Can *anything* evolve by Natural Selection?

Heredity

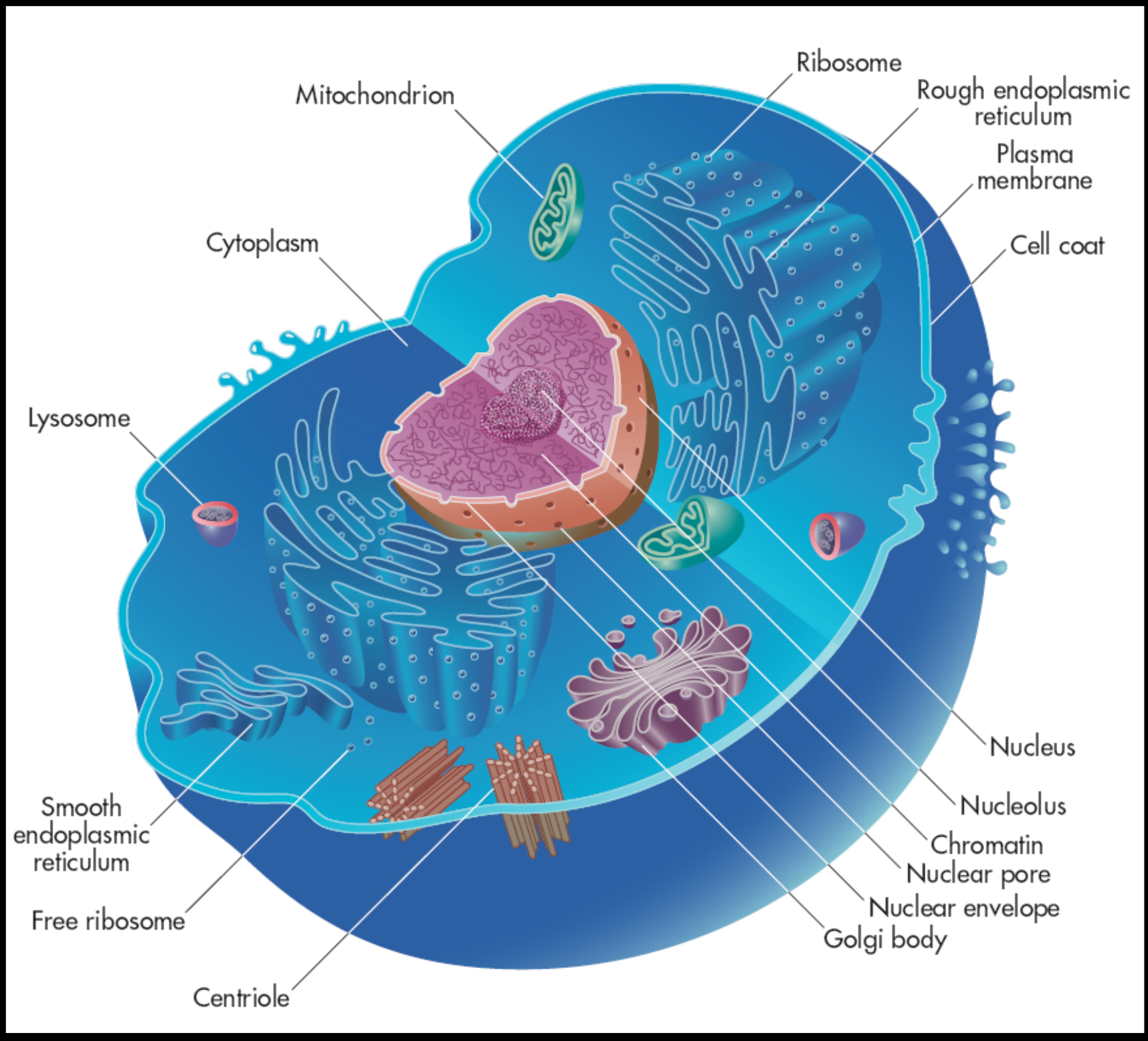
- What is a phenotype? What is a genotype?
- How are phenotypes created?
- What are the relative influences of genetics and environment on phenotype?

DNA

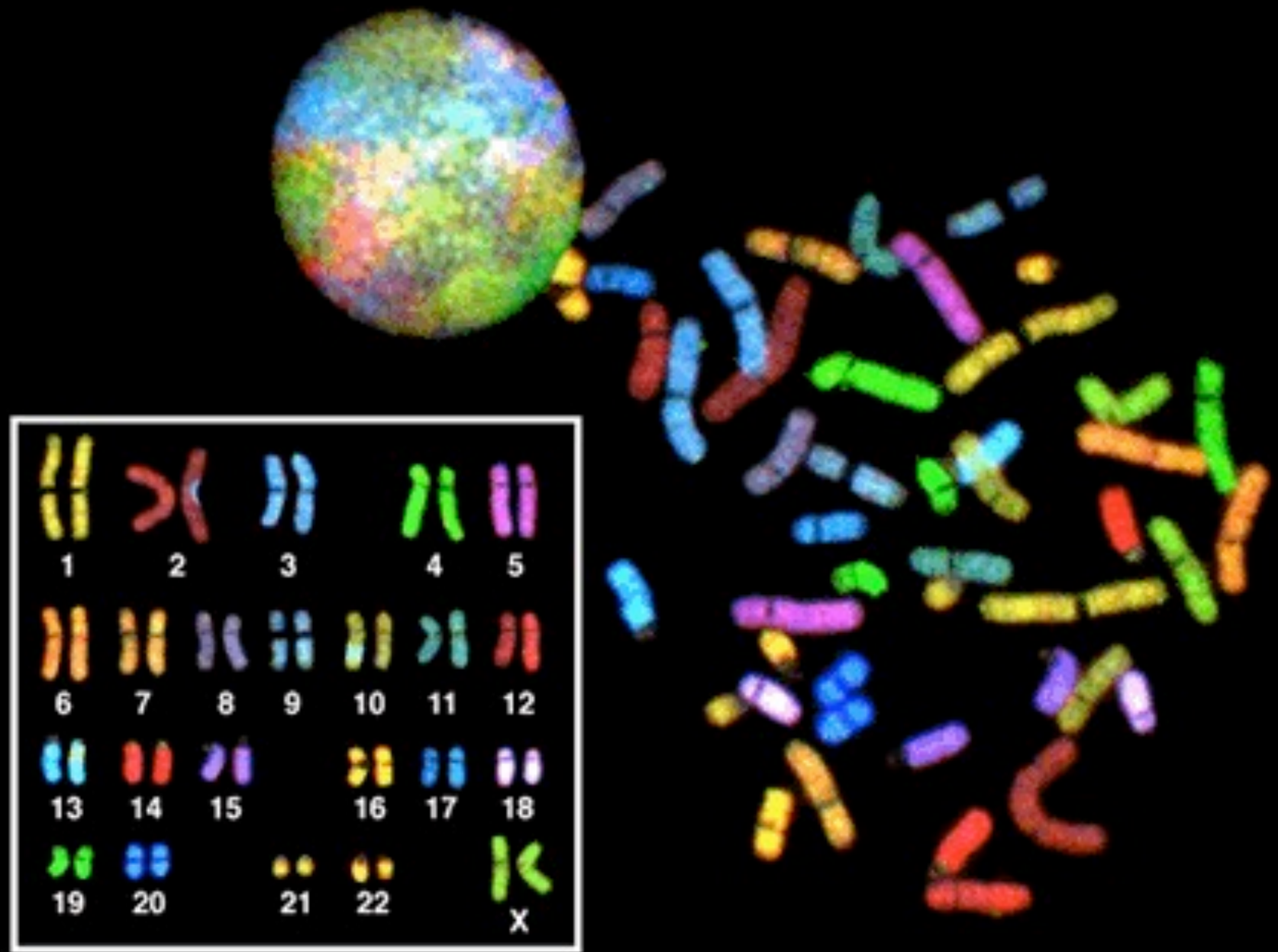
- What is DNA?
    - What is its shape? Why is the shape important?
- Where is it found?
- What does it do?

