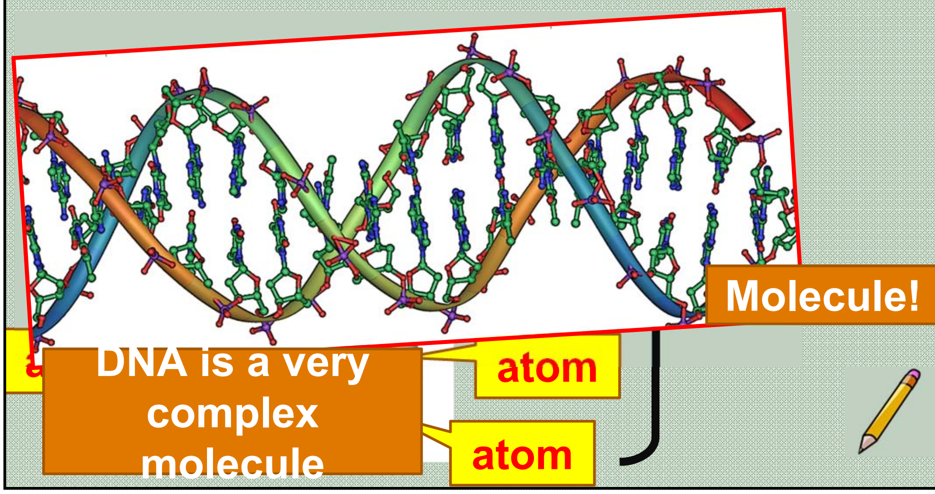
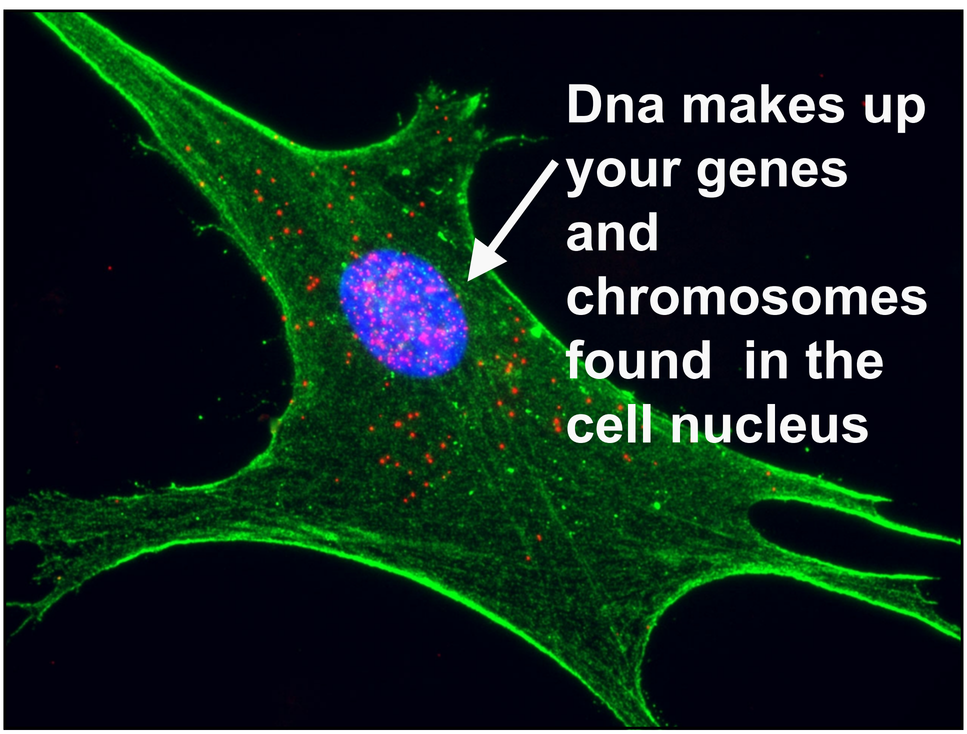
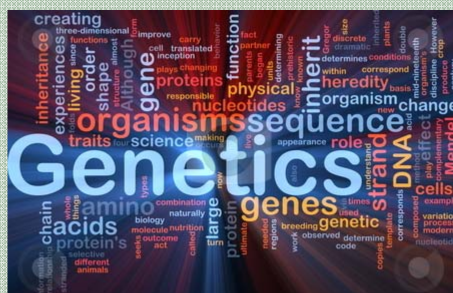
DNA (Deoxyribonucleic Acid
the basis of your inherited traits



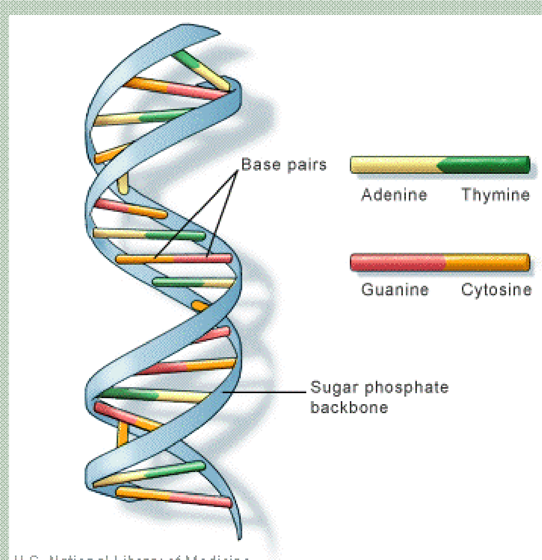


Fun Fact

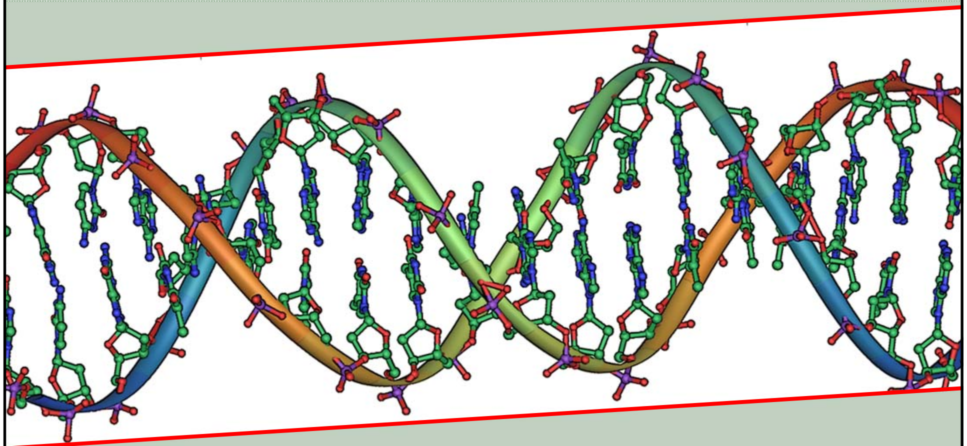
- 99.9% of your DNA is identical to everyone else's
- The remaining 0.1% influences our differences (hair color, eye color, height, etc.)



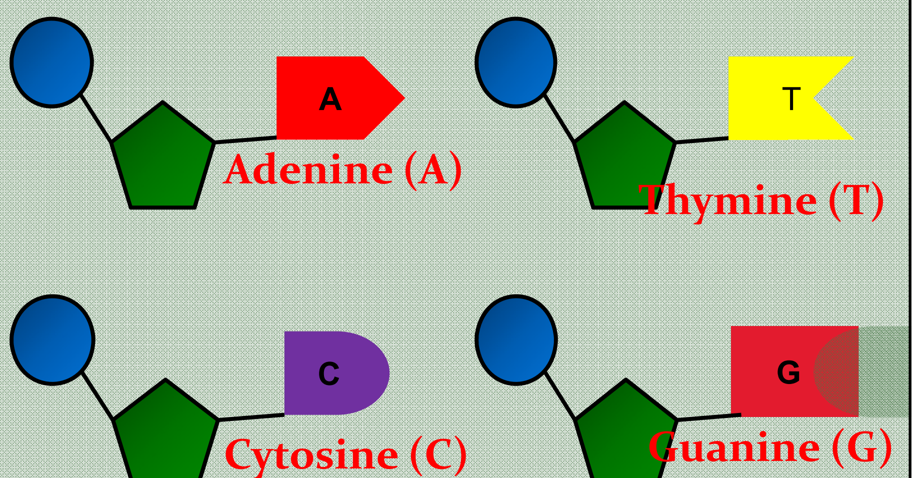
Structure of DNA



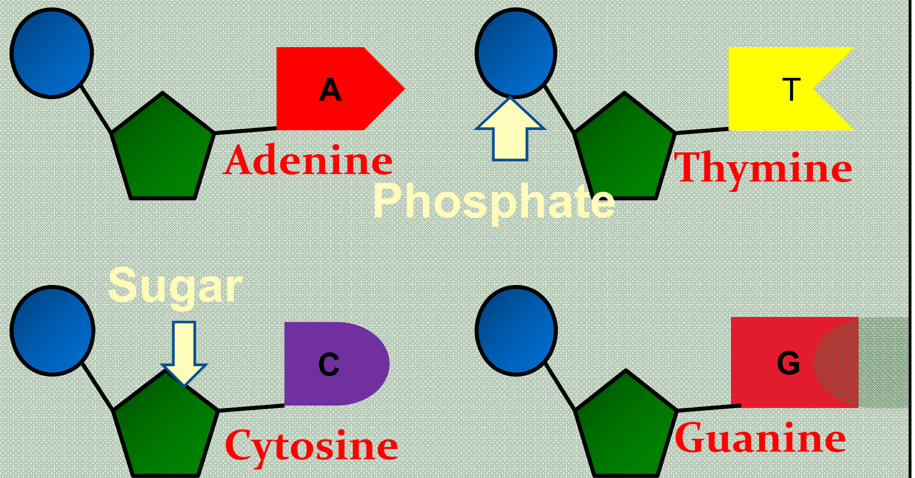
The DNA molecule is made of two strands **twisted** together in a **double helix** (a double coil)



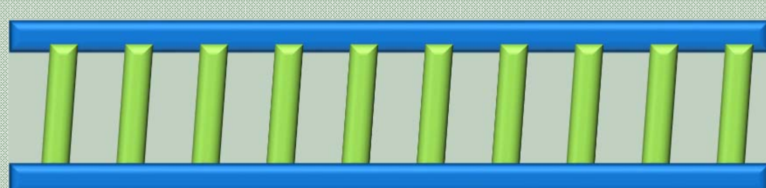
DNA is a little like a Lego building – it is made of 4 kinds of blocks called **nucleotides**



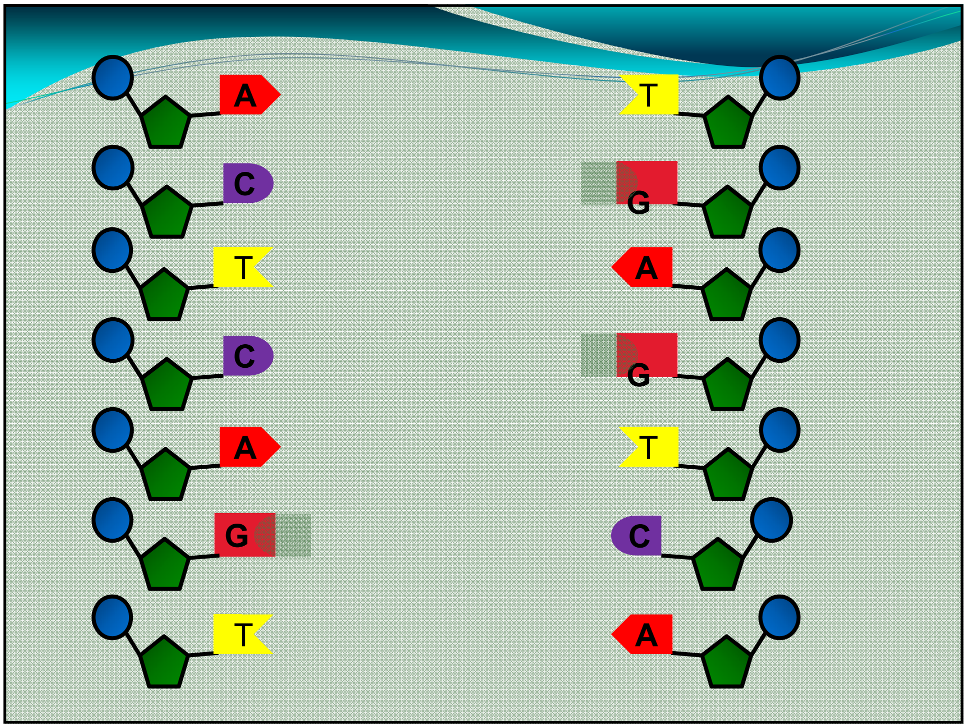
Each block (nucleotide) has a sugar, a phosphate and a base (ATCG)

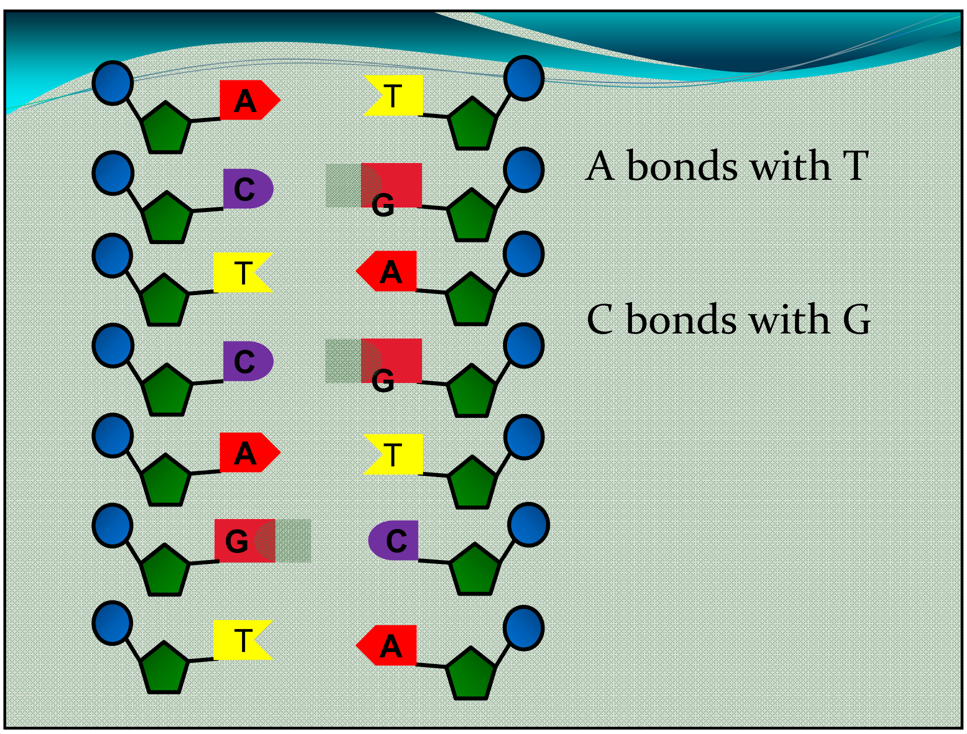


- The phosphate and sugar form the backbone of the DNA molecule, whereas the bases form the “rungs”.

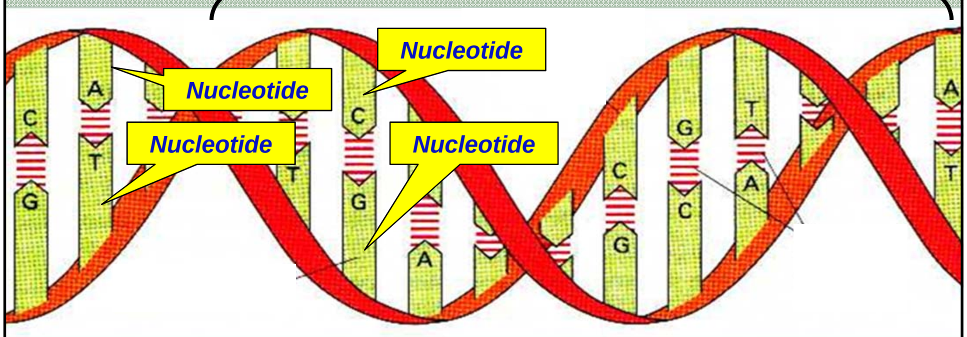


- The four bases are ……
- ATCG


A
C
T
C
A
G
T
T
G
A
G
T
C
A


A
C
T
C
A
G
T
T
G
A
G
T
C
A
A bonds with T
C bonds with G

a segment of DNA (called a GENE)



- **The genetic code** – *comes from the order the blocks (nucleotides) are in.*
- *Each gene has the code* (**instructions) for putting together one protein**

Chromosomes are like **books**

(Humans have 46 chromosomes)

The words and letters in the books are like letters (nucleotides) in the **DNA**.
(the code or language of genes)

Table of Contents

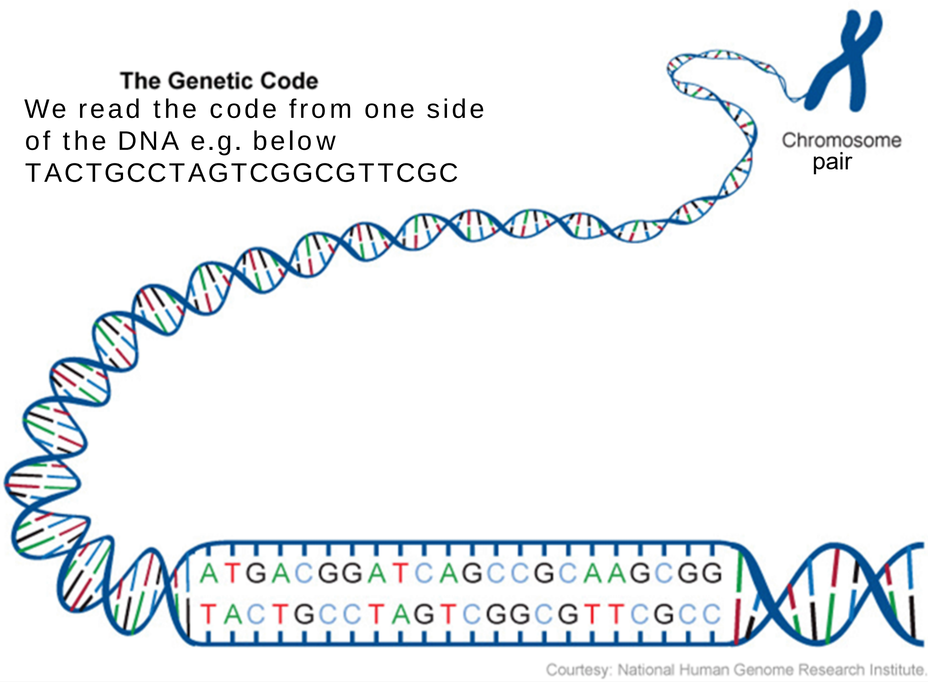
1. **Eye color**
   - Blue
   - Brown
   - Green
2. **Earlobe Shape**
   - Attached
   - Hanging
3. **Hair Color**
   - Blonde
   - Black
   - Brown
   - Red

Genes are like the **chapters** in the books

(Humans have About 20,000 genes)

The Genetic Code

We read the code from one side of the DNA e.g. below TACTGCCTAGTCGGCGTTCGC



DNA → amino acid code

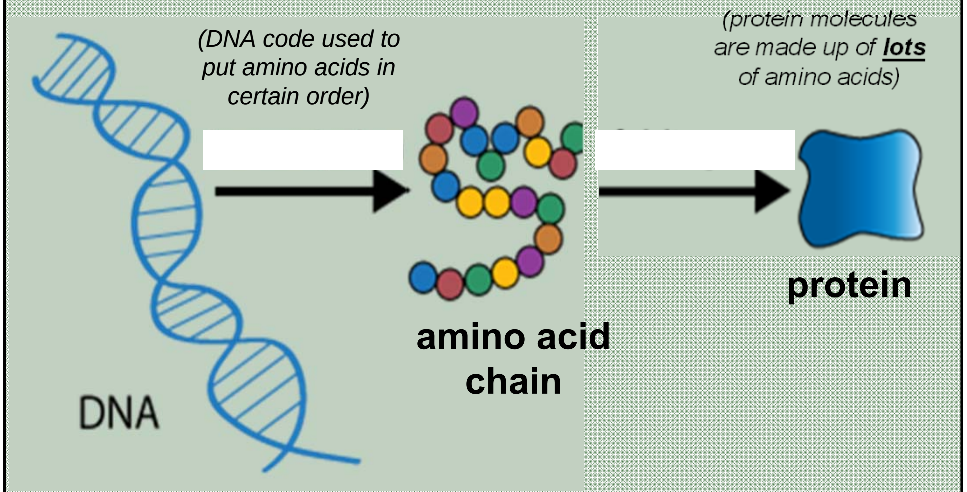
Second Letter

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

Common Amino Acids

Abbreviations for amino acids

Amino acid	*Three-letter abbreviation*	*One-letter symbol*
Alanine	Ala	A
Arginine	Arg	R
Asparagine	Asn	N
Aspartic acid	Asp	D
Asparagine or aspartic acid	Asx	B
Cysteine	Cys	C
Glutamine	Gln	Q
Glutamic acid	Glu	E
Glutamine or glutamic acid	Glx	Z
Glycine	Gly	G
Histidine	His	H
Isoleucine	Ile	I
Leucine	Leu	L
Lysine	Lys	K
Methionine	Met	M
Phenylalanine	Phe	F
Proline	Pro	P
Serine	Ser	S
Threonine	Thr	T
Tryptophan	Trp	W
Tyrosine	Tyr	Y
Valine	Val	V



DNA is code to make lots of different proteins!

- **Why do Genes contain the code for making PROTEINS?**
- **Because you are made of proteins!**
- Your hormones/ enzymes/ muscles/bones/skin/ hair etc. all are proteins

Example – What does the DNA strip above code for? (use your DNA Chart)

- TAC TGC CTA GTC GGC GTT CGC

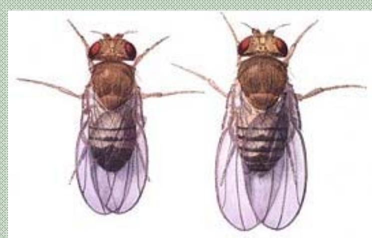
Codes for:

Tyr – Cys – Leu – Val –Gly – Arg

Thyrosine – Cysteine- Leucine – Valine – Glycine- Arginine

Fun Fact

- Humans share between 40 -50% of their genes with fruit flies
  http://www.nature.com/nature/journal/v4 … 241.html).

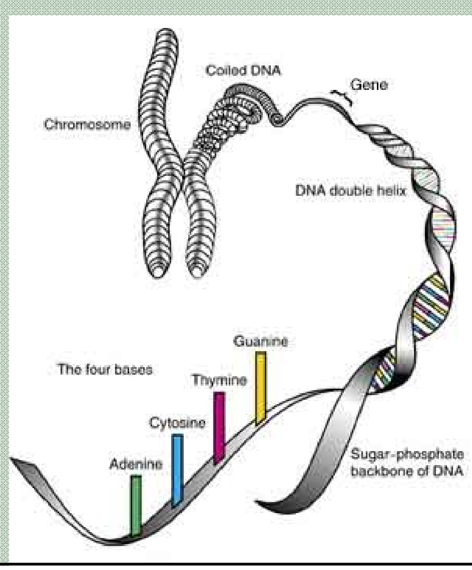


Fun Fact

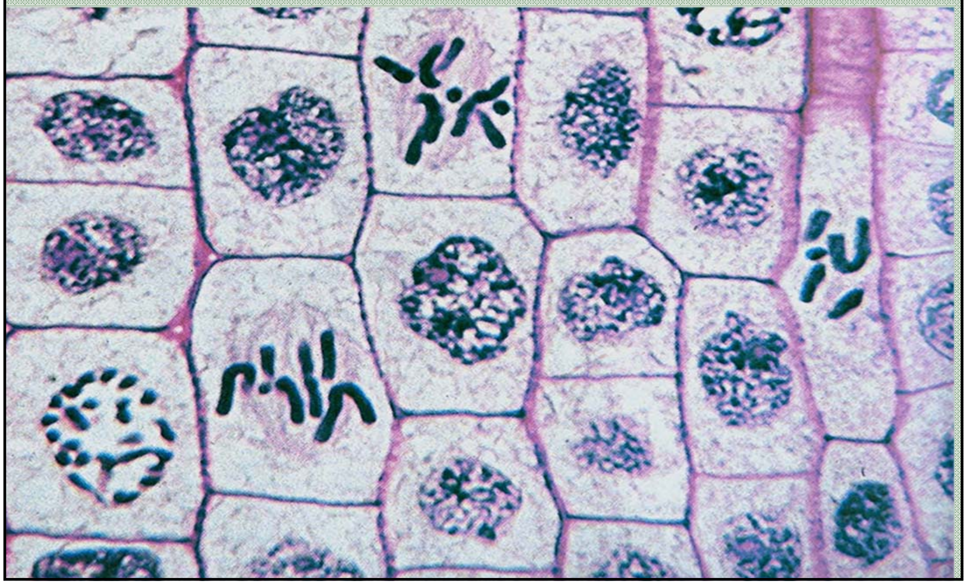
Now solve the mystery!

- Each group should send one person up to get their mystery DNA package.
- In this activity you are going to:
  - Build both sides of a ‘gene’
  - Figure out what amino acids the ‘gene’ codes for
  - Figure out the mystery word your strip of DNA codes for and put it on the board
  - Decode a DNA message

More details of DNA, Chromosomes and Genes

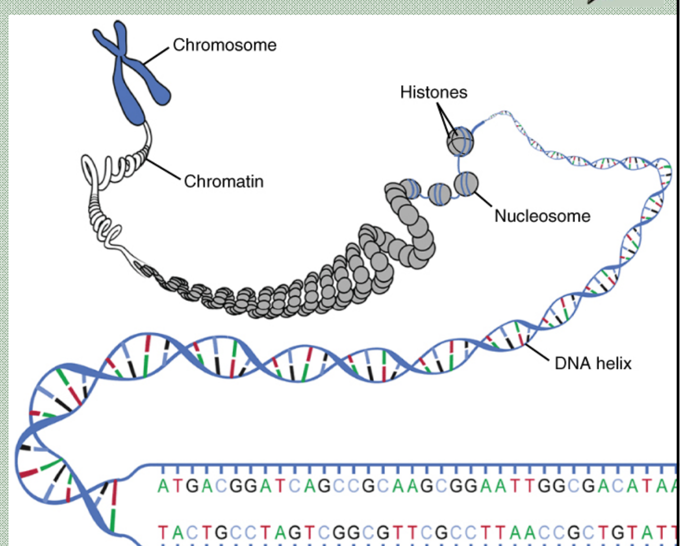


You find your chromosomes (which are made of DNA and proteins (histones)) in the nucleus of the cell.



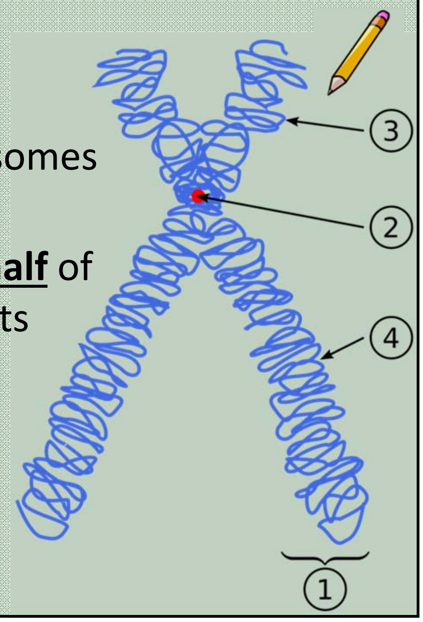
Up close look at a chromosome

- **A chromosome is made up of DNA coiled**- around proteins (histones.) This reduces tangling



Chromosomes

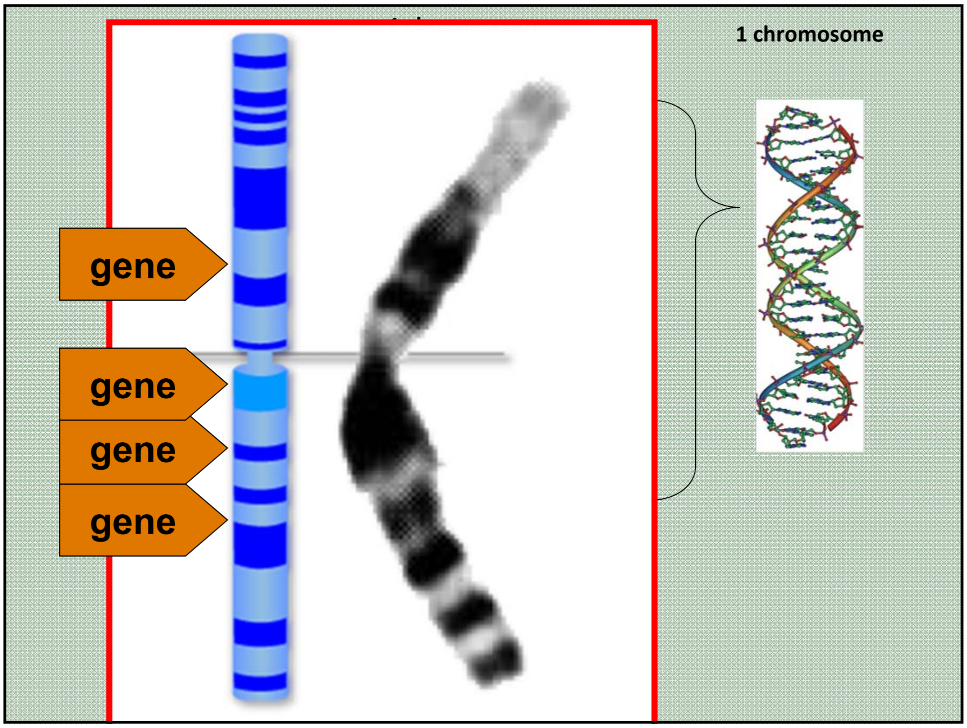
- Humans have **46** chromosomes in our **body** cells
- **Each** parent contributes **half** of his/her chromosomes to its **offspring**

