DNA AND LIVING THINGS

How is DNA the foundation of unity and diversity of living things?

KEY TERMS FOR THIS UNIT

- **DNA –**
- **Nucleotide –**
- **Nitrogenous Bases –**
- **Complimentary Bases**
- **Chromosome –**

KEY TERMS FOR THIS UNIT

- **Karyotype –**
- **Species –**
- **Homologous Chromosome –**
- **Gene –**
- **Allele –**

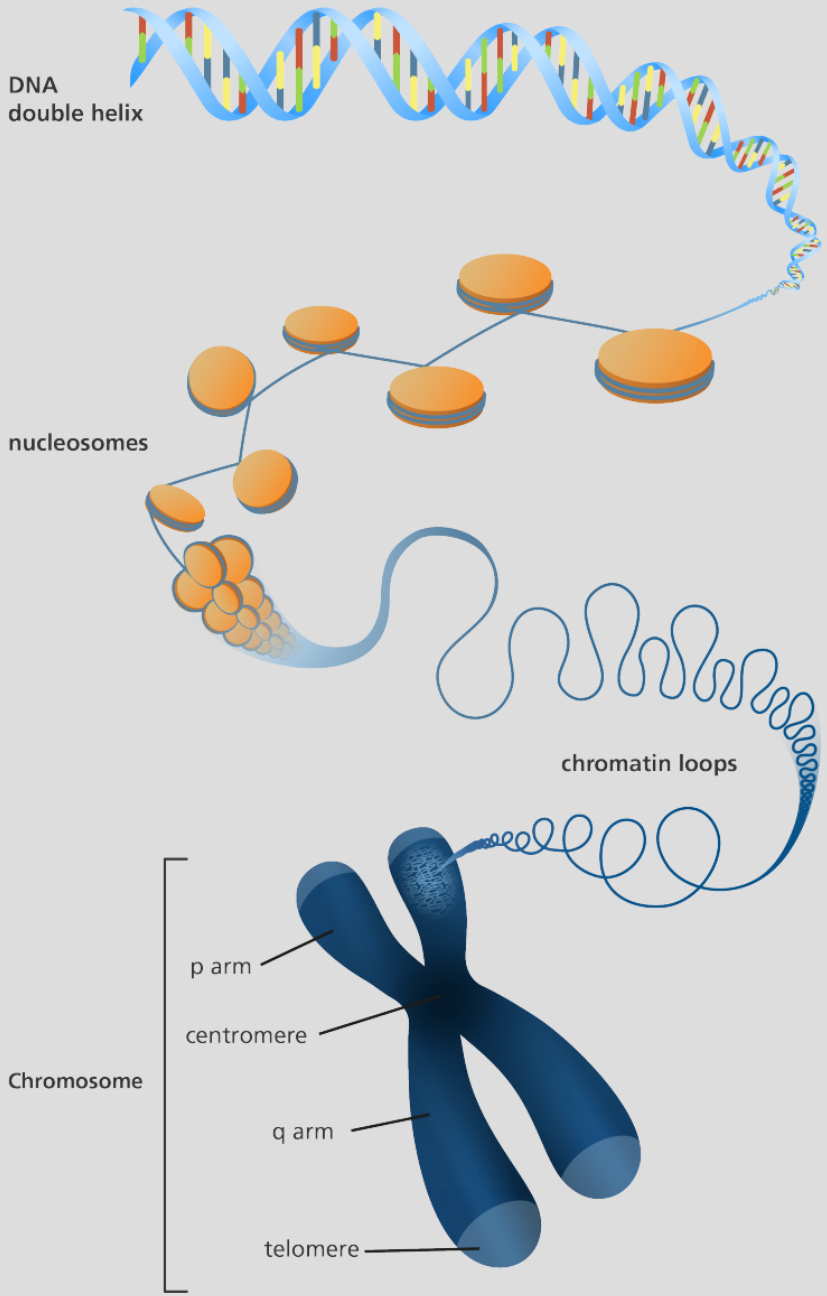
THINK PAIR SHARE

How many different kinds of living things are on Earth? Why do you think diversity is important or valuable?

THINK PAIR SHARE

What do you recall about the structure and function of DNA from last year?

DNA STRUCTURE



CHARACTERISTICS OF LIFE

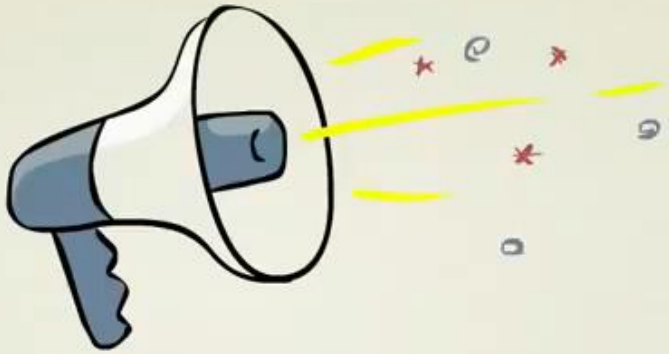
1. Being made up of **cells**
2. Using **energy**
3. **Growing** and changing
4. Reproducing (having **offspring**)
5. Pass **traits** to their offspring (**DNA and RNA)**

WHAT IS GENETICS?

- Genetics is the study of how **inherited** traits are passed on from generation to **generation**
- Traits are passed on to the next generation via **genes** (a section of chromosome that codes for a specific **protein)**
- The genetic code: the chemical **language** that contains the information for **coding** proteins

