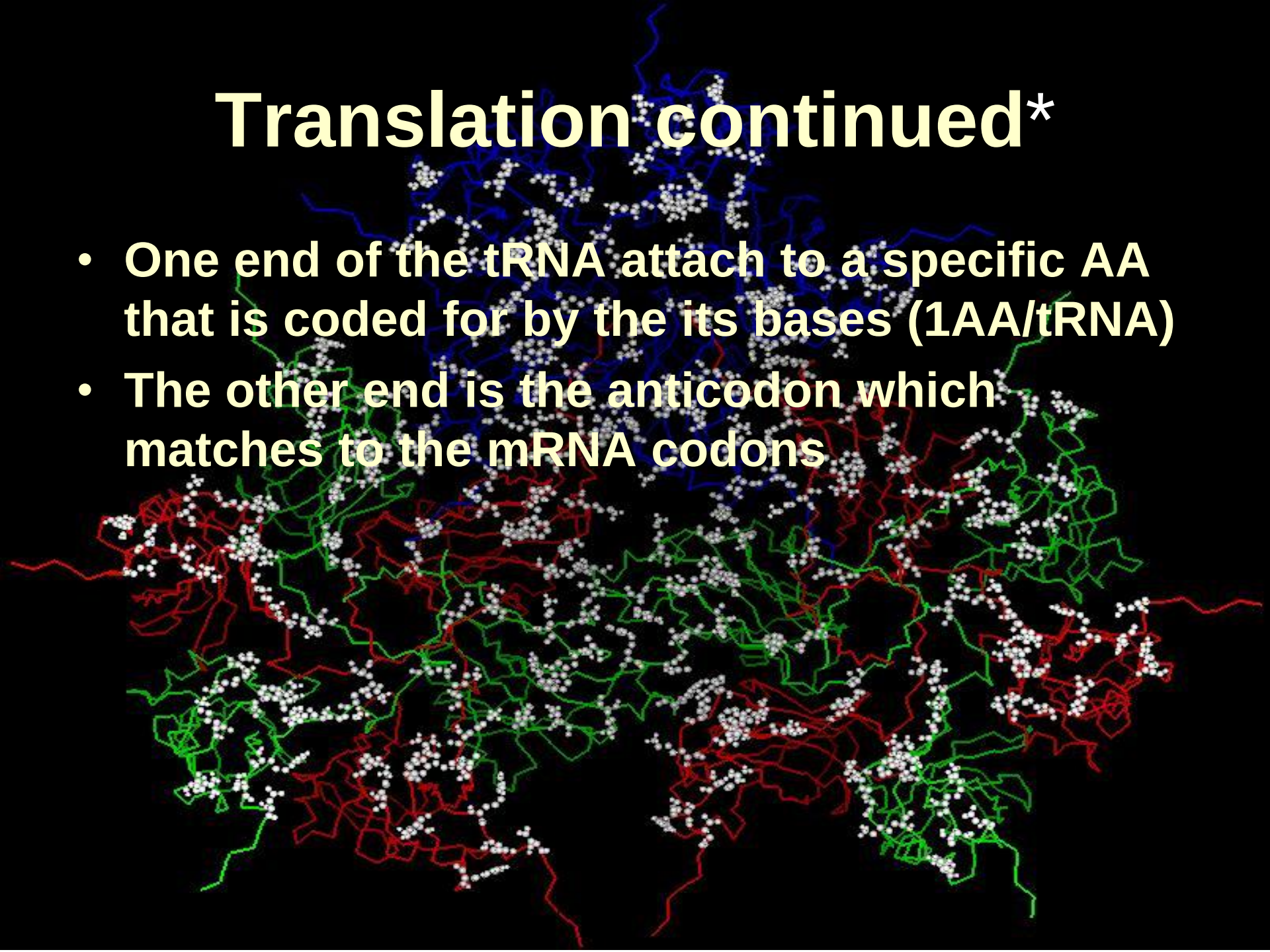


Protein synthesis

Protein Synthesis Animation

Translation continued*

- One end of the tRNA attach to a specific AA that is coded for by the its bases (1AA/tRNA)
- The other end is the anticodon which matches to the mRNA codons