3 Part question

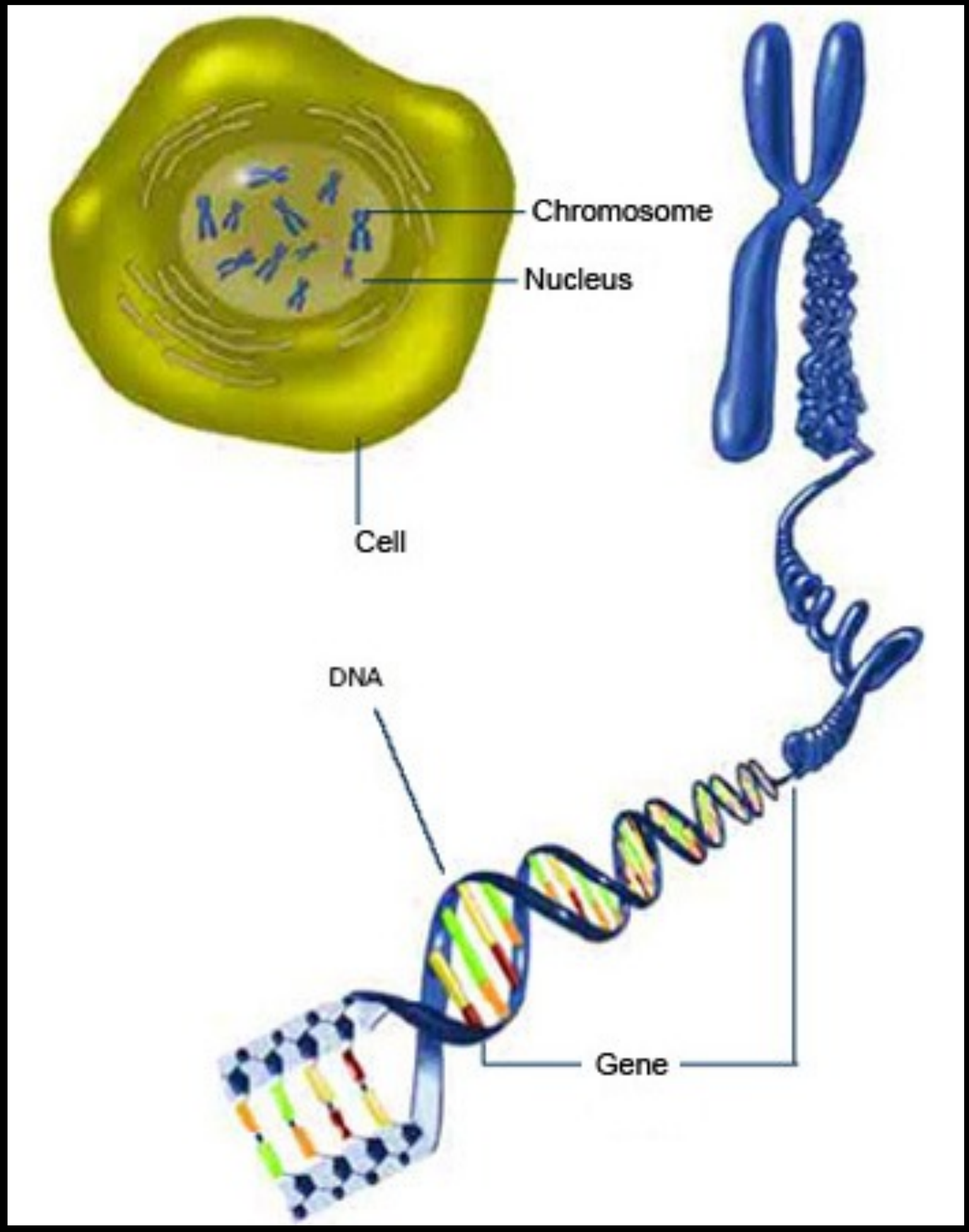
- How does the genetic code create a characteristic?
- How come we resemble our parents? That is, how is our heritable information passed from generation to generation?
- Where does variation in the code come from?


Ribosome
Mitochondrion
Rough endoplasmic reticulum
Plasma membrane
Cytoplasm
Cell coat
Lysosome
Nucleus
Nucleolus
Chromatin
Nuclear pore
Nuclear envelope
Golgi body
Smooth endoplasmic reticulum
Free ribosome
Centriole