HEREDITY

The passing on of traits from one generation to the next generation

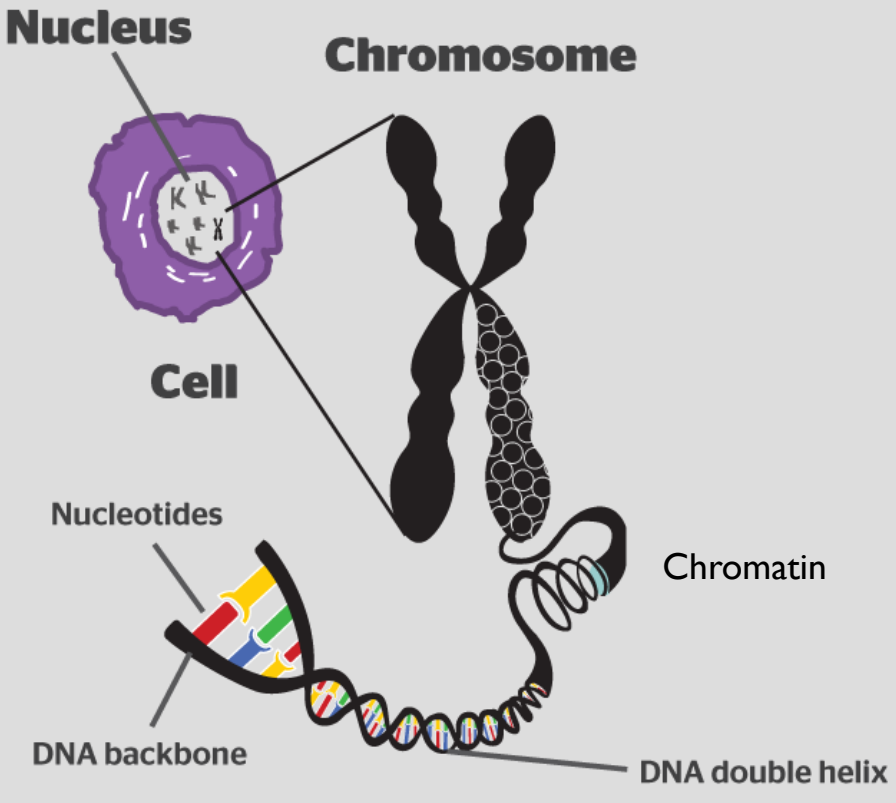


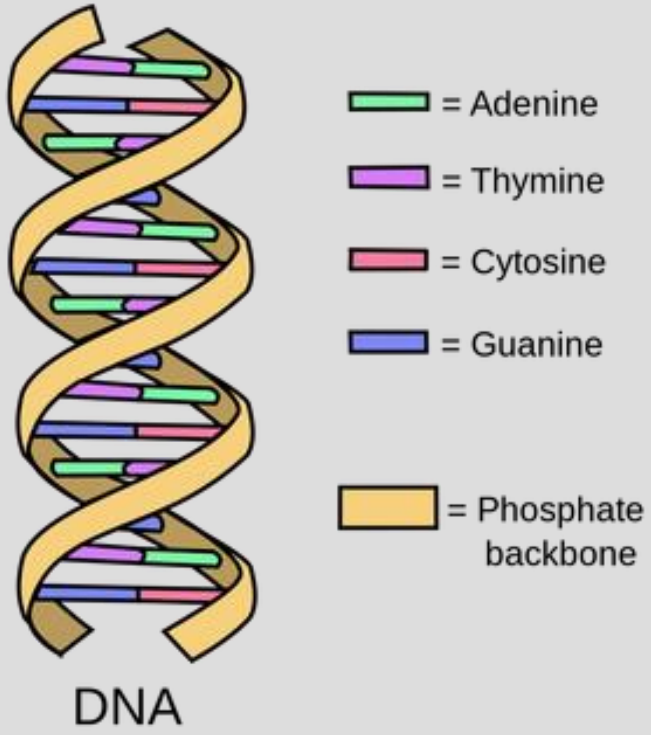
Stated Clearly

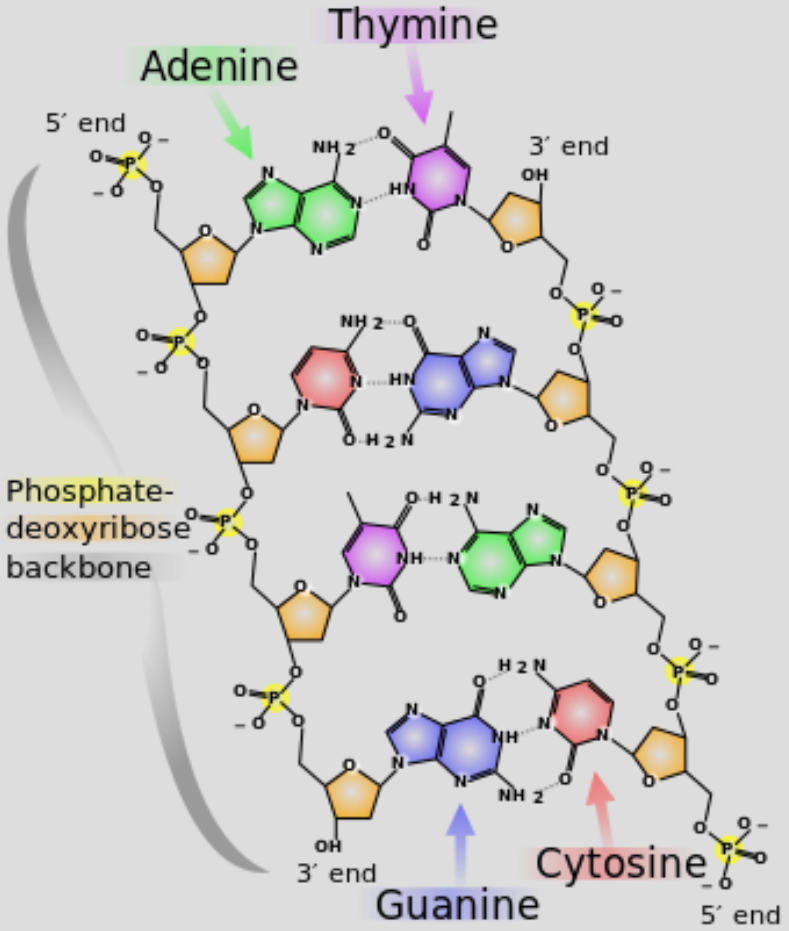
DEOXYRIBONUCLEIC ACID

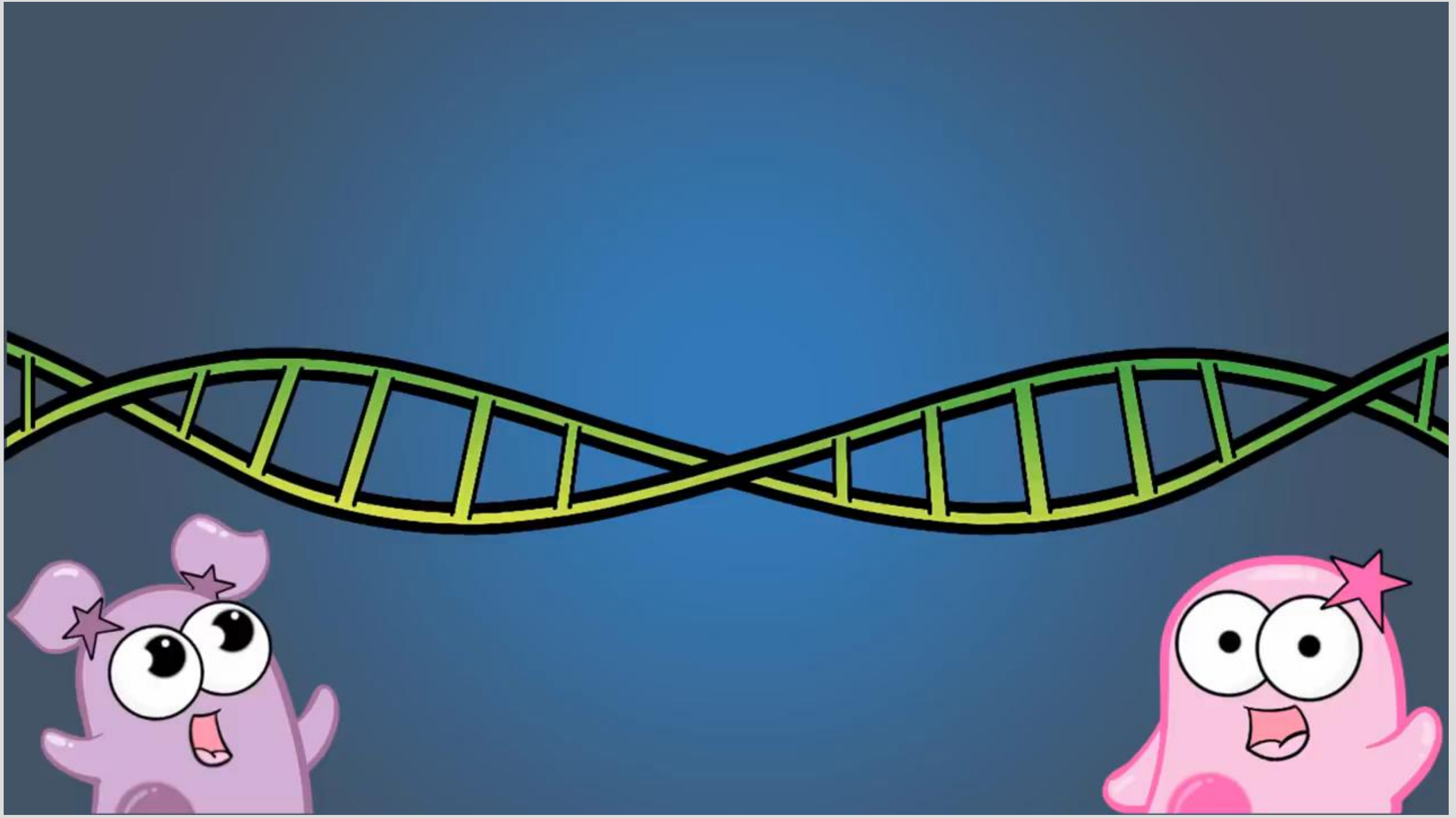
- Aka **DNA**
- All **living things** have DNA
- Genetic material that stores information and contains all the necessary instructions for life
- DNA is responsible for **variation** among all living things
- Most cells of an organism contain genetic information that has **an influence on its appearance and life processes**

STRUCTURE OF DNA



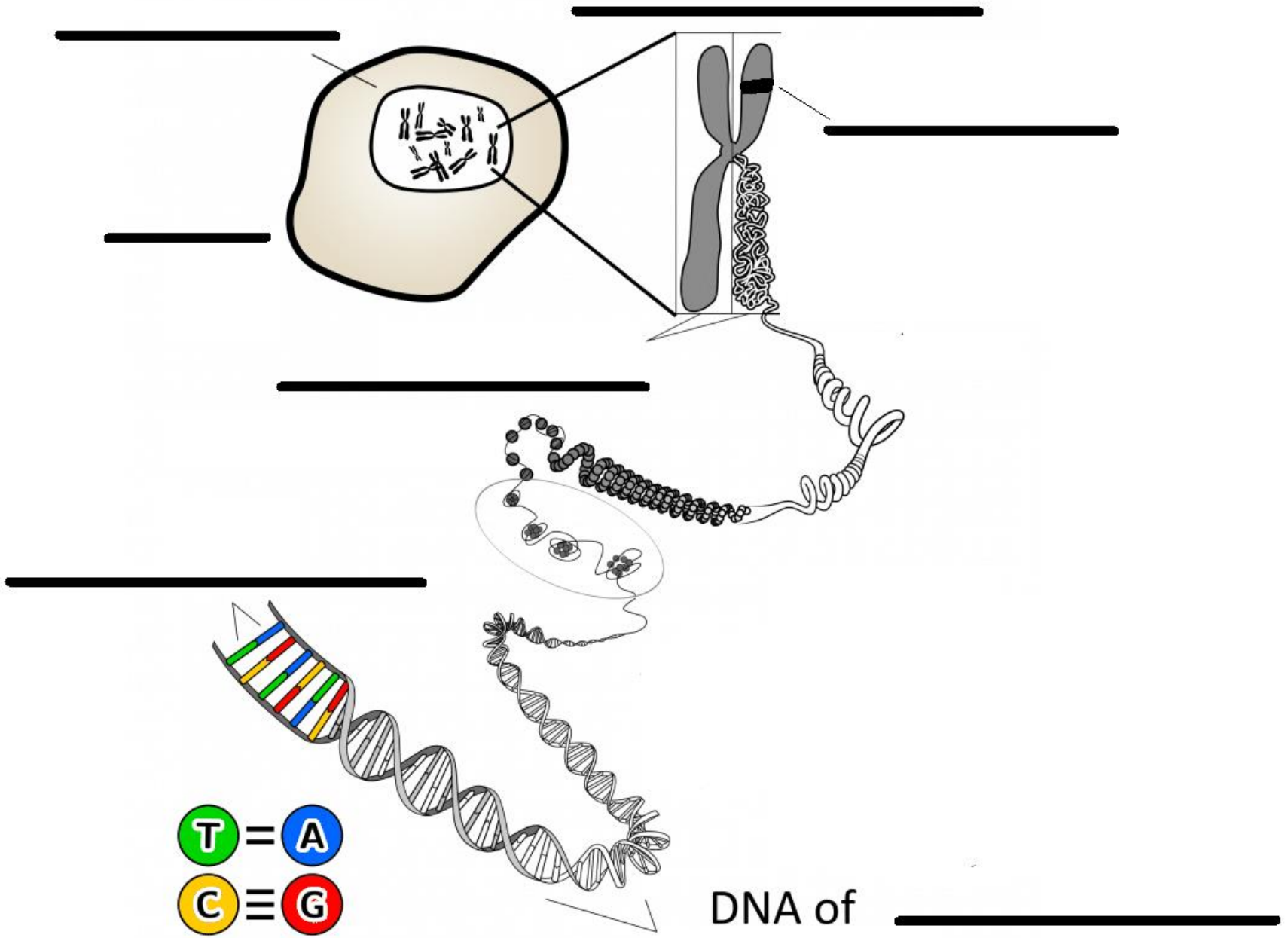






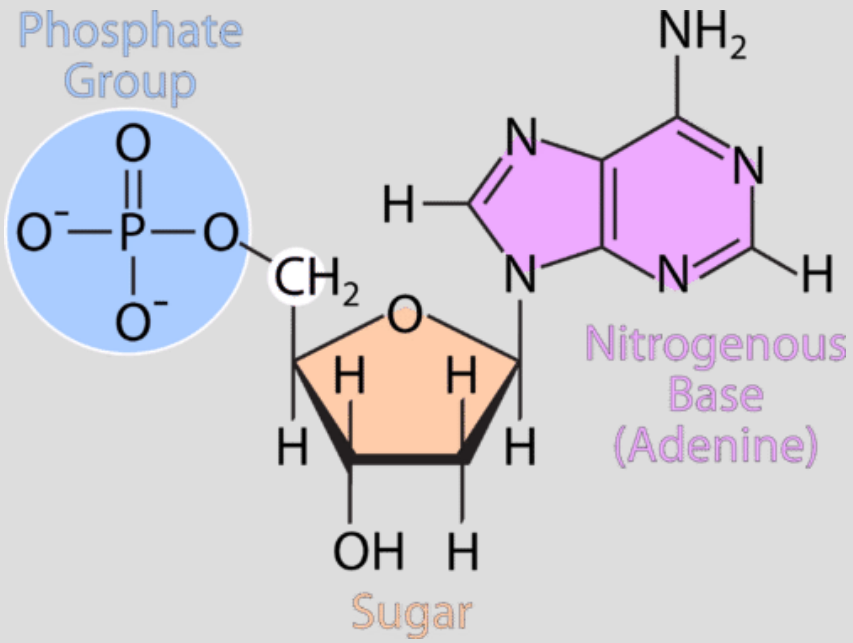
RECALL

- All living things have DNA – **deoxyribonucleic acid**
- DNA exists in long fibres called **chromatin**
- Coiled strand of chromatin is called a **chromosome**
- Genetic material carried in **genes** which are located in the chromosomes