Translation Continued *

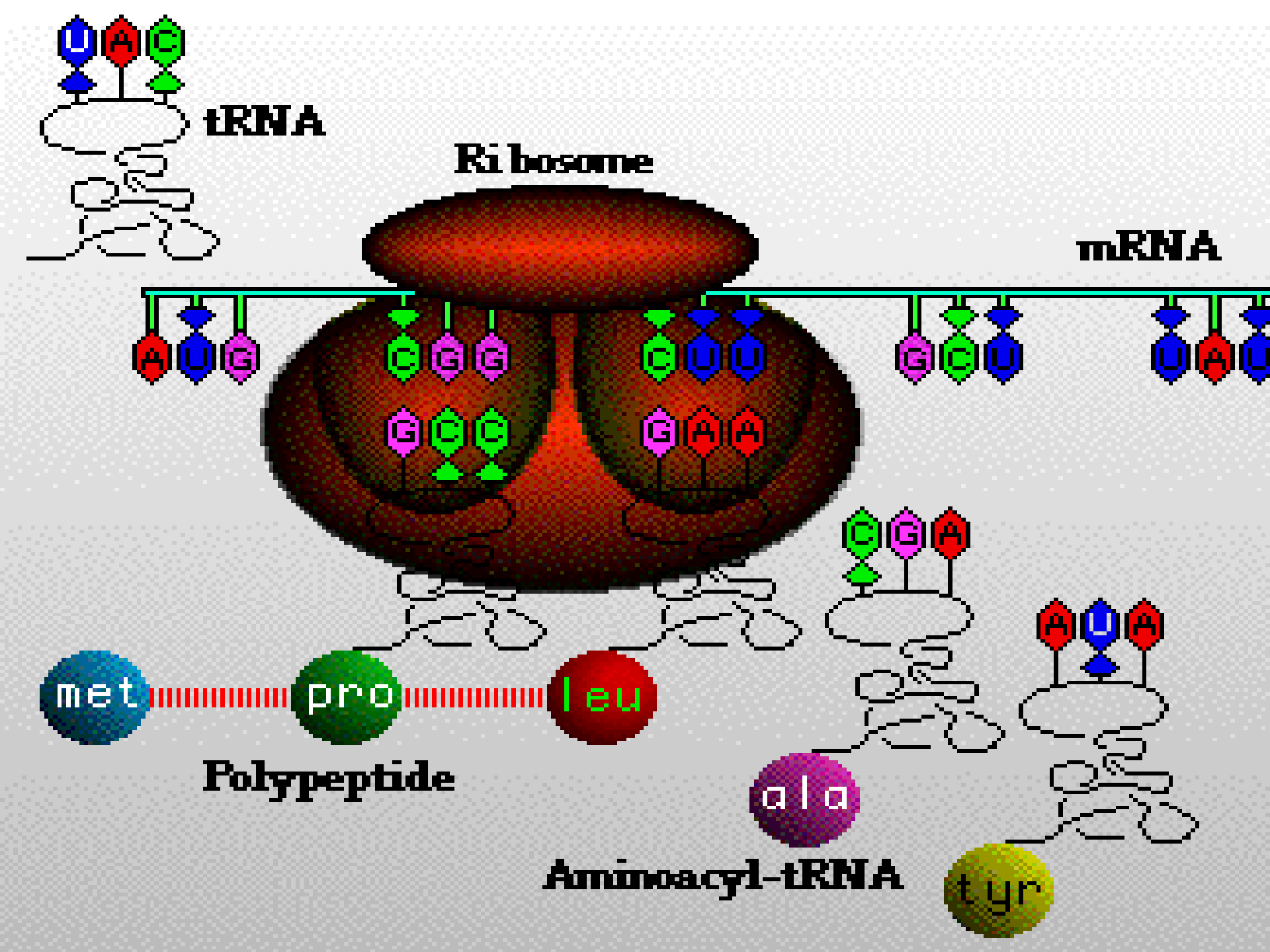
- If the mRNA codon is CCG, then the tRNA anticodon is GGC

mRNA Codon	tRNA Anticodon
UUC	AAG
GGU	CCA
AAU	UUA

- Correct fitting of the codon and anticodon helps insure proper sequence of amino acids in a protein transferring DNA code to RNA

How many bases make up a codon?

*If the messenger RNA codon is GAA, what is the the tRNA anticodon?**


tRNA
Ribosome
mRNA
met
pro
leu
Polypeptide
ala
Aminoacyl-tRNA
tyr

tRNA

Translation continued*

- Each AA attaches to the previous in a continual chain by peptide bonds in the order set out by the mRNA
- The process of bringing the amino acids (AA) by the tRNA to the mRNA and joining them is called translation
- Ribosomes move along messenger RNA and are involved in the translation process