Human DNA in Chromosomes

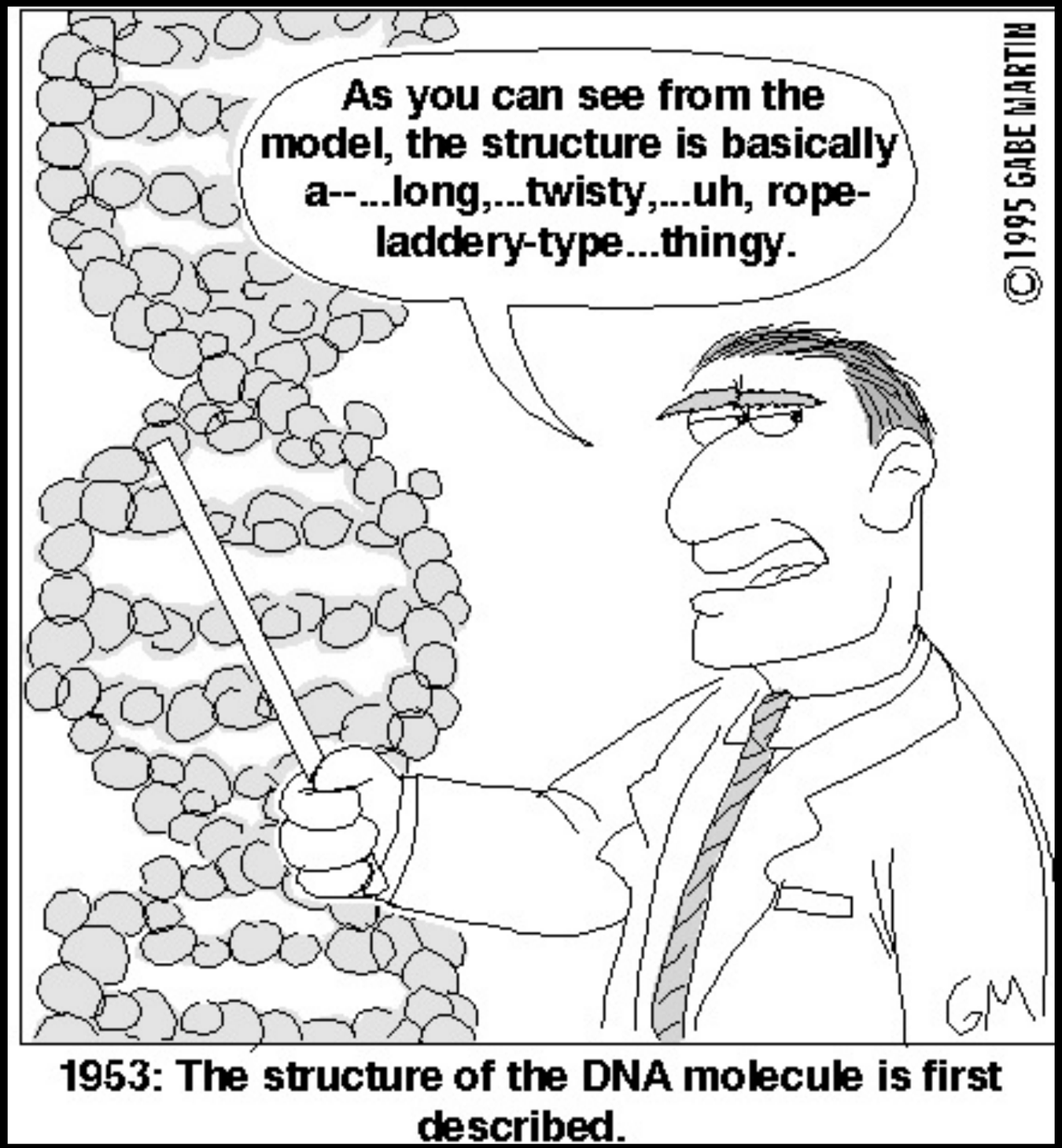


Chromosomes are DNA



DNA

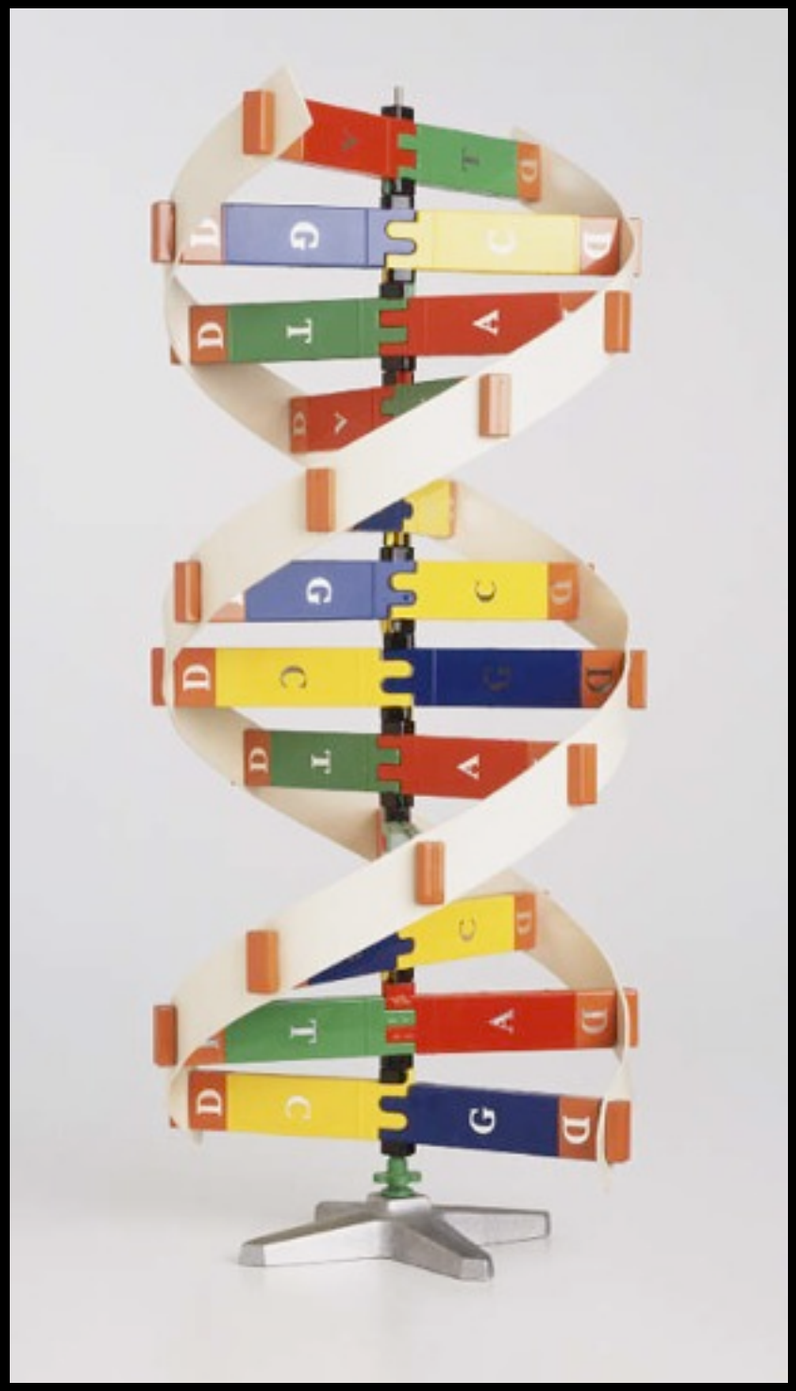
- A SEGMENT OF DNA is a particle of inheritance
- All scrunched up in nucleus – supercoiled into tiny packs
- Forms the Chromosomes
- Really long! Haploid genome of one gamete = about 1 meter
- Double helix



1953: The structure of the DNA molecule is first described.