T = A
C ≡ G
DNA of

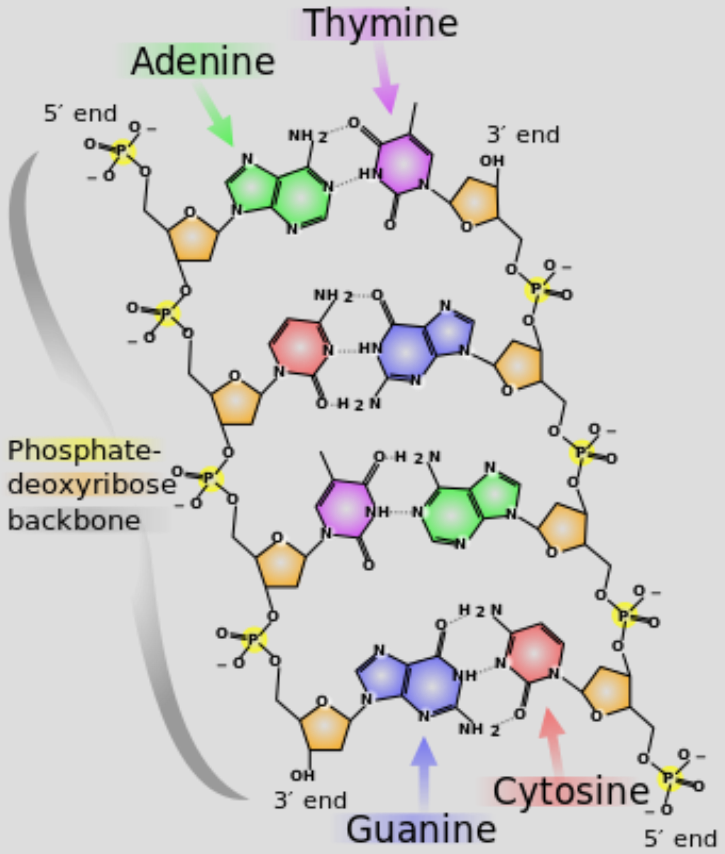
STRUCTURE OF DNA

- Cells contain 2 types of nucleic acids: DNA and RNA
- Nucleic acids are made up of Nucleotides –
  - **Sugar**
  - **Phosphate group**
  - **Nitrogenous base**
- There are 4 nitrogen bases in DNA
  - **Adenine** (A)
  - **Cytosine** (C)
  - **Guanine** (G)
  - **Thymine** (T)

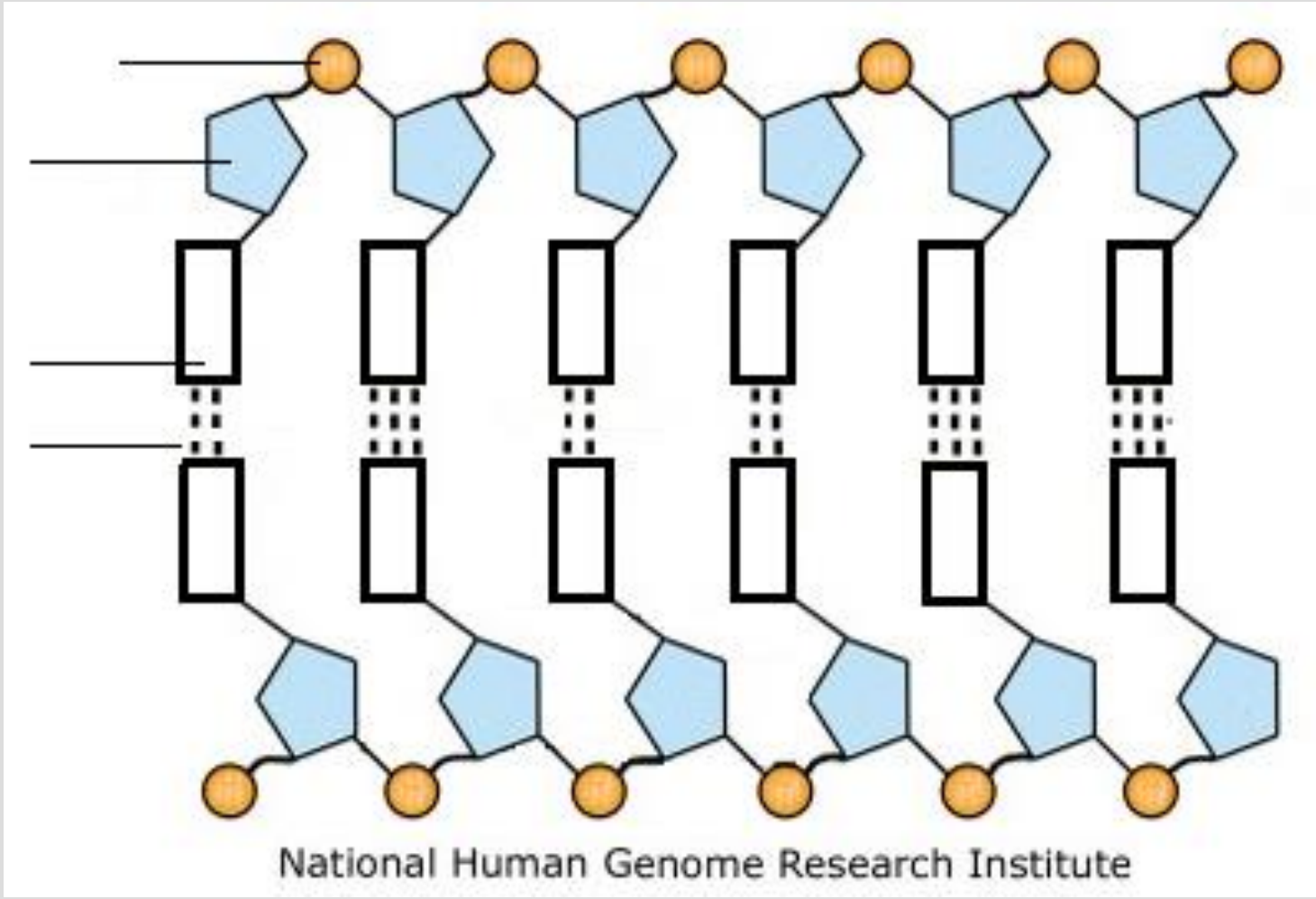


DNA MOLECULE

- DNA is a molecule made up of 2 strands of **nucleotides** linked together
- The sides of the ladder are made of sugar and phosphate groups
- Each rung of the ladder is two nitrogenous bases bonded as **base pairs** and are joined by hydrogen bonds
  - Adenine (A) **<u>always</u>** joins with Thymine (T)
  - Cytosine (C) **<u>always</u>** joins with Guanine (G)
  - When bonded, these are considered complimentary bases
- The twisted structure is called a **double helix** (looks like a twisted ladder)



DRAW AND LABEL



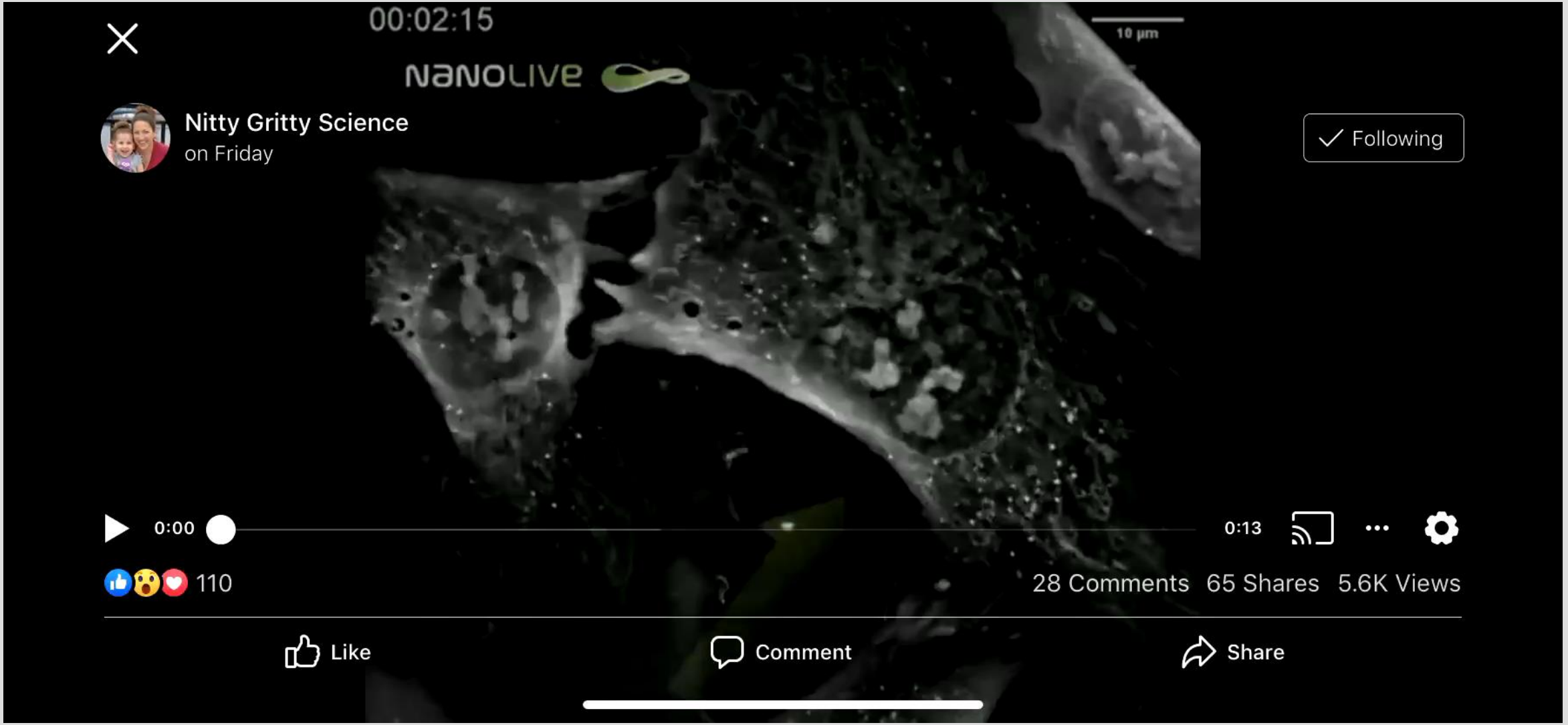
LET'S BUILD ONE!