ol

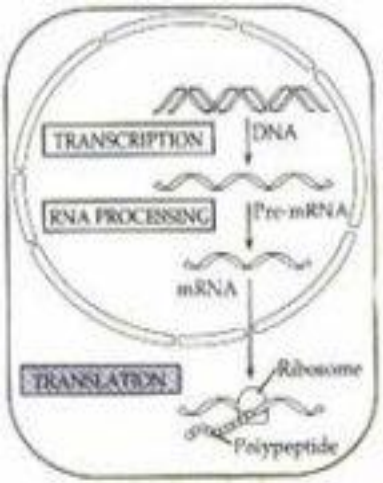
ATP

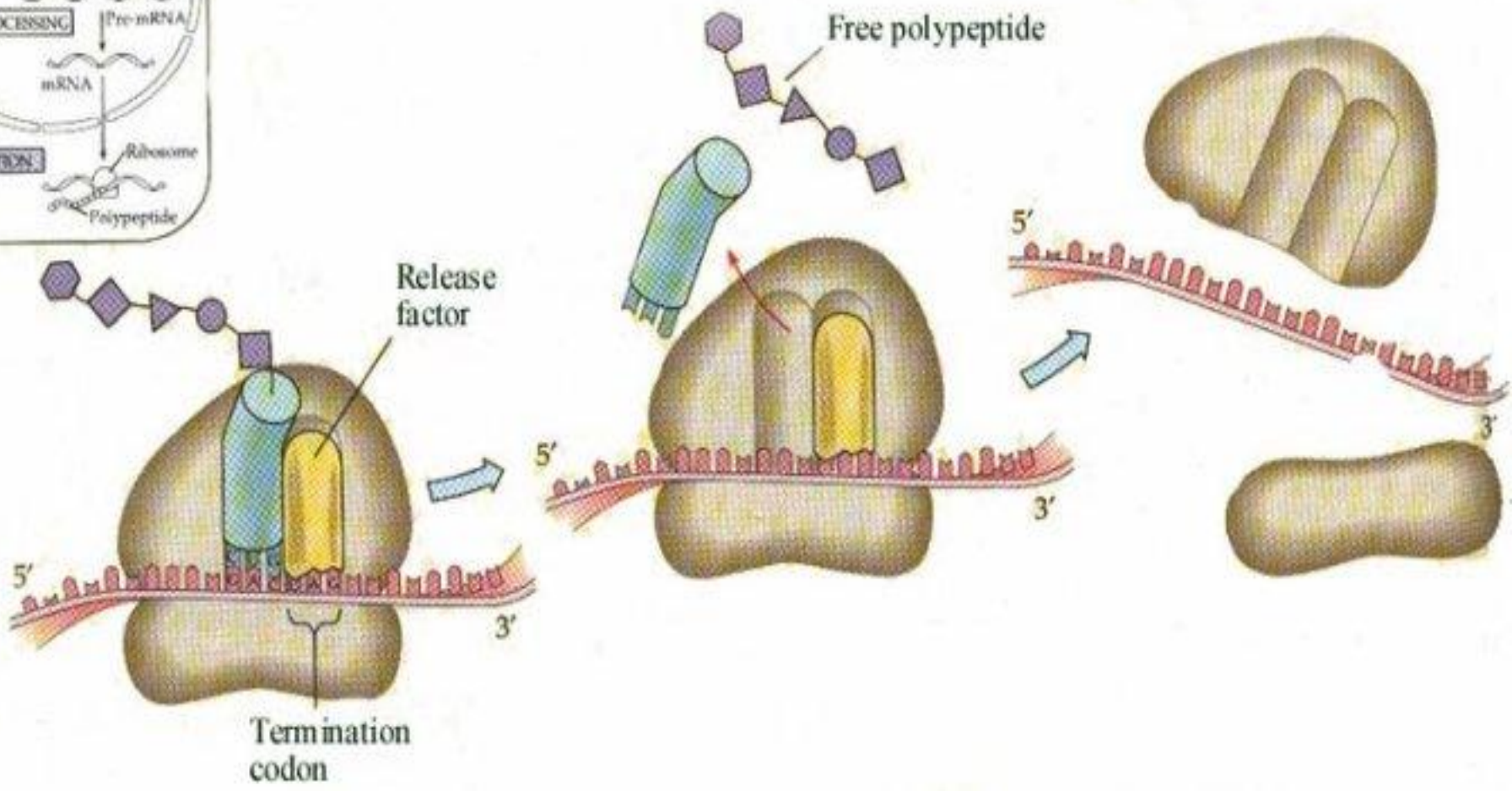
Translation continued *

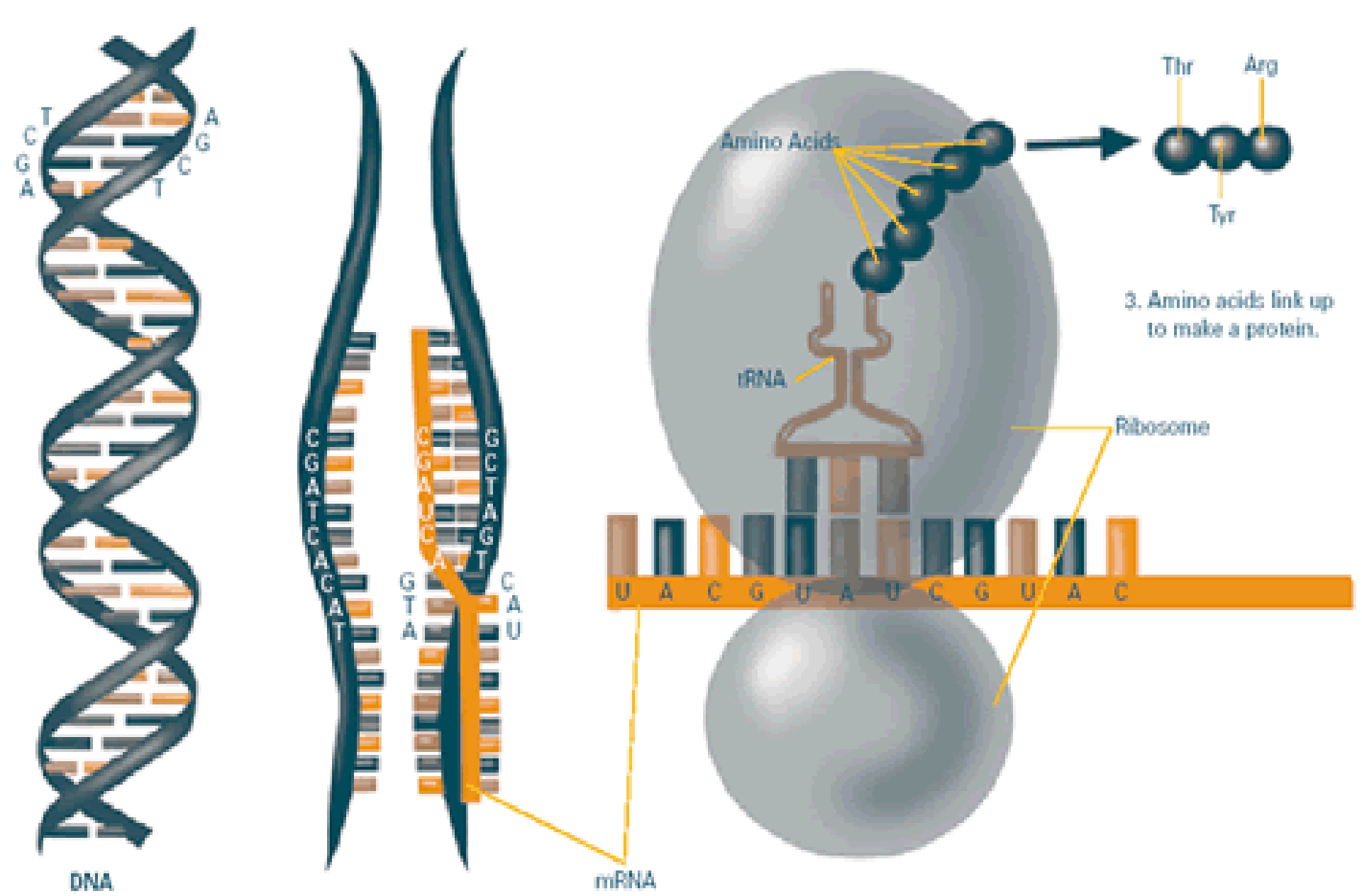
- **Stopping the process**
- **Certain codons stop Protein Synthesis**
  - **UAG, UAA, UGA**
- **No tRNA fit these codons**
- **Several copies of the protein are made, then the mRNA is destroyed**