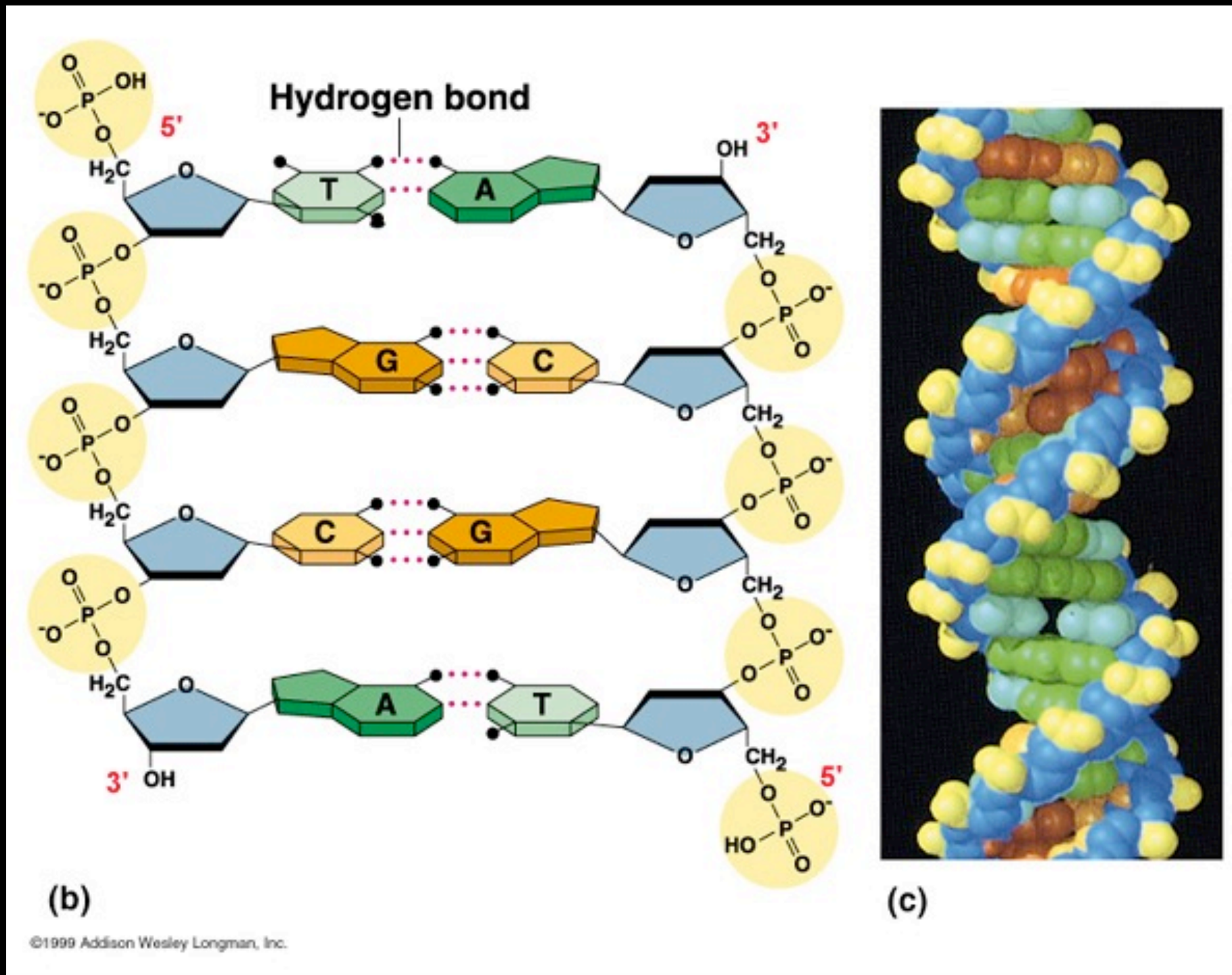
DNA made of 4 bases

- Adenine
- Guanine
- Cytosine
- Thymine



A--T
G--C

DNA structure

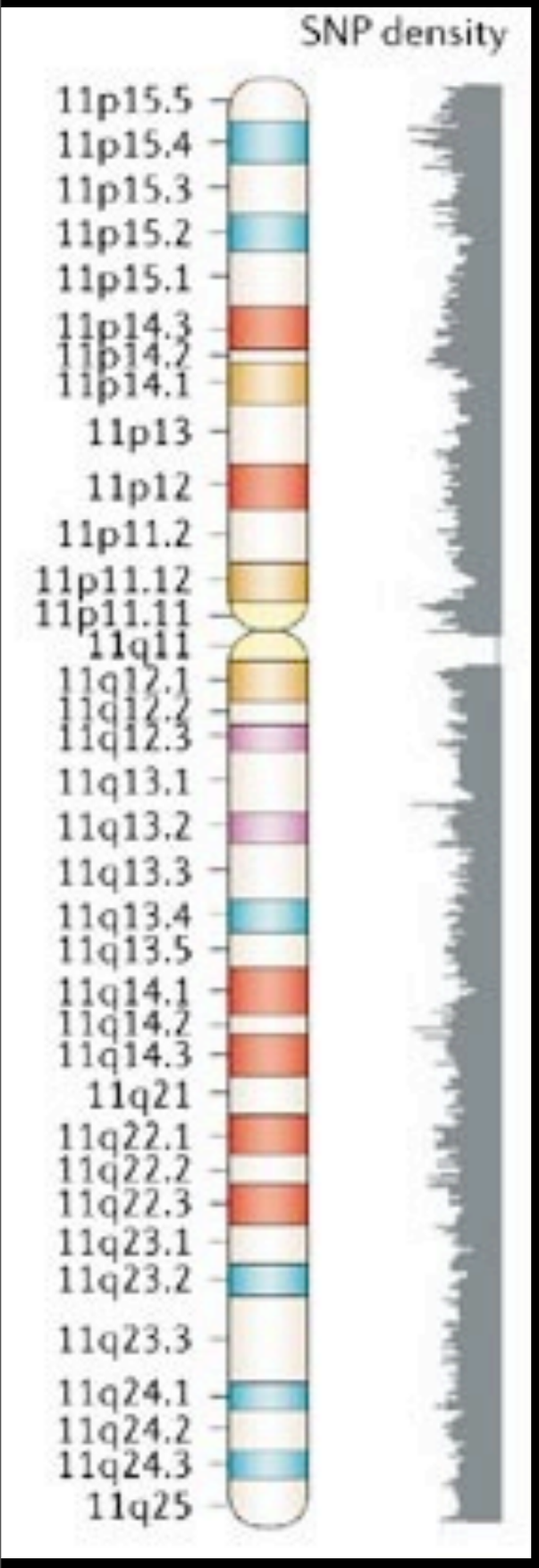


Particle of Inheritance?

- A segment of a chromosome
- A segment of DNA
- A series of bases
- A gene
- An allele
- A segment of DNA with a particular job

DNA's Job

- DNA carries the code for making proteins
- Proteins are the building blocks of the body
- What proteins you make or don't make determines your phenotype
- Different sequences can create different proteins and therefore different phenotypes



Example: Sickle Cell Anemia

- part of 11p15.5 makes hemoglobin B
- "normal" 11p15.5 makes "normal" hemoglobin
- sickle cell results from a different sequence

Examples

- Provide structural support (collagen)
- Regulate metabolic processes (digestion, body temperature, melanin production, etc)
- Influence gene expression: hormones, enzymes
- Regulatory genes

Proteins

- Made of amino acids
- 20 amino acids
- Different combinations and lengths for different proteins
- Insulin = 51 AA long; Hb = 574 AA

How does DNA make a protein?

Has to give the instructions on how to build the amino acid chain

Gives the order of amino acids

Sequence of bases gives sequence of amino acids

TABLE 3–1 The Genetic Code

AMINO ACID SYMBOL	AMINO ACID	DNA TRIPLET	mRNA CODON
Ala	Alanine	CGA, CGG, CGT, CGC	GCU, GCC, GCA, GCG
Arg	Arginine	GCA, GCG, GCT, GCC, TCT, TCC	CGU, CGC, CGA, CGG, AGA, AGG
Asn	Asparagine	TTA, TTG	AAU, AAC
Asp	Aspartic acid	CTA, CTG	GAU, GAC
Cys	Cysteine	ACA, ACG	UGU, UGC
Gln	Glutamine	GTT, GTC	CAA, CAG
Glu	Glutamic acid	CTT, CTC	GAA, GAG
Gly	Glycine	CCA, CCG, CCT, CCC	GGU, GGC, GGA, GGG
His	Histidine	GTA, GTG	CAU, CAC
Ile	Isoleucine	TAA, TAG, TAT	AUU, AUC, AUA
Leu	Leucine	AAT, AAC, GAA, GAG, GAT, GAC	UUA, UUG, CUU, CUC, CUA, CUG
Lys	Lysine	TTT, TTC	AAA, AAG
Met	Methionine	TAC	AUG
Phe	Phenylalanine	AAA, AAG	UUU, UUC
Pro	Proline	GGA, GGG, GGT, GGC	CCU, CCC, CCA, CCG
Ser	Serine	AGA, AGG, AGT, AGC, TCA, TCG	UCU, UCC, UCA, UCG, AGU, AGC
Thr	Threonine	TGA, TGG, TGT, TGC	ACU, ACC, ACA, ACG
Trp	Tryptophan	ACC	UGG
Tyr	Tyrosine	ATA, ATG	UAU, UAC
Val	Valine	CAA, CAG, CAT, CAC	GUU, GUC, GUA, GUG
Terminating triplets		ATT, ATC, ACT	UAA, UAG, UGA