- You will be given some candy! – but don't eat it, Mr. Ferdosian rubbed them on his feet!
- Using toothpicks, twizzlers, and marshmallows you will create your own strand of DNA
    - Pink –
    - Green –
    - Orange –
    - Yellow –
- Once your model is complete, draw and label it (nucleotide, nitrogen bases (A, T, G, C) sugar, phosphate) on the next page, then bring your molecule up to the front ☺

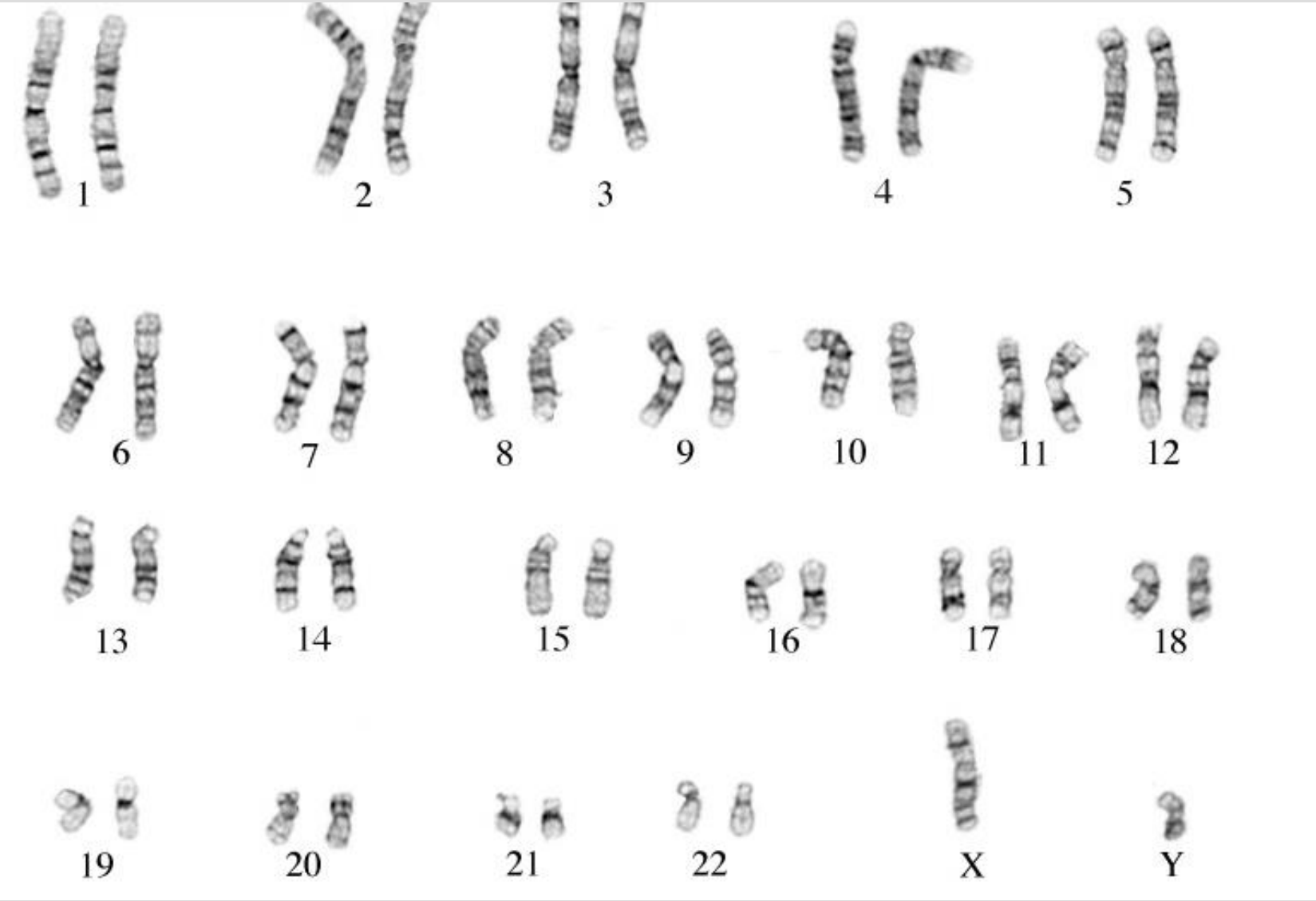
A QUICK RECAP!

- Structure of DNA
  - ATGC, Nitrogenous bases, Phosphate group, sugar, double helix
- Mitosis
  - Cell replication – One diploid cell makes two diploid cells
- Meiosis
  - Gamete production – One diploid cell makes 4 haploid cells

CELL DIVISION



HUMAN KARYOTYPE



KARYOTYPE

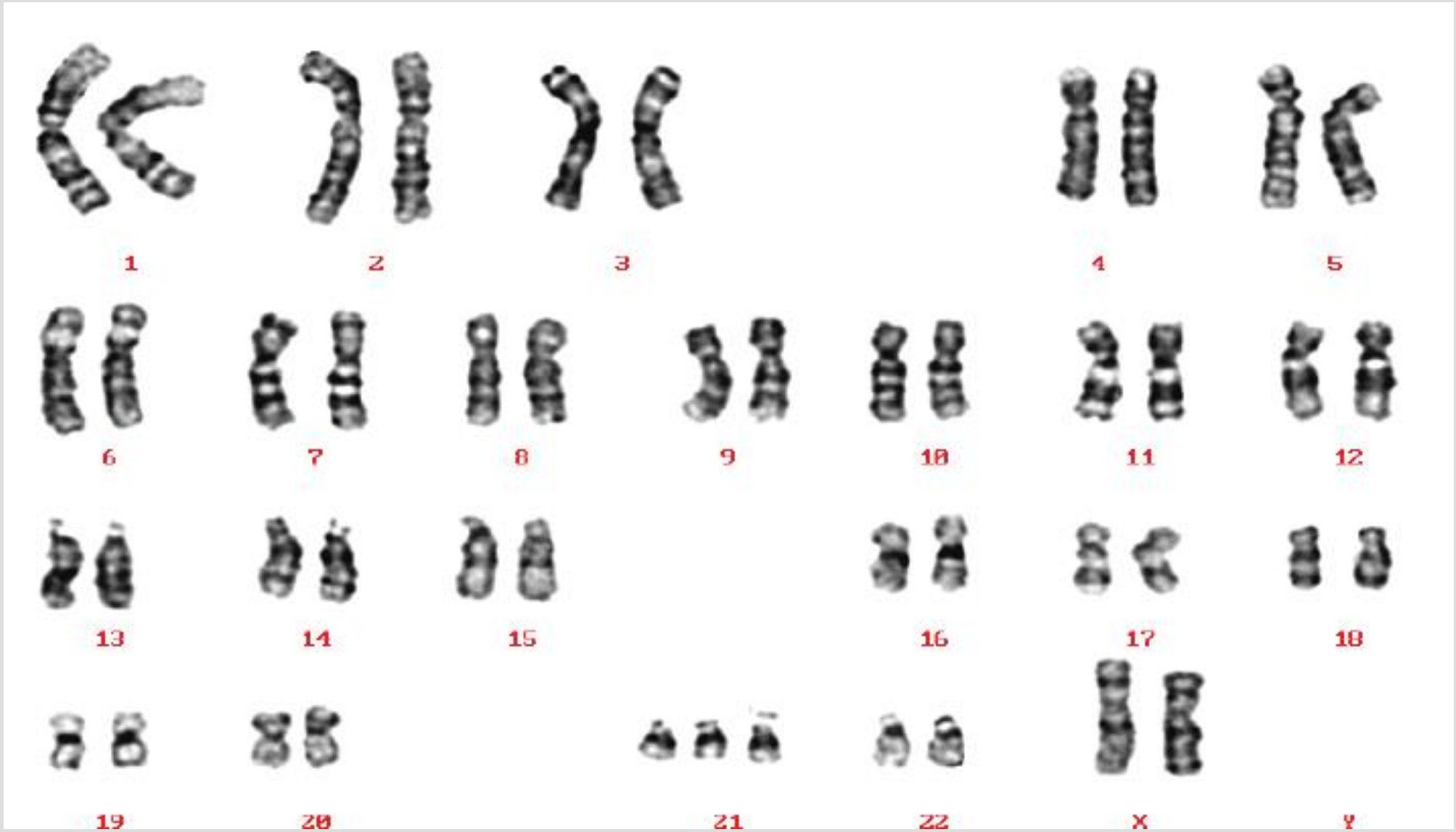
- In small groups – you will cut out the chromosomes from one page
- You and your group will try to piece together the puzzle matching up the homologous chromosomes by looking at patterns and size
- Once complete, call the teacher over to see if correct

QUESTIONS

- Is the karyotype indicating that the sex of this person is male or female? How can you tell?