*What is translation and what molecules are involved, and what is its purpose?**

How are proteins made?*



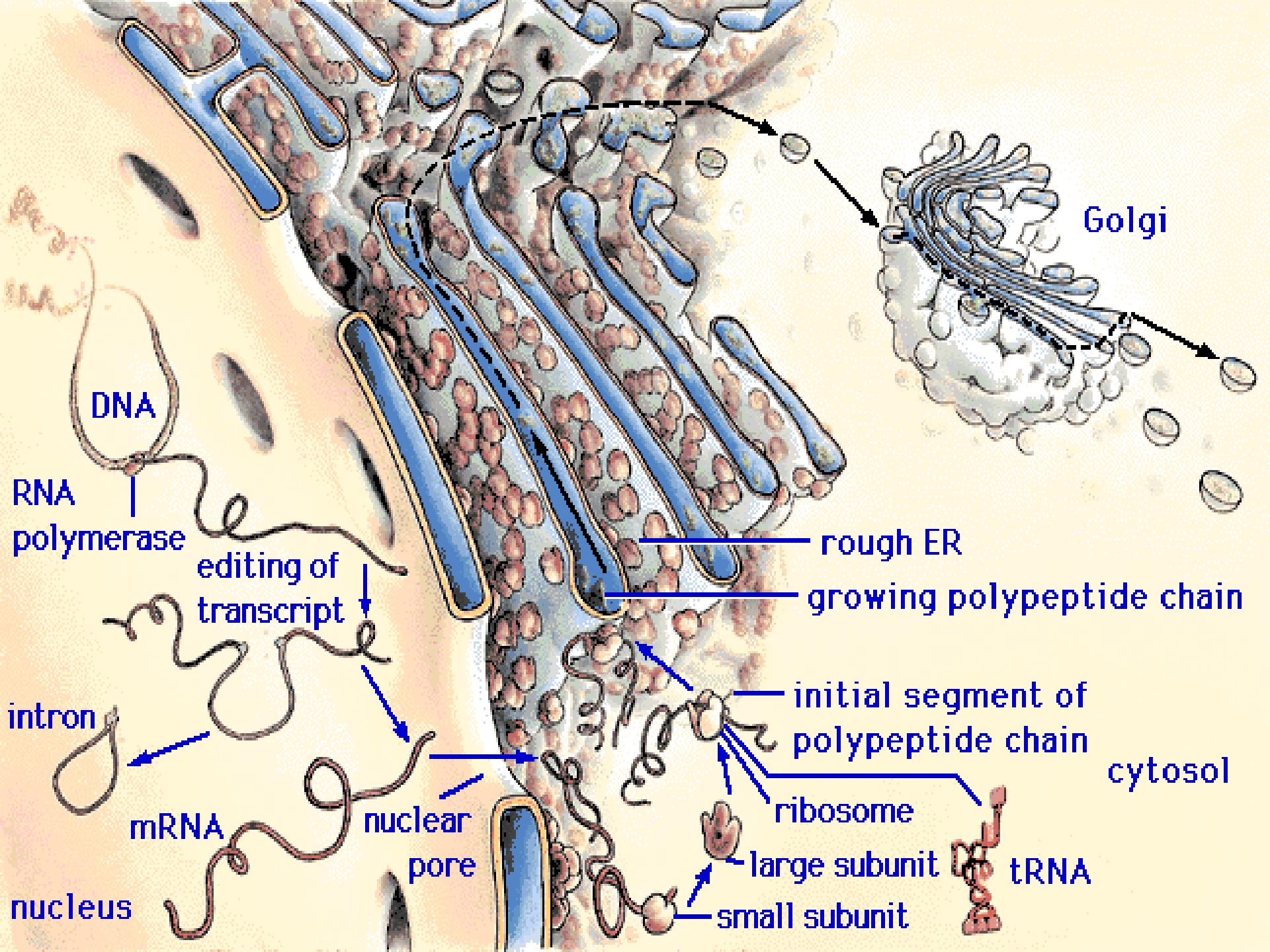


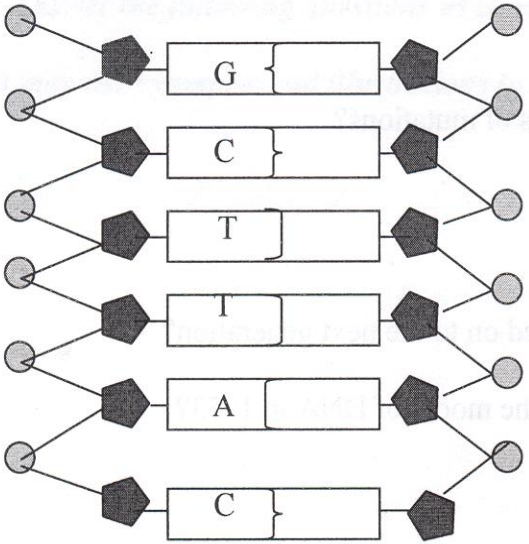


1. Enzymes "copy" DNA to make messenger RNA (mRNA).

2. On ribosomes, transfer RNA (tRNA) helps convert mRNA into protein.

3. Amino acids link up to make a protein.


Golgi
DNA
RNA
polymerase
editing of
transcript
rough ER
growing polypeptide chain
intron
initial segment of
polypeptide chain
cytosol
mRNA
nuclear
pore
ribosome
large subunit
tRNA
small subunit
nucleus



The diagram represents a portion of:

What do the center letter rectangles represent in the diagram?

What do the pentagon shapes represent?

What does the circle that connects the pentagon shapes together represent?

What do the connected circle, pentagon, and rectangle part together represent.

What would be the correct sequence of lettered parts in the missing half of this molecule?

If the molecule portion shown were being transcribed, What would the correct sequence in the mRNA molecules be?

What is the highest possible number of amino acids coded for by the molecule portion shown in the diagram?

Mutations

- Mutations are mistakes in the DNA message or in whole chromosomes
  - Any permanent change in the DNA