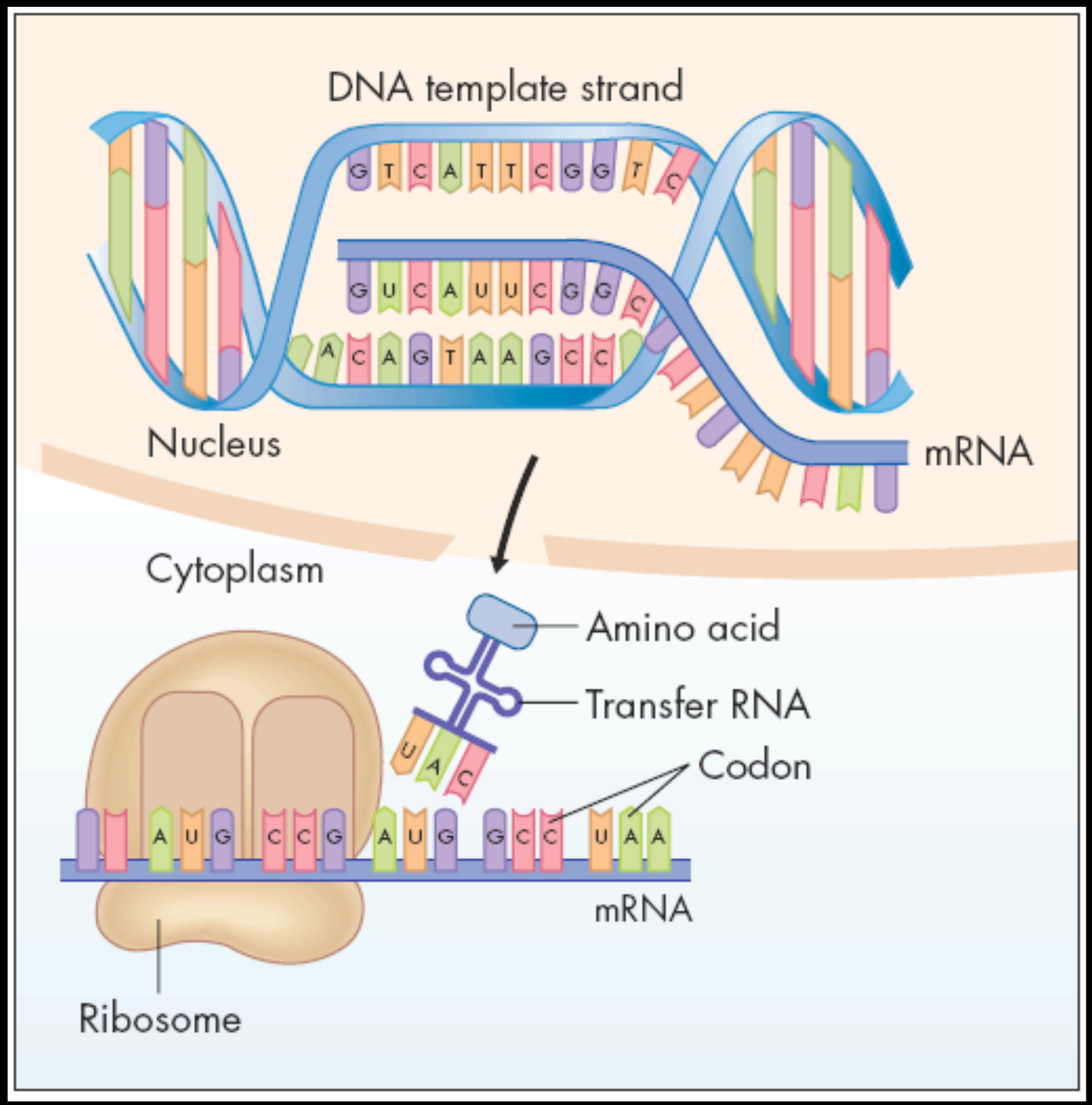
DNA is

- Universal
- Triplet
- Redundant

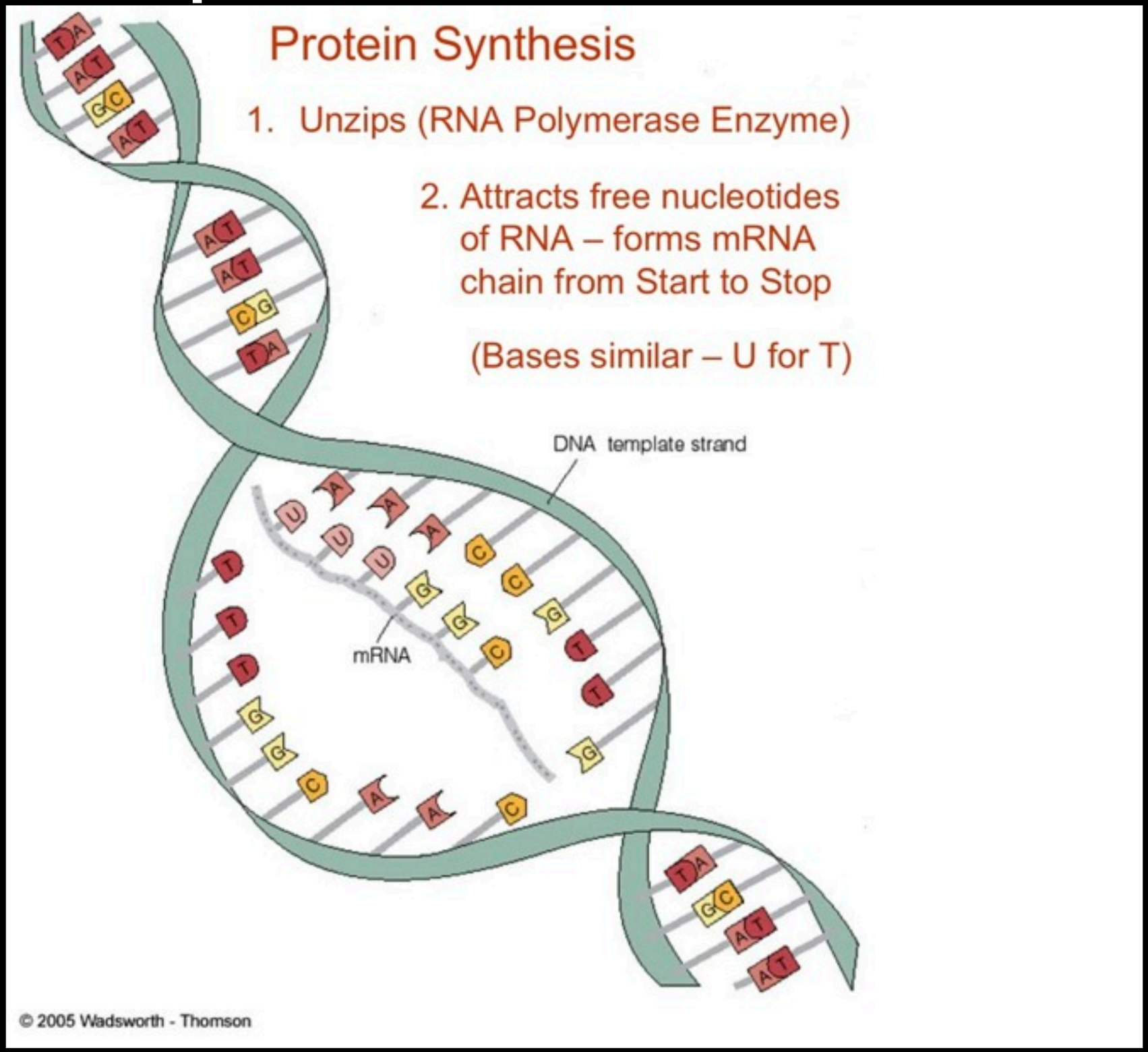
Protein synthesis

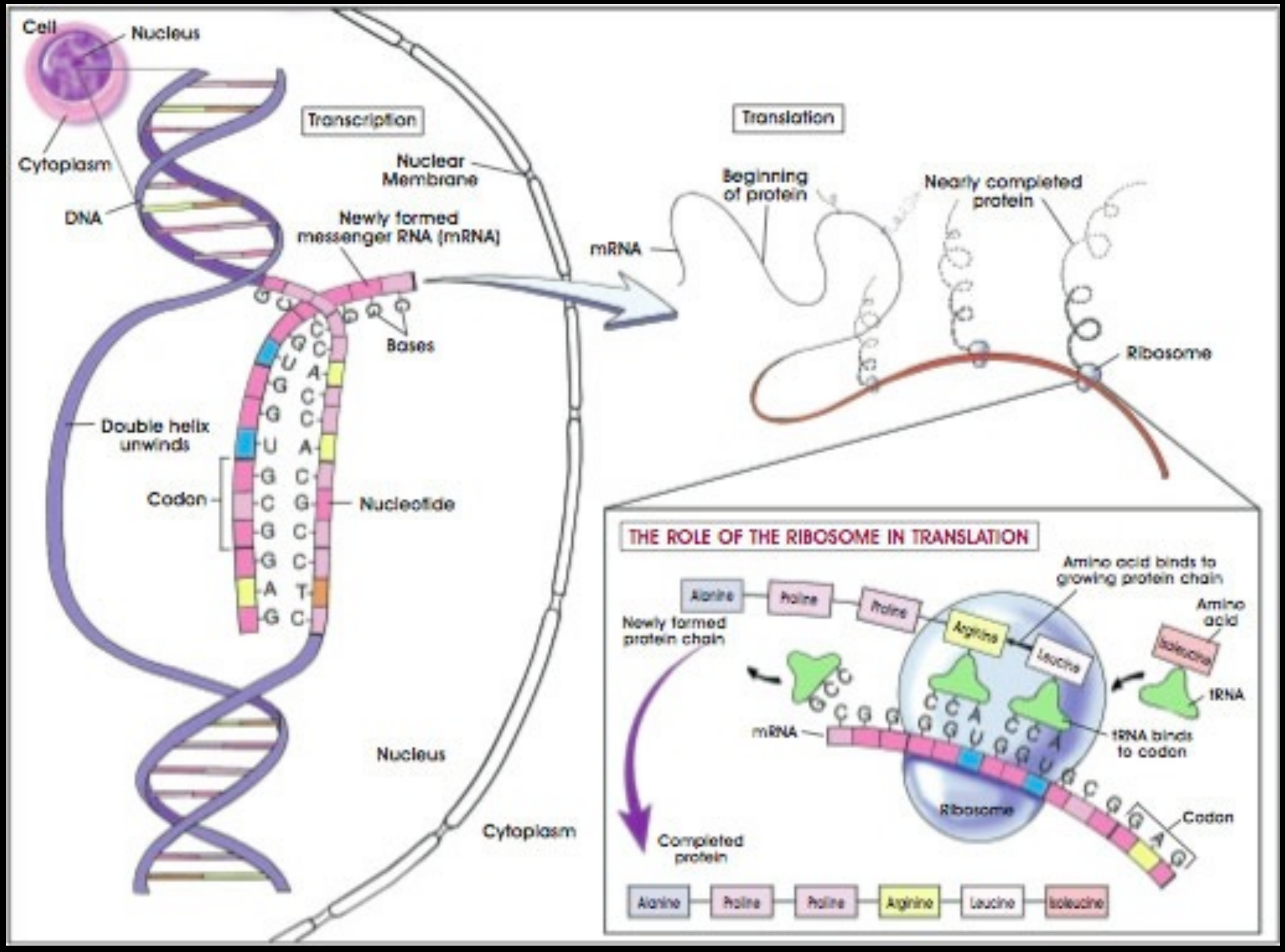
- TRANSCRIPTION - the copying of DNA by mRNA
- TRANSLATION - the meeting of mRNA and tRNA to translate the base sequence into a chain of amino acids