- Males will have and X chromosome, and a Y chromosome
- Females have 2 X chromsomes

- You can also use a Karyotype to determine is the person has any genetic disorders (eg. Down's Syndrome (trisomy 21))


1
2
3
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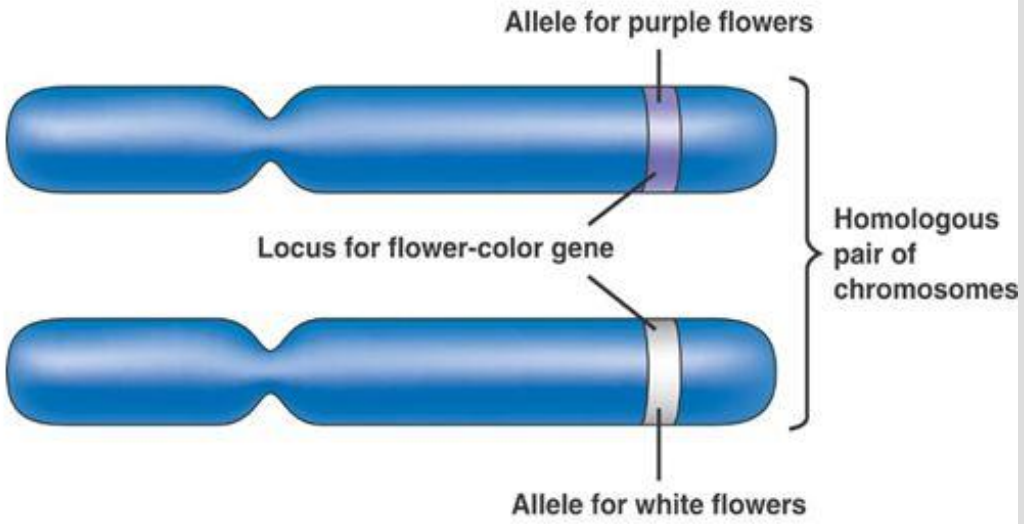
11
12
13
14
15
16
17
18
19
20
21
22
X
Y

Genes and Alleles

- Gene: a heritable factor that controls a specific characteristic
  - Located in specific places on chromosomes
  - Humans have roughly 20,000-25,000 genes.
- Alleles: alternative forms of gene
- Example:
  - Gene: eye color
  - Alleles: blue vs. brown



THE BEGINNING OF GENETICS

- Gregor Mendel: (1822 – 1884)
- Austrian Monk who was the first person to conduct experiments on genetics


bio.COM

MENDEL'S HYPOTHESES:

1. Different elements are passed on from parents to their offspring
2. Different elements will determine different traits
3. The elements will remain the same throughout the organisms life
    1. Elements are passed on to new offspring in the same form in which they had been inherited from the parents
4. The elements are passed on through the gametes of an organism

MENDEL'S EXPERIMENTS

- Mendel chose pea plants for his experiments
- Peas had 7 different traits with two contrasting forms:

- Seed Shape: Smooth vs Wrinkled
- Seed Colour: Yellow vs Green
- Flower Colour: Purple vs White
- Pod Shape: Inflated vs Constricted
- Pod Colour: Green vs Yellow
- Flower Position: Side vs Tips
- Stem Height: Tall vs Short

Seed		Flower	Pod		Stem	
Form	Cotyledon	Color	Form	Color	Place	Size
						
Round	Yellow	White	Full	Green	Axial pods	Tall
						
Wrinkled	Green	Violet	Constricted	Yellow	Terminal pods	Short
1	2	3	4	5	6	7

MENDELIAN GENETICS

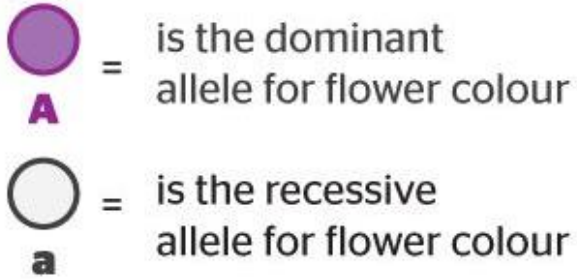
BUT WHY PEAS?!

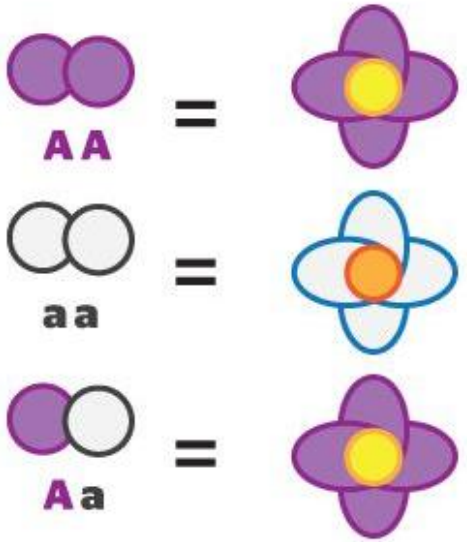
Feature of Peas	Usefulness to Mendel
Peas produce many offspring quickly	He could study many generations of peas in a short period of time
Individual peas produce both male and female gametes (sperm and egg cells) and can self-fertilize	He could self-fertilize plants to produce pure lines for various traits**
Traits with only two forms	He could study simple traits with only two possible outcomes

** Pure breeding – A group of identical individuals that always produce the same phenotype when intercrossed

Dominant vs Recessive

- **Dominant** allele is allele that is expressed when two different alleles or two dominant alleles are present (upper case letter= A)
- **Recessive** allele is allele that is only expressed when two copies are present (lower case letter=a)





Genotype versus Phenotype

- Genotype
  - Refers to the two alleles an individual has for a specific trait
  - If identical, genotype is homozygous
  - If different, genotype is heterozygous
- Phenotype
  - Refers to the physical appearance of the individual

Homozygous Dominant

A	A

Heterozygous

A	a

Homozygous Recessive

a	a

HOMOZYGOUS VS. HETEROZYGOUS

- **<u>Homozygous</u>** – Term used to refer to an organism that has two *identical* alleles for a particular trait (**TT or tt**)

RR

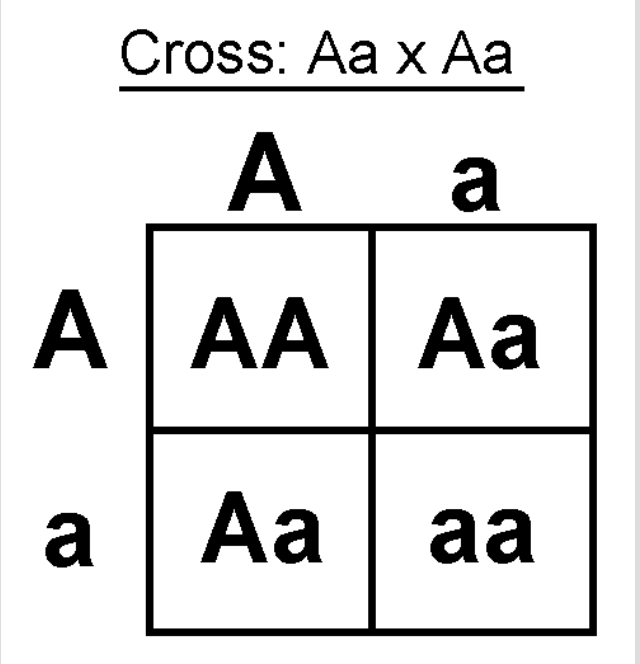
rr

- **<u>Heterozygous</u>** - Term used to refer to an organism that has two *different* alleles for the same trait (**Tt**)