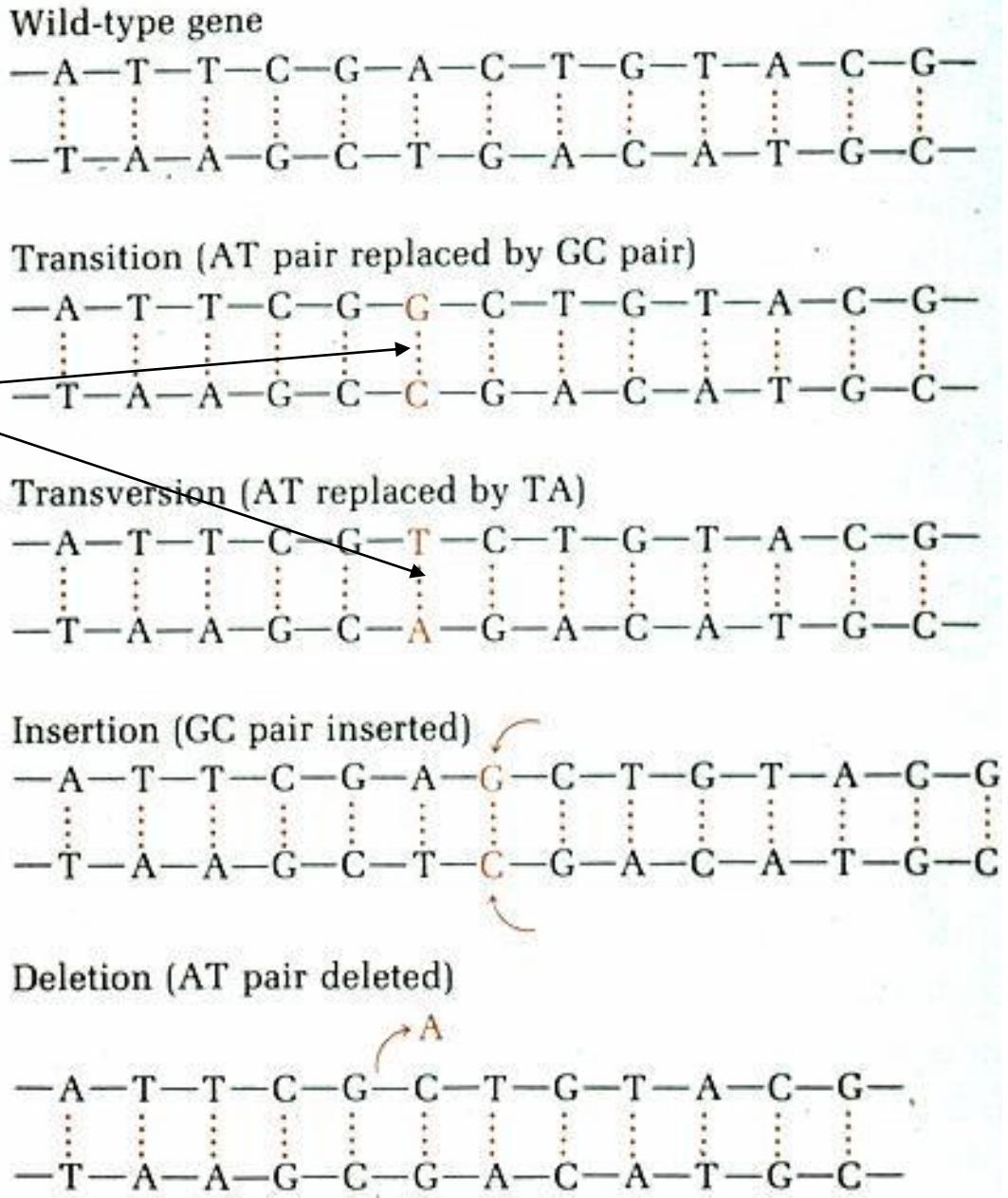
Mutations

- Ways that mutations can occur and result in a abnormality in DNA (genes)
  - Deletion – a nucleotide is left out resulting in different codon sequence and thus an amino acid sequence
  - Insertion – an extra nucleotide is added during replication
  - Point mutation – A base substitution occurs, and one nucleotide is substituted for another (one gene being altered can greatly change the outcome of the gene)

What are the three basic types of mutations at the DNA level? Explain each type.

Point Mutation

Figure 31-23
Types of point mutations.