Protein Synthesis

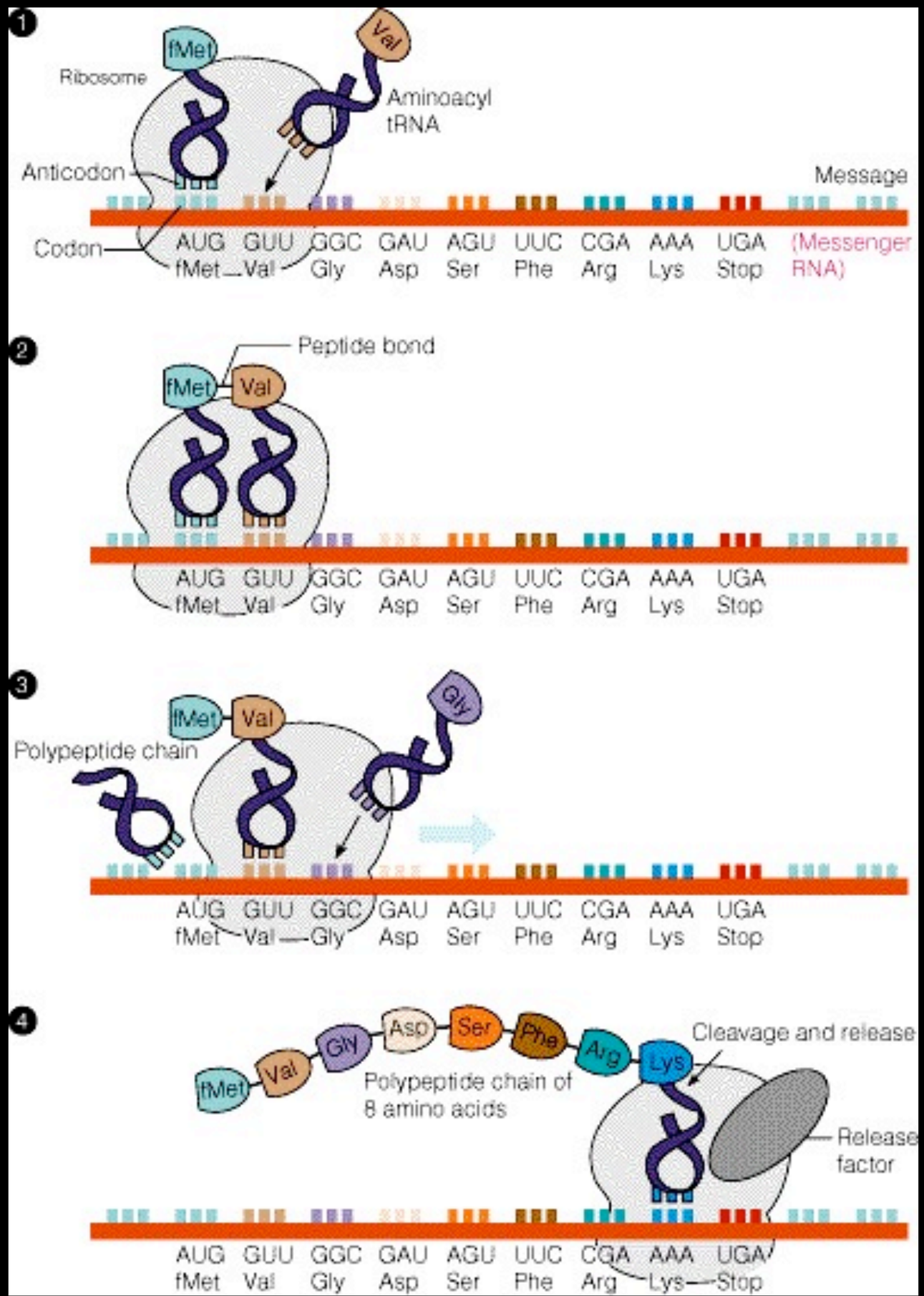


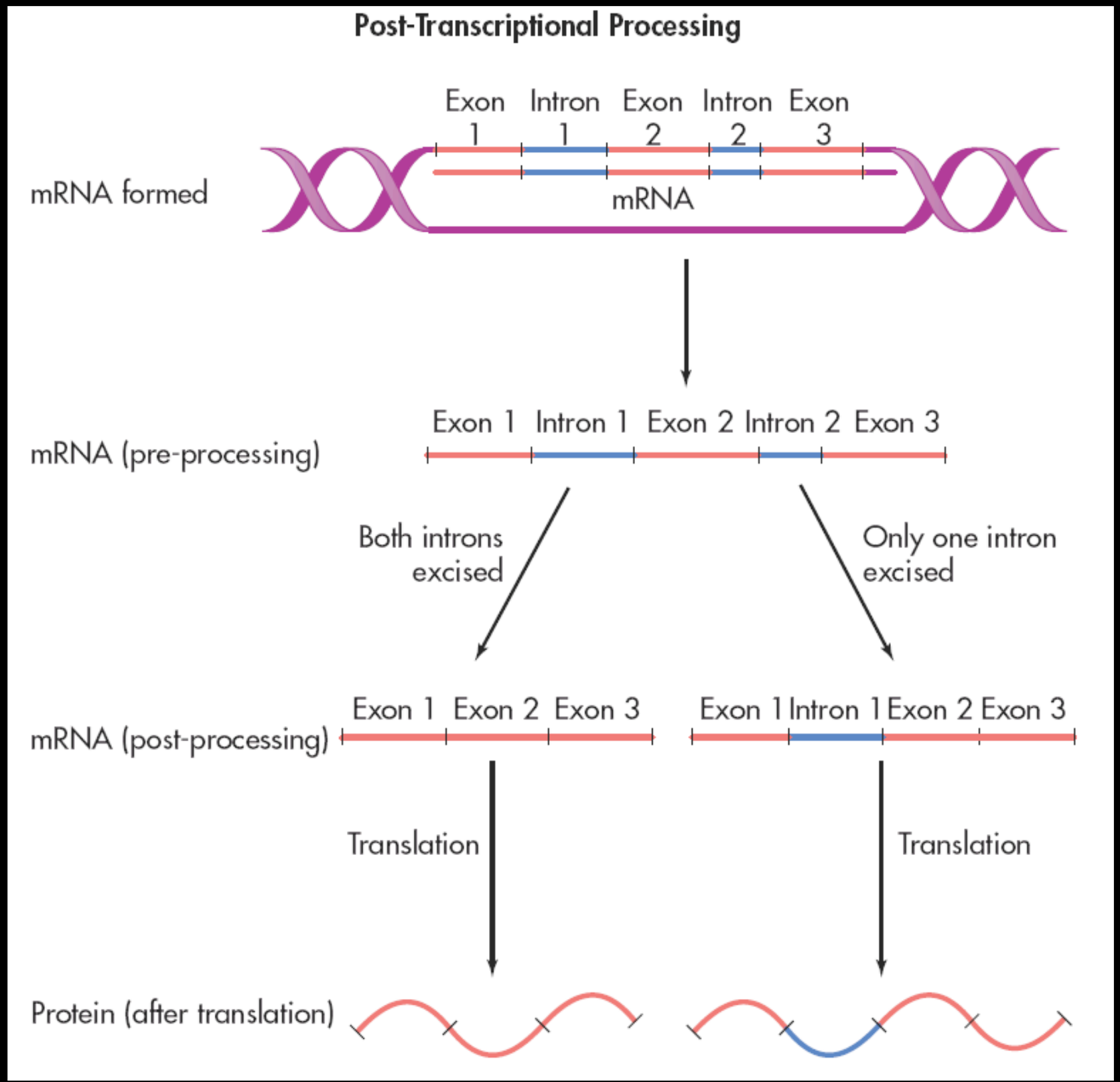
Transcription




Cell
Nucleus
Cytoplasm
DNA
Transcription
Nuclear Membrane
Newly formed messenger RNA (mRNA)
Bases
Double helix unwinds
Codon
Nucleotide
Nucleus
Cytoplasm
Translation
mRNA
Beginning of protein
Nearly completed protein
Ribosome
THE ROLE OF THE RIBOSOME IN TRANSLATION
Amino acid binds to growing protein chain
Alanine
Proline
Proline
Arginine
Leucine
Amino acid
Isoleucine
tRNA
Newly formed protein chain
mRNA
tRNA binds to codon
Ribosome
Codon
Completed protein
Alanine
Proline
Proline
Arginine
Leucine
Isoleucine

Translation




Post-Transcriptional Processing
Exon 1
Intron 1
Exon 2
Intron 2
Exon 3
mRNA formed
mRNA
mRNA (pre-processing)
Exon 1 Intron 1 Exon 2 Intron 2 Exon 3
Both introns excised
Only one intron excised
mRNA (post-processing)
Exon 1 Exon 2 Exon 3
Exon 1 Intron 1 Exon 2 Exon 3
Translation
Translation
Protein (after translation)

(a)

Peptide bonds

Amino acids

(b)