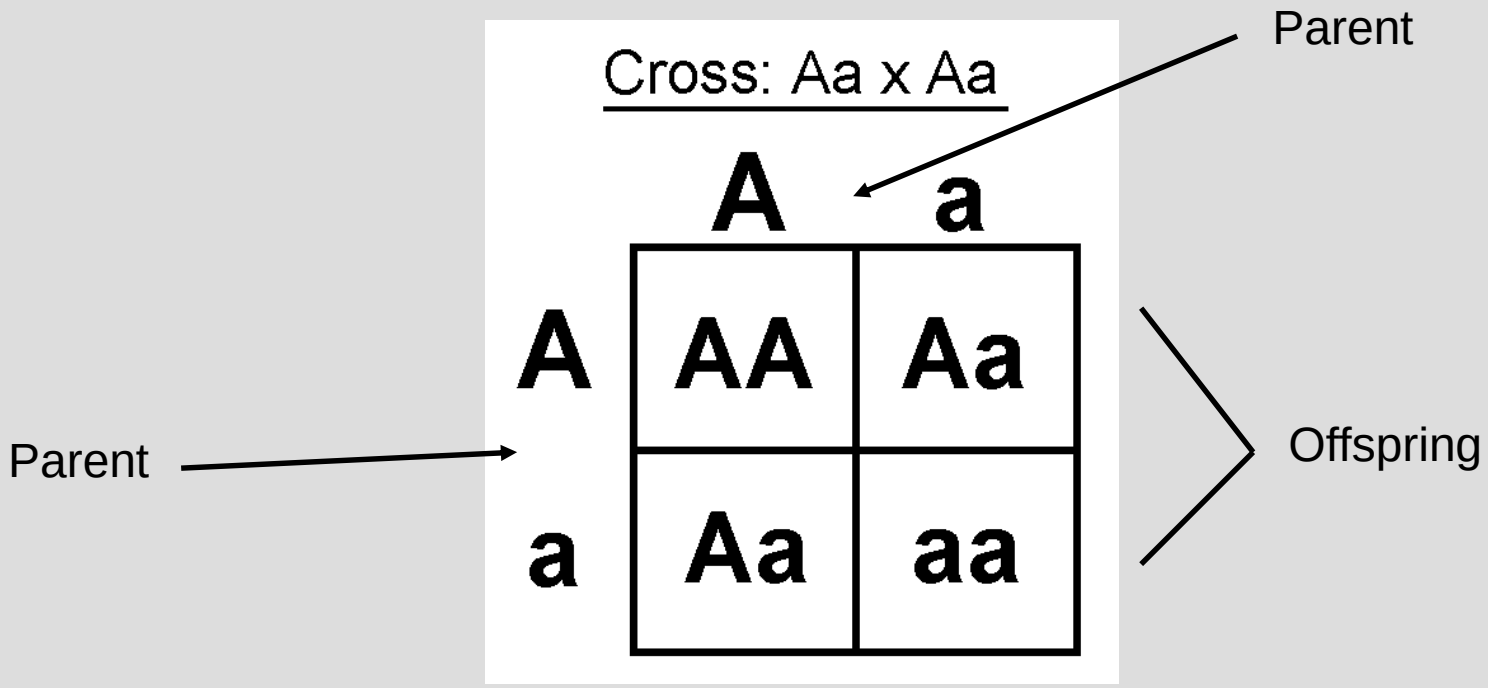
Rr

PUNNETT SQUARES

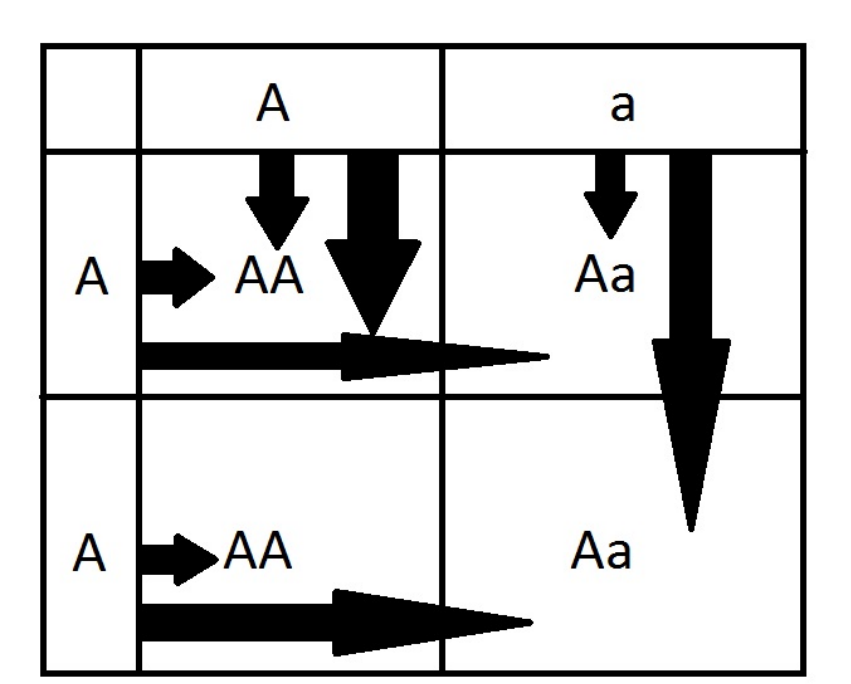
- **Punnett Square** – Diagram showing the gene combinations that might result from a genetic cross
- Used to calculate the probability of inheriting a particular trait
  - **Probability** – The chance that a given event will occur

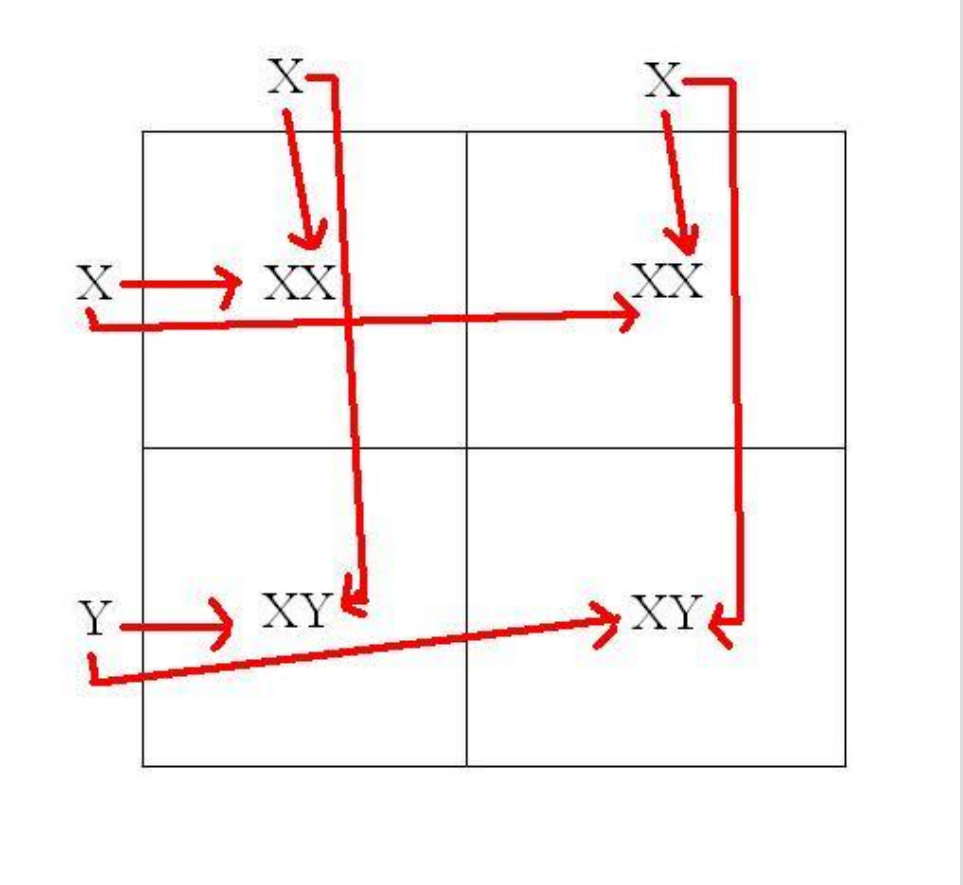


PUNNETT SQUARE



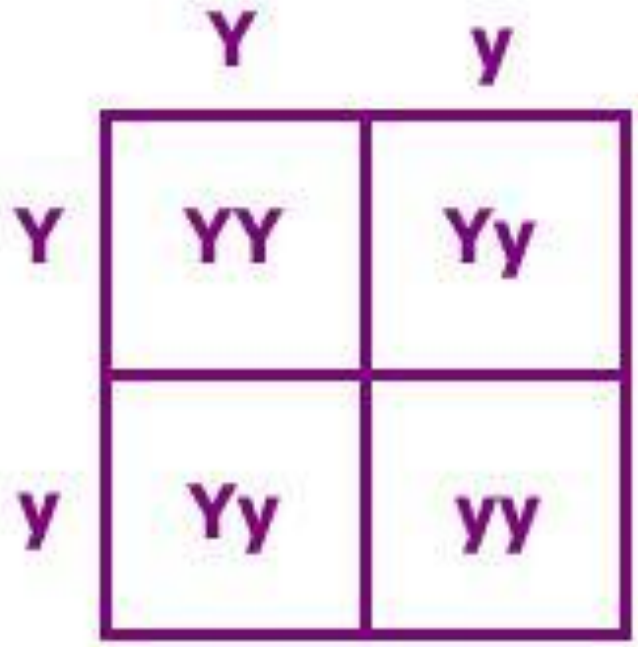
HOW TO COMPLETE A PUNNETT SQUARE





Yy x Yy

Each parent could give either a Y or a y to the next generation in its gamete. There is an equal chance for giving either.



Y-Yellow
y-white

<u>Genotype:</u>
1:2:1
(YY:Yy:yy)

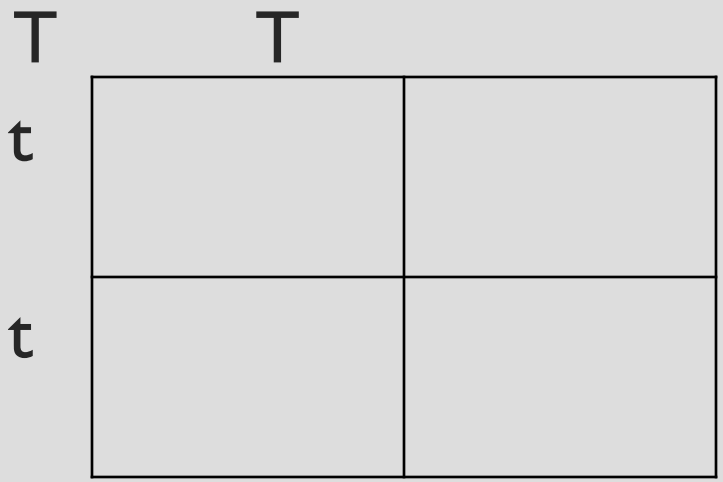
<u>Phenotype</u>:
3 Yellow
1 White

YOU TRY IT NOW!

- Give the genotype and phenotype for the following cross: TT x tt (T = Tall and t = Short)

TT X TT

Step One: Set Up Punnett Square (put one parent on the top and the other along the side)