Structural Abnormalities

Normal

1. Deletion

2. Duplication

Insertion

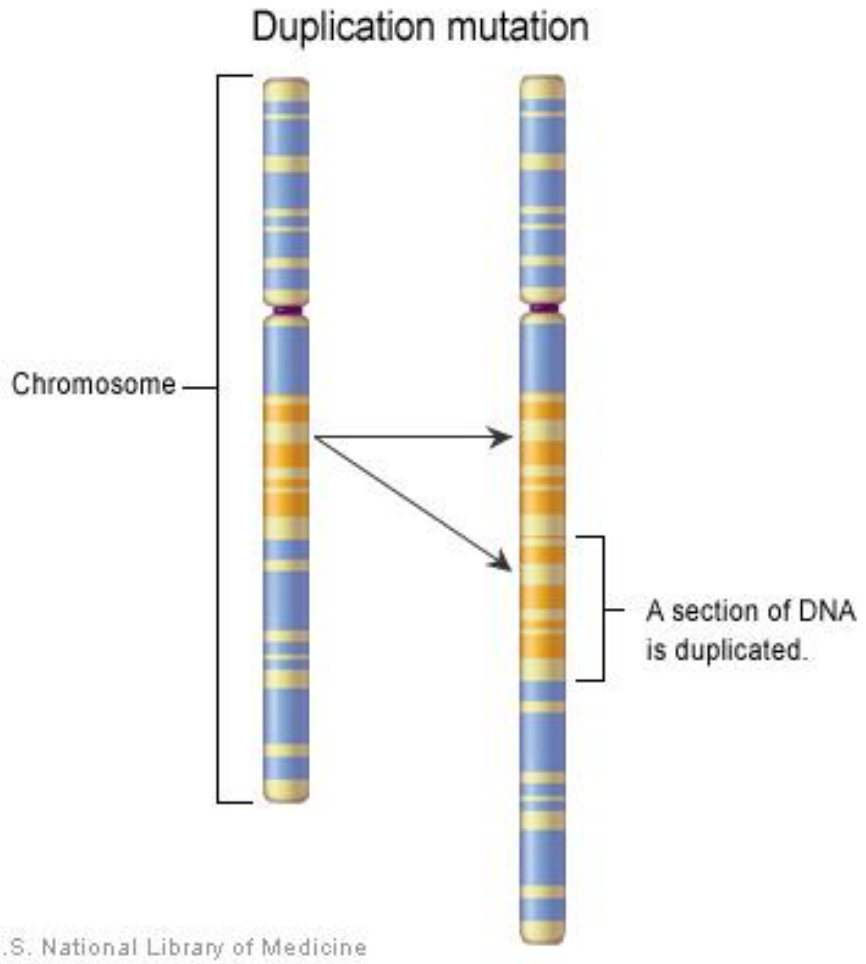
3. Inversion

Point Mutation

4. Translocation

Chromosome mutations

- A part of a chromosome may be dropped off or lost during crossing over
- Chromosomes reattach backwards or upside down
- A pieces of chromosome attaches to the wrong chromosome
- Nondisjunction – gametes with extra or missing chromosomes due to one of the above problems



*How do mutations take place at the Chromosome level?**

Rate of mutations

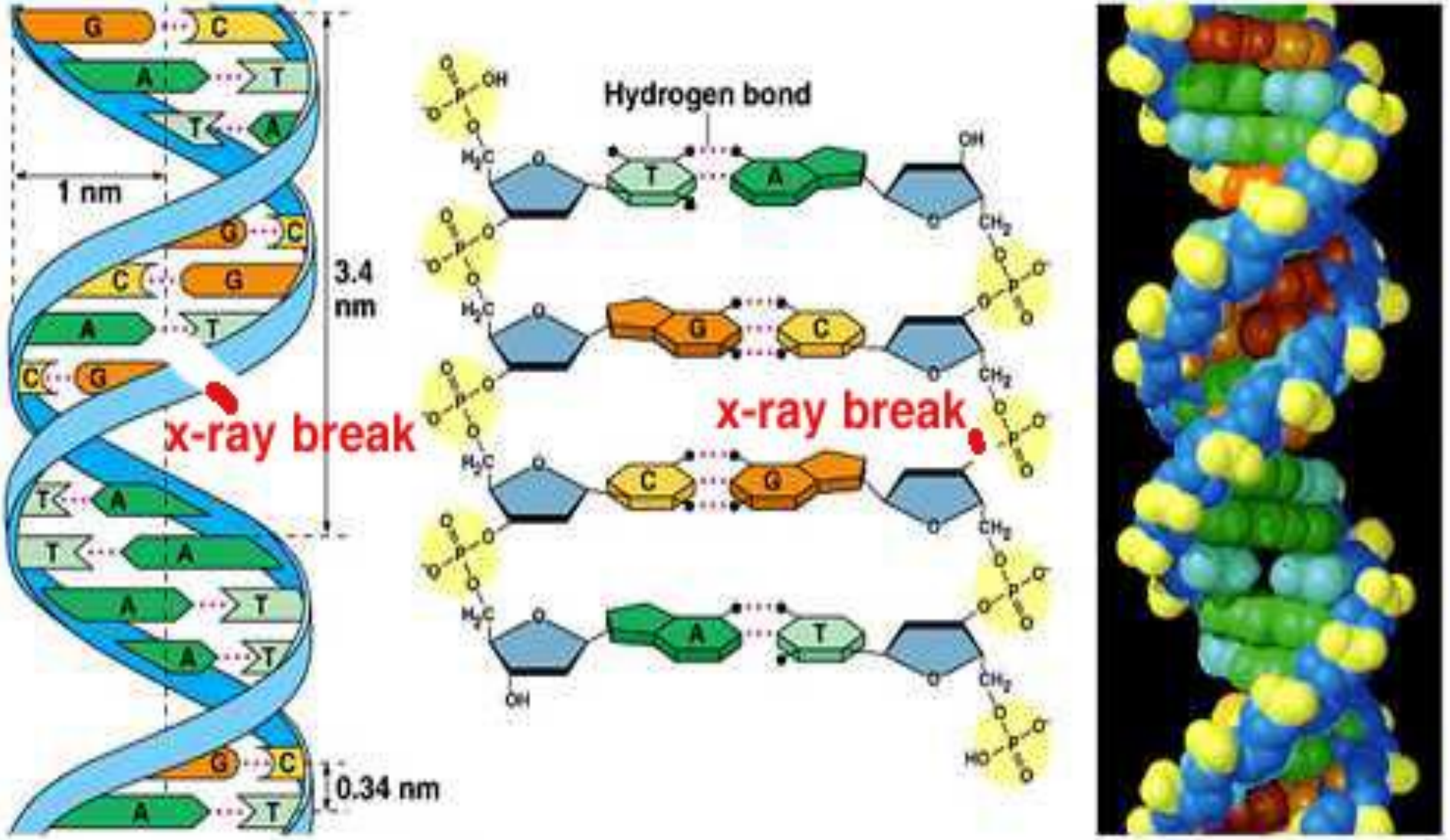
- Radiation and high temperatures are external causes of mutation
- Mutagen – is a mutation causing chemical (carcinogen)
  - Example: formaldehyde
- Lethal mutation – is a mutation that causes death
- Mutations in sex cells can effect the population
- Nonlethal mutation – is a mutation that doesn't cause death to the organism
- A very small percent of these <u>may</u> be beneficial

