DNA, Chromosomes, and Genes

DNA Structure

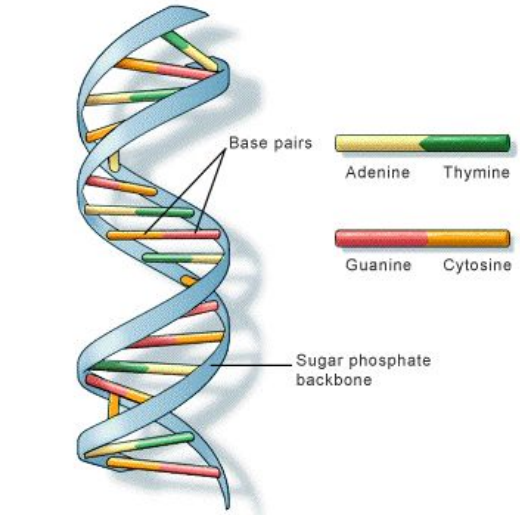
DNA = Deoxyribonucleic Acid

Shape: Double Helix

Backbone made from sugar and phosphate

Rungs of ladder made of nitrogen bases

Pairing: A-T, C-G



U.S. National Library of Medicine

DNA Function

The DNA molecule is a “recipe book” that has all the instructions for structure and function of an organism

Each “recipe” is called a **gene** - one segment of DNA that codes for a specific trait

- Ex. You have genes that code for your hair colour, eye colour, and what enzymes your cells make

DNA Code

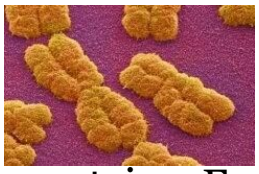
3 nitrogen bases together are a code for a single amino acid

Many amino acids connected together make a protein

Proteins act as structural components of an organism and are enzymes that help the chemical reactions necessary to function.

The code to make an entire protein = **a gene**

Chromosomes

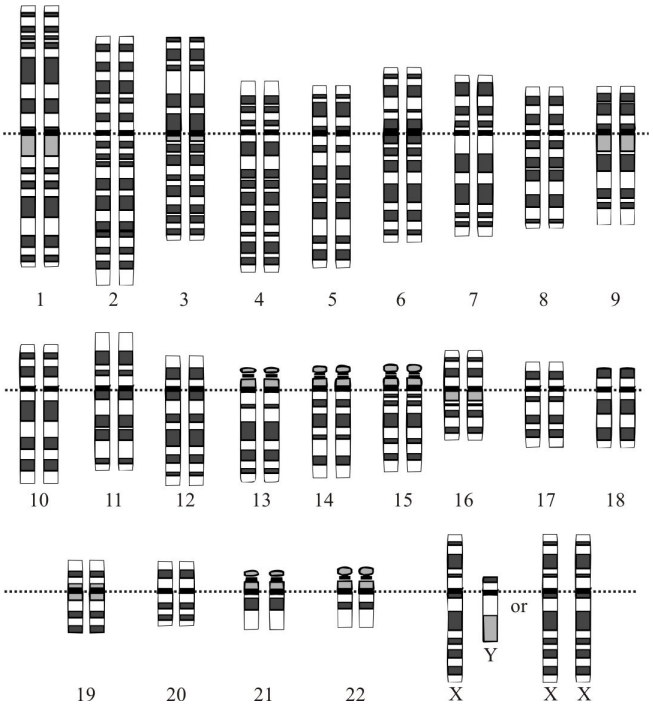


DNA is supercoiled and packaged up with proteins. Each DNA package is called a **chromosome**

Humans are **diploid** - have 2 copies every gene; one from our mother and one from our father.

Humans have **46** chromosomes or **23** matching pairs of chromosomes in every body cell.

- Sex cells (eggs and sperm) have only **23** chromosomes or one of each gene



DNA to Protein Sequence

Use the following chart to translate the given DNA code to the amino acid sequence in a protein. When you reach the **stop codon**, stop translating.

DNA Sequence:

ATGACTCCCACCAATGGTGGAGAACATTAACAC

Amino Acid Sequence:

_____

first base in codon	second base in codon: T	C	A	G	third base in codon
T	TTT Phe	TCT Ser	TAT Tyr	TGT Cys	T
	TTC Phe	TCC Ser	TAC Tyr	TGC Cys	C
	TTA Leu	TCA Ser	TAA stop	TGA stop	A
	TTG Leu	TCG Ser	TAG stop	TGG Trp	G
C	CTT Leu	CCT Pro	CAT His	CGT Arg	T
	CTC Leu	CCC Pro	CAC His	CGC Arg	C
	CTA Leu	CCA Pro	CAA Gln	CGA Arg	A
	CTG Leu	CCG Pro	CAG Gln	CGG Arg	G
A	ATT Ile	ACT Thr	AAT Asn	AGT Ser	T
	ATC Ile	ACC Thr	AAC Asn	AGC Ser	C
	ATA Ile	ACA Thr	AAA Lys	AGA Arg	A
	ATG Met	ACG Thr	AAG Lys	AGG Arg	G
G	GTT Val	GCT Ala	GAT Asp	GGT Gly	T
	GTC Val	GCC Ala	GAC Asp	GGC Gly	C
	GTA Val	GCA Ala	GAA Glu	GGA Gly	A
	GTG Val	GCG Ala	GAG Glu	GGG Gly	G

ANSWER

ATG ACT CCC ACC AAT GGT GGA GAA CAT TAA CAC

Met-Thr-Pro-Thr-Asn-Gly-Gly-Glu-His-Stop

DNA Mutations

3 types of mutations:

- Deletion mutations - <u>a nitrogen base is deleted</u>
  - This causes the code to be read differently from that spot onwards so the whole protein changes
  - Ex. The **<u>r</u>**ed fox runs → The edf oxr uns
- Addition mutations - <u>a nitrogen base is added</u>
  - Same consequence as deletion
  - Ex. The red fox runs → The red **<u>s</u>**fo xru ns
-

DNA Mutations

- Substitution mutation - <u>one base is switched for another</u>
  - This may have no effect
    - ex. change GT<u>T</u> to GT<u>C</u>; both code for Valine
  - may change one amino acid
    - ex. Change <u>G</u>TT to <u>A</u>TT; Valine is now Isoleucine
  - may cause the protein to stop being made from that point on
    - Ex. Change TAC to TAA; Tyr is now a stop codon.

Consequences of Mutation

1. Neutral Mutation - <u>have no effect on the survival of the organism</u>
   a. Ex. changes to the eye colour of an organism.

2. Helpful Mutations - <u>improves the ability of the organism to survive or reproduce</u>
   a. Ex. changes to the beak shape of a bird so that it can collect more food at once

Consequences of Mutation

3. Harmful Mutations - <u>decreases the ability of the organism to survive or reproduce.</u>

   a. Ex. Changes to an enzyme needed to digest protein making it no longer functional.

Consequences of Mutation

Why do harmful mutations persist in a population? Why are they not eliminated through natural selection?

- Some mutant genes can be carried by individuals while having no effect or even a helpful effect on that organism
- Ex. Sickle Cell Anemia - causes painful or even fatal blood clots to those afflicted
- Those people who are carriers are not affected but are immune to malaria giving them a better chance to survive

Causes of Mutations

1. List 5 different causes of mutation.

2. How do mutations cause cancer?

3. Name 3 carcinogens.