Hydrogen bonds

Pleated sheet

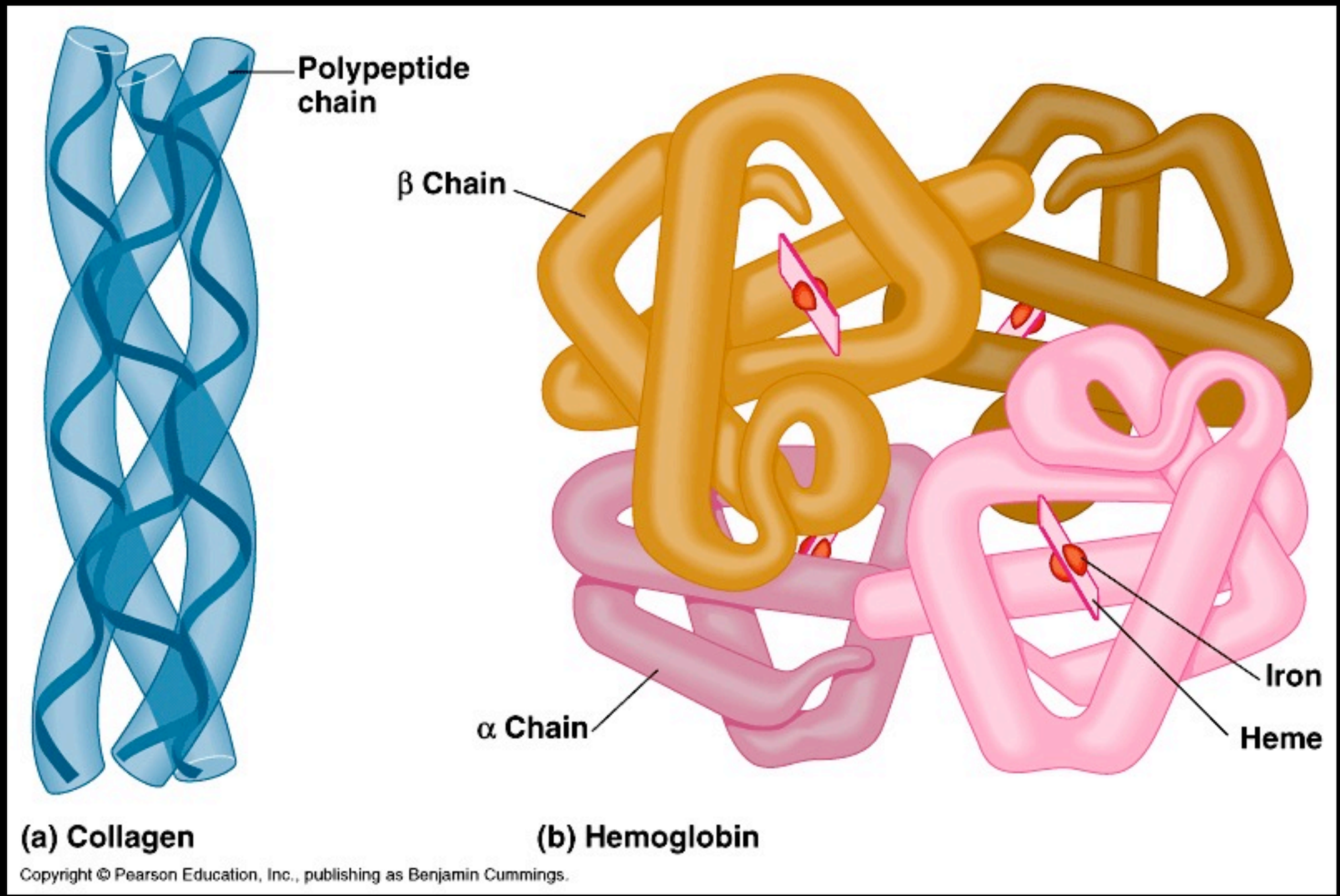
Alpha helix

Random coil

(c)

(d)

Protein composed of four identical subunits



3 Part question

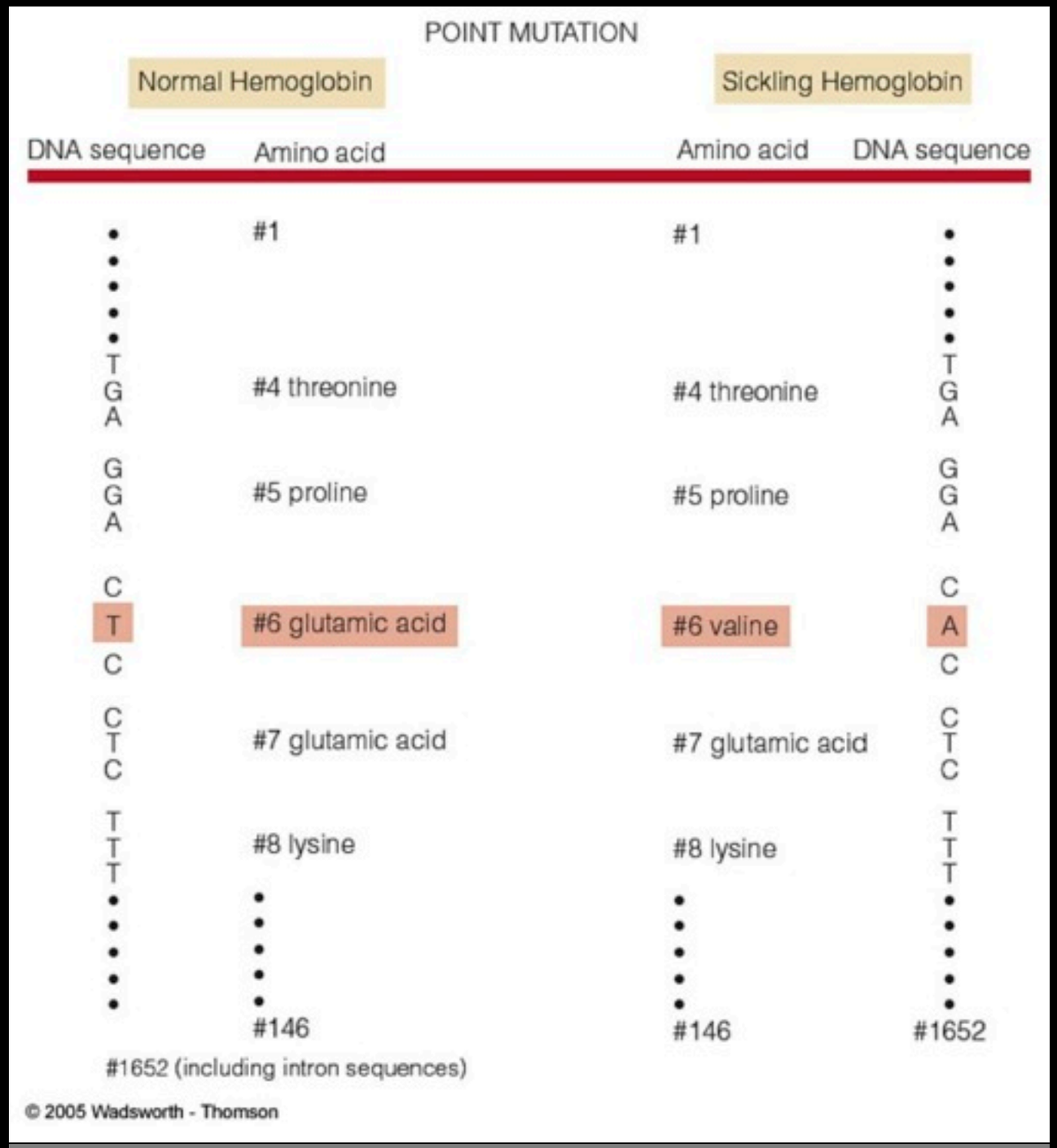
- How does the genetic code create a characteristic?
- Where does variation in the code come from?
- How come we resemble our parents? That is, how is our heritable information passed from generation to generation?

This is how a protein is created --
But this is only the start

We don't just have one copy of a gene, we have two, and we have to know

- How do these two copies combine to create a phenotype?
- How do we get our two copies?
- How is variation produced?

Example: Sickle Cell



Example: Blood Type

- ABO
- A creates an antigen on the blood, which will result in antibodies against B
- B creates an antigen on the blood, which will create antibodies against A
- O creates no antigens - but will create antibodies against both
- AB creates both antigens, and therefore no antibodies

Example: Eye Color

- actually created by pigment genes at at least 3 locales
- Blue eyes are due to the lack of other pigmentation
- One allele makes nothing, others make pigmentation.