*What are three external causes of mutations?**

*When can mutations be passed on to the next generation?**

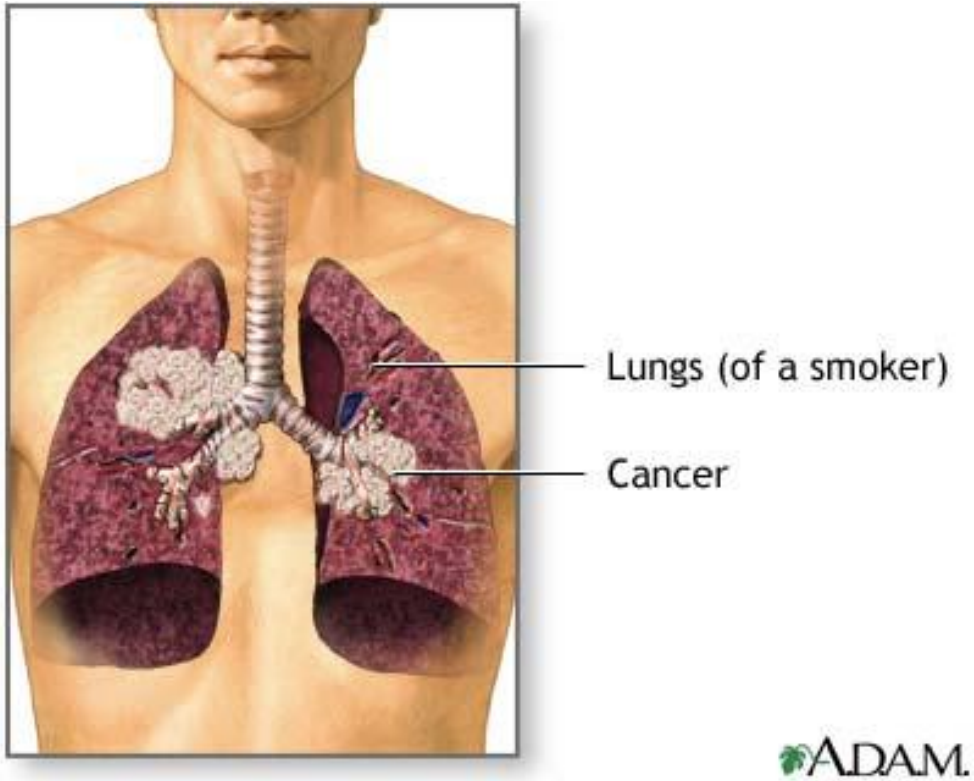
*How do mutagens cause mutations?**

Carcinogens



Cancer

- Cancer is usually the result of mutations of normal chromosomes
- These abnormal cells reproduce making more cells like themselves
- these cells reproduce in an uncontrolled way crowding and starving out other cells
- Malignant means that the cells spread to the rest of the body
- Almost any body cell can become malignant



Causes of Cancer

- What causes normal genes to become malignant
- Mutant forms of genes result in abnormal proteins that disrupt the normal growth and reproduction patterns of cells.
- Such cancer causing genes are called oncogenes
  - Some oncogenes are inherited
  - Some oncogenes are transferred by a virus
  - Some oncogenes are the result of normal genes (proto-oncogenes) mutating

Cancer

- The changing over of normal genes to cancerous genes is many times caused by carcinogens (cancer causing chemicals) or harmful radiation
- How oncogenes disrupt growth and development of cells
  - code for abnormal growth factors
  - Some produce defective receptors, preventing signals from being received by cells
    - These set off a series of reactions within cells.
  - some code for defective enzymes so that proper reactions don't proceed properly
  - Some prevent timely transcription

*What is the name of a chemical that can cause cancer?**

DNA outside the nucleus

- In Eukaryotic cells mitochondria & chloroplasts contain DNA
- Organelle DNA – also have mRNA, tRNA & rRNA
- Reproduce on there own
- Technology of recombinant DNA p 68 & 269

*What is recombinant DNA?**

*How much genetic engineering do you believe should be done to make crops more pest, weed of herbicide tolerate, and are there any negative side effects of genetic engineering?**

Quiz

1. *What is the name of a chemical that can cause cancer?*
2. *What are the three basic types of mutations at the DNA level? Explain each type.*
3. *What are three external causes of mutations?*
4. *When can mutations be passed on to the next generation?*
5. *How do mutagens cause mutations?*
6. *Explain 3 differences between DNA & RNA.*