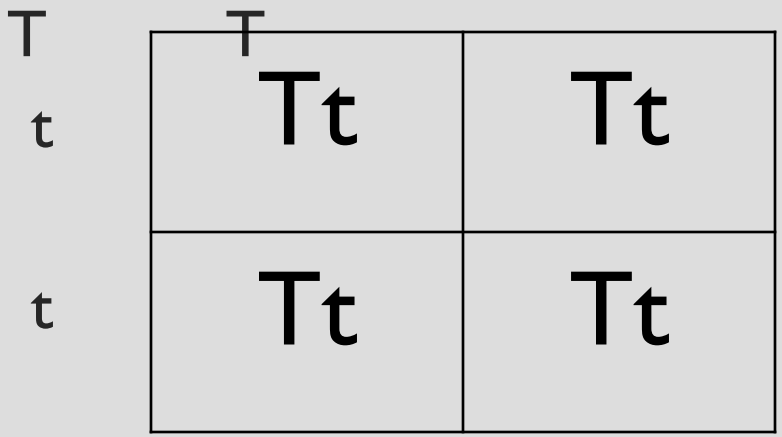
TT X TT

Step Two: Complete the Punnett Square

	T	T
t	Tt	Tt
t	Tt	Tt

TT X TT

Step Three: Write the genotype and phenotype



Genotype:
4 - Tt

Phenotype:
100% Tall

Remember: Each box is 25%

PUNNET SQUARE

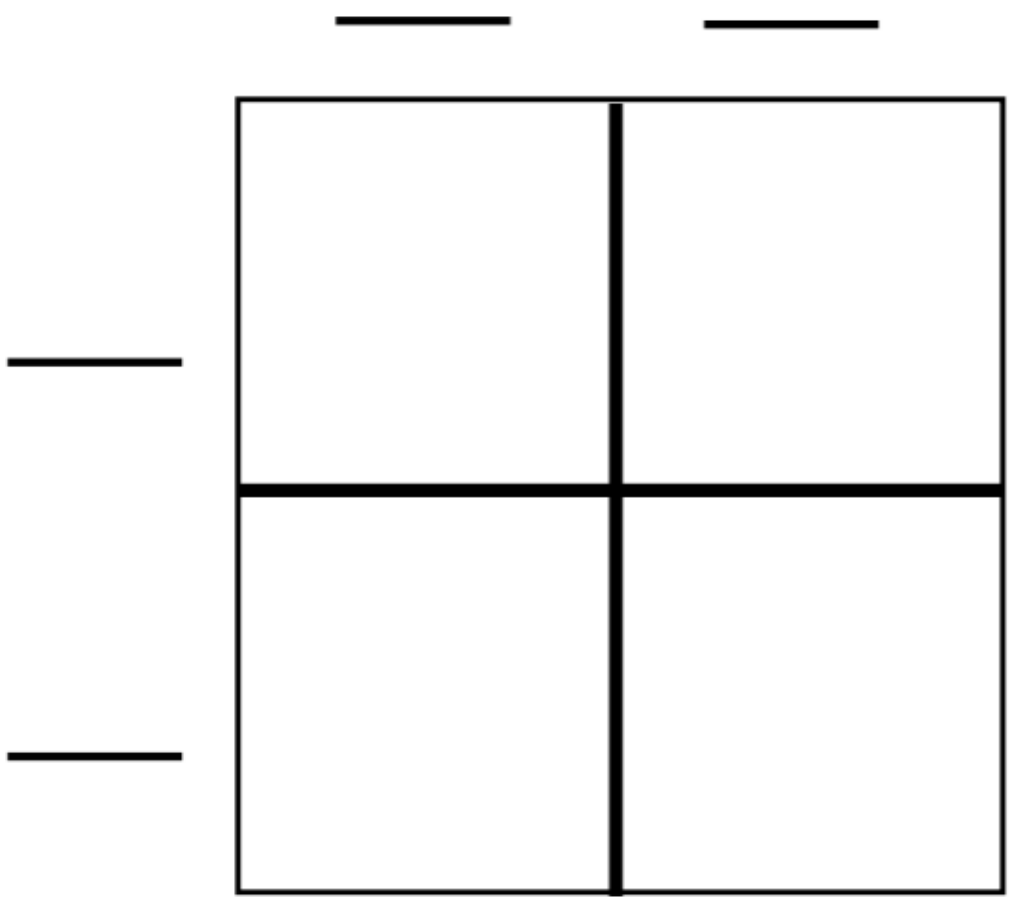
Parent 1: Freckles dominant FF

Parent 2: Freckles dominant Ff

Possible genotypes of outcomes and percentage of probability:

Which genotype(s) will display the dominant trait?

Which genotype(s) will display the recessive trait?



ASSIGNMENT

INCOMPLETE DOMINANCE

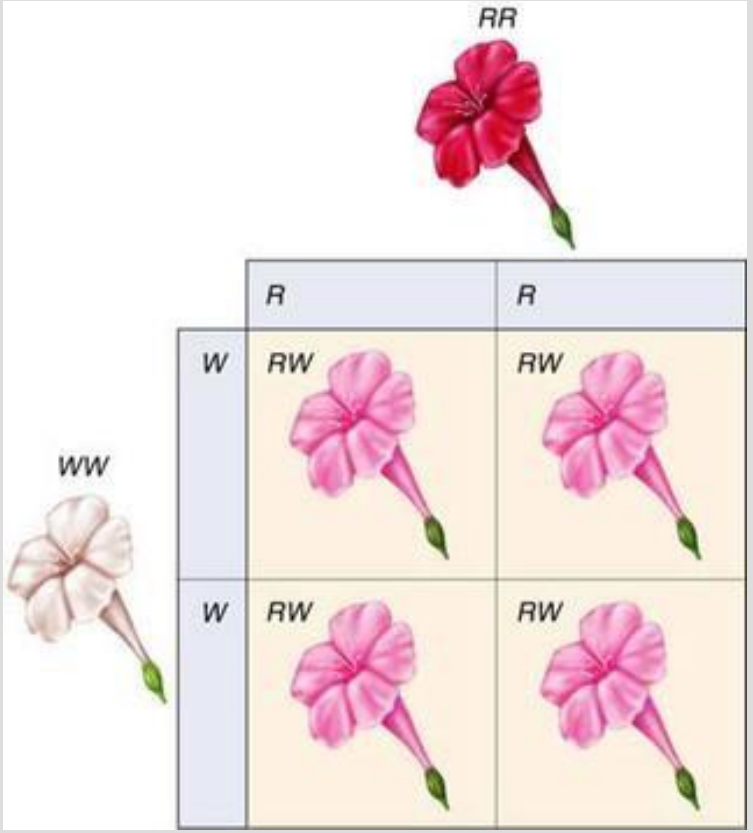
- In Mendel's pea experiments, the pea's required only one gene to control the trait
  - There were only 2 alleles – one was completely dominant, the other was recessive
- Many traits in real life are controlled in a more complicated way requiring many genes acting together or by genes with several alleles.

INCOMPLETE DOMINANCE

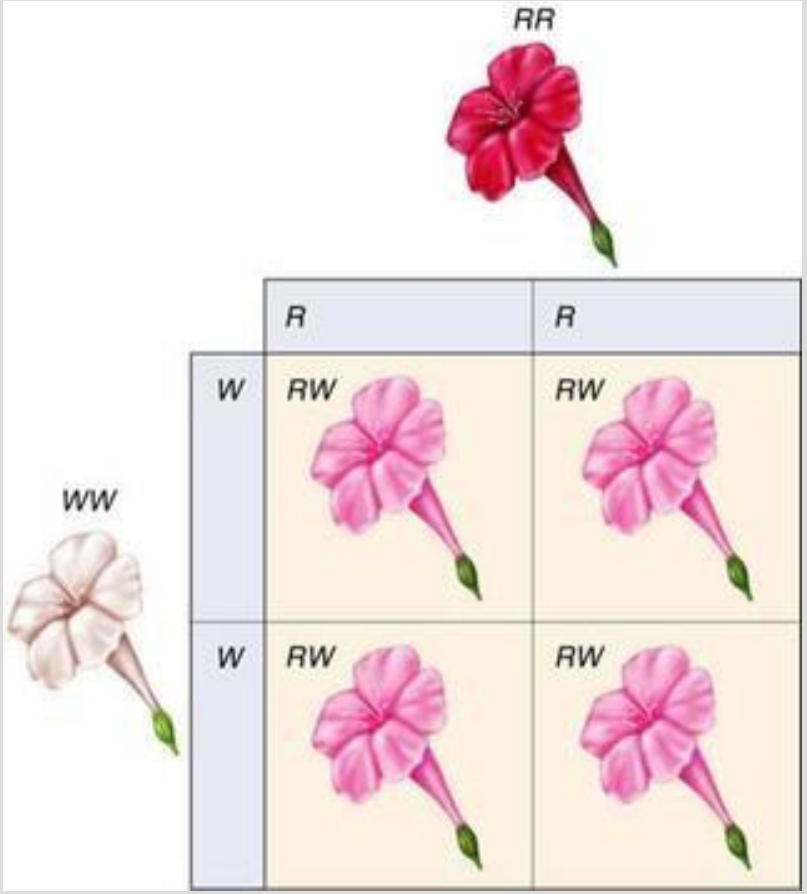
- Consider true breeding red carnations and true breeding white carnations that are crossed together.

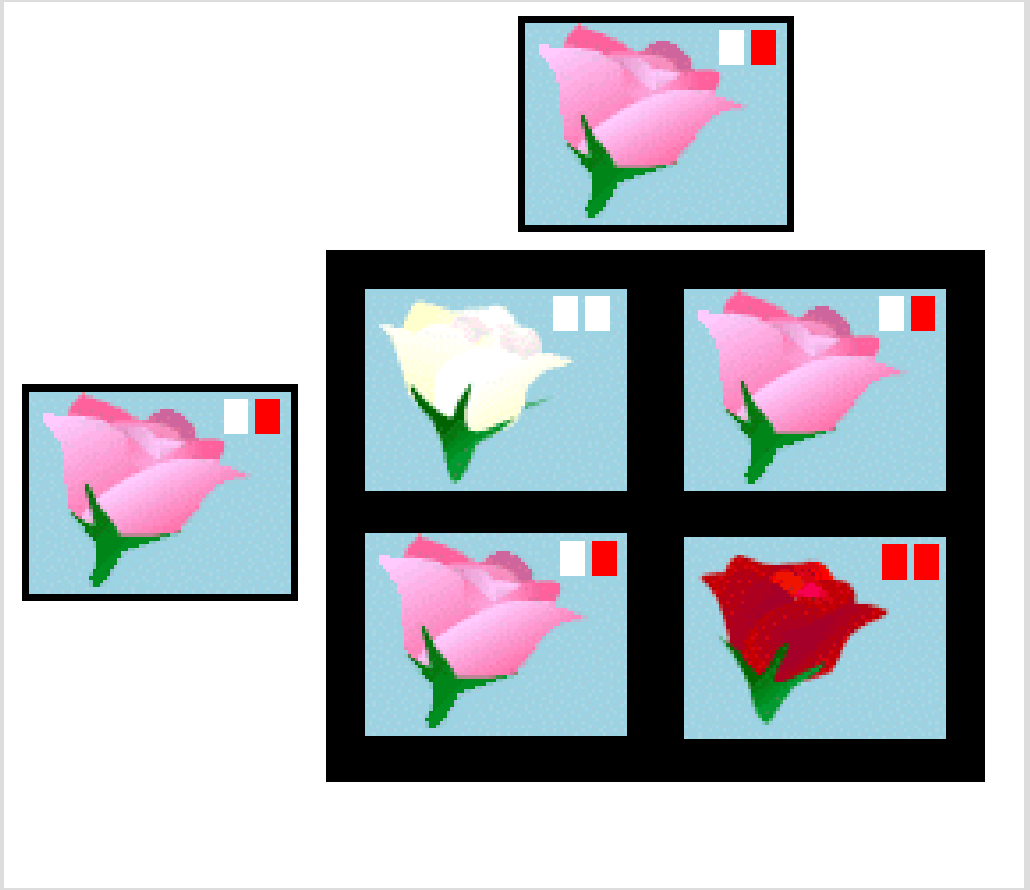
RR x WW

- The resulting colour of the offspring is Pink (RW)
- This is called incomplete dominance, the genotype of the F_1 generation is heterozygous, neither allele is dominant with red being slightly more dominant over white.



INCOMPLETE DOMINANCE





GENO/PHENOTYPES

F_1 Generation:

Geno: _____

Pheno: _____

Pheno ratio: _____

F_2 Generation:

Geno: _____

Pheno: _____

Pheno ratio: _____

Intermediate phenotype: The offspring have a mixture of the phenotype of the parents.

CO-DOMINANCE

- Some genes that control traits have several different alleles. These genes are said to have multiple alleles.
- Individuals can have only two of these alleles – one is found on each chromosome of a homologous pair.
- Example of multiple alleles is blood type in humans. **A, B, AB, O**

BLOOD TYPES

- Each blood type has an antigen found on the surface of the blood cell.
  - Type A has antigen A
  - Type B has antigen B
  - Type AB has antigen AB
  - Type O has neither antigen
- The different blood phenotypes are controlled by the gene *I*
- There are 3 different alleles: I^A, I^B, i

Genotypes	A antigen	B antigen	Phenotype (blood group)
I^AI^A	+	-	A
I^Ai	+	-	A
I^BI^B	-	+	B
I^Bi	-	+	B
I^AI^B	+	+	AB
ii	-	-	O

CODOMINANCE

- When both genes contribute equally to the phenotype

- Examples:
  - Colouring in cows
  - Sickle cell anemia

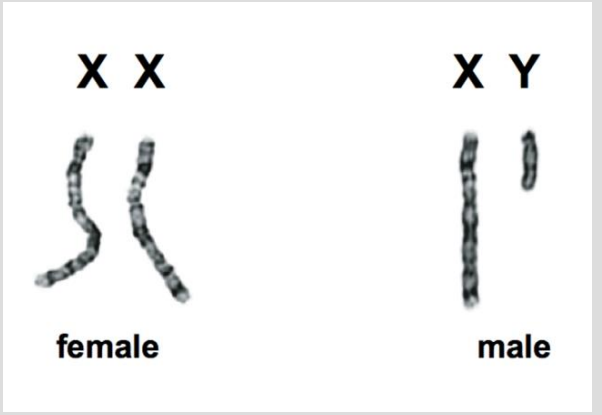
CO-DOMINANCE QUESTION

- The allele for normal hemoglobin is represented as HbA and the allele for sickle cell anemia is represented as HbS
- Individuals who are homozygous for sickle cell anemia have the blood disorder, individuals who are heterozygous have the trait but rarely experience any symptoms

- What are the chances that the offspring of a Heterozygous mother and a Homozygous normal blooded parent will have sickle cell anemia?

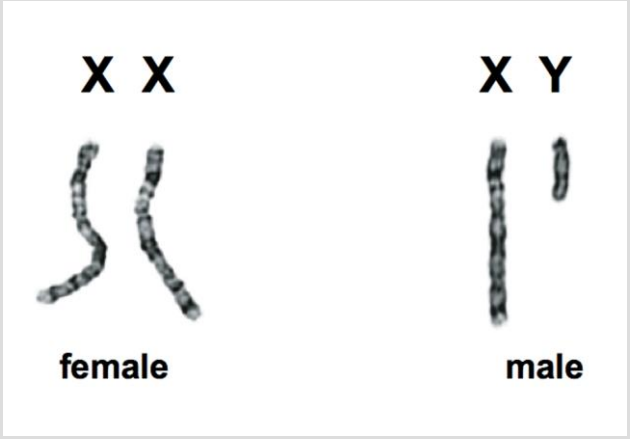
SEX-LINKED TRAITS

- There are 23 pairs of chromosomes in the human genome
- The 23rd chromosome pair determines the gender of a person
  - XX – Female
  - XY – Male



CHROMOSOMES

	Father	Mother
Parents	XY	XX
Gametes	X and Y	X and X



Predicted Ratio of the offspring:

½ Male, ½ Female

SEX LINKAGE

- The X and Y chromosomes are not completely homologous. The X chromosome is larger than the Y chromosome. Thus there is only one copy of the gene and do not have a pare of alleles for all of the same genes.

SEX LINKAGE

- An example of sex-linked traits is colour blindness as the gene is found on the X chromosome. The gene that codes for colour vision is dominant. The gene for colour blindness is recessive. The Y chromosome does not have a copy of the gene for distinguishing the colours.

COLOUR BLINDNESS

- To show a sex-linked gene we use the following notation:
  - F – allele for full colour vision (dominant)
  - f – for colour blindness (recessive)
- The gene is carried on the X chromosome with alleles written as:
  - X^F – full colour vision
  - X^f – colour blindness

WHAT ARE THE IMPLICATIONS OF HAVING ONLY ONE COPY?

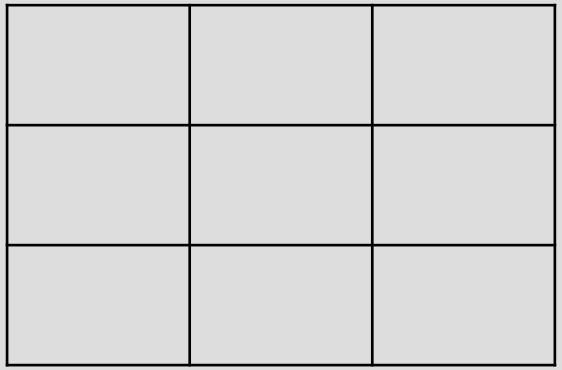
- Males have a 50% chance of having this gene, whereas females only have a 25% chance of having the gene passed to them.
- Females can be carriers, but not be colour blind themselves, whereas males will not be able to pass the gene on without being colour blind themselves.

WHO ARE THE INDIVIDUALS THAT ARE MOST AFFECTED BY THIS?

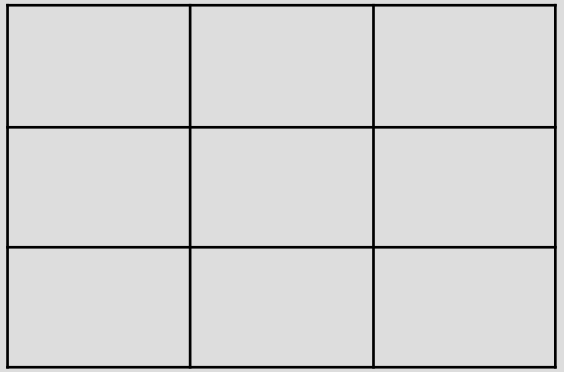
- Males – they only have one chromosome that could have the allele, whereas females get 2 copies and if even one of them is dominant then the colour blind trait won't be displayed

USING A PUNNETT SQUARE, SHOW HOW A MALE WOULD INHERIT COLOUR BLINDNESS. ASSUME THE FEMALE PARENT HAS NORMAL VISION?

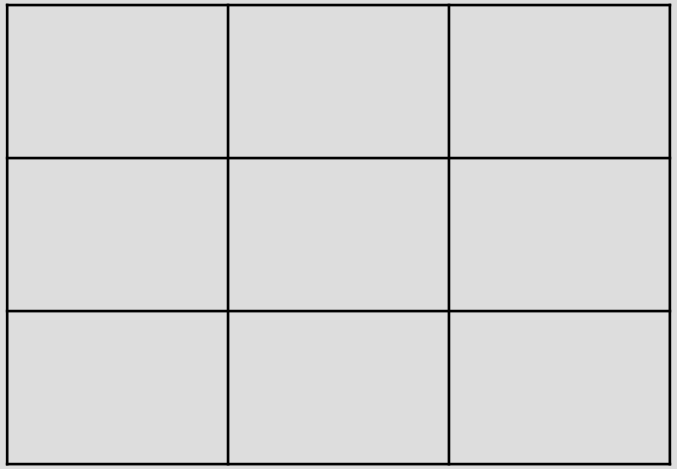
Male inheriting colour blindness

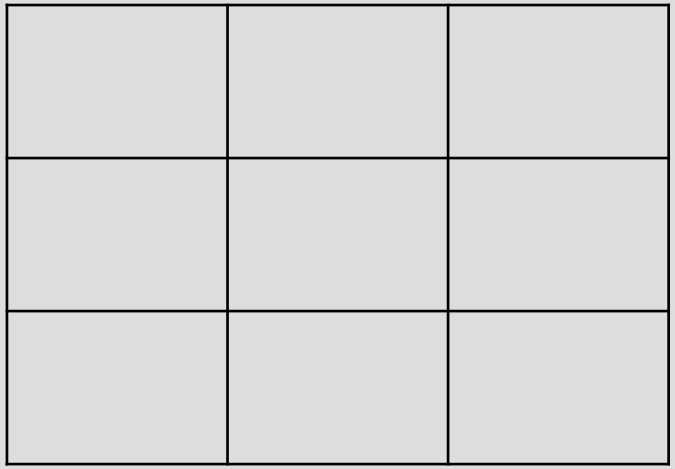


Female inheriting colour blindness



COLOUR BLINDNESS IN PUNNET SQUARE





WORK TIME

GENE EDITING

- https://www.ted.com/talks/paul_knoepfler_the_ethical_dilemma_of_designer_babies?referrer=playlist-get_into_your_genes
- https://www.youtube.com/watch?v=jAhjPd4uNFY
- https://www.youtube.com/watch?v=b0HvLaXOhEY
- https://www.youtube.com/watch?v=UKbrwPL3wXE
- https://www.youtube.com/watch?v=fGoWLWS4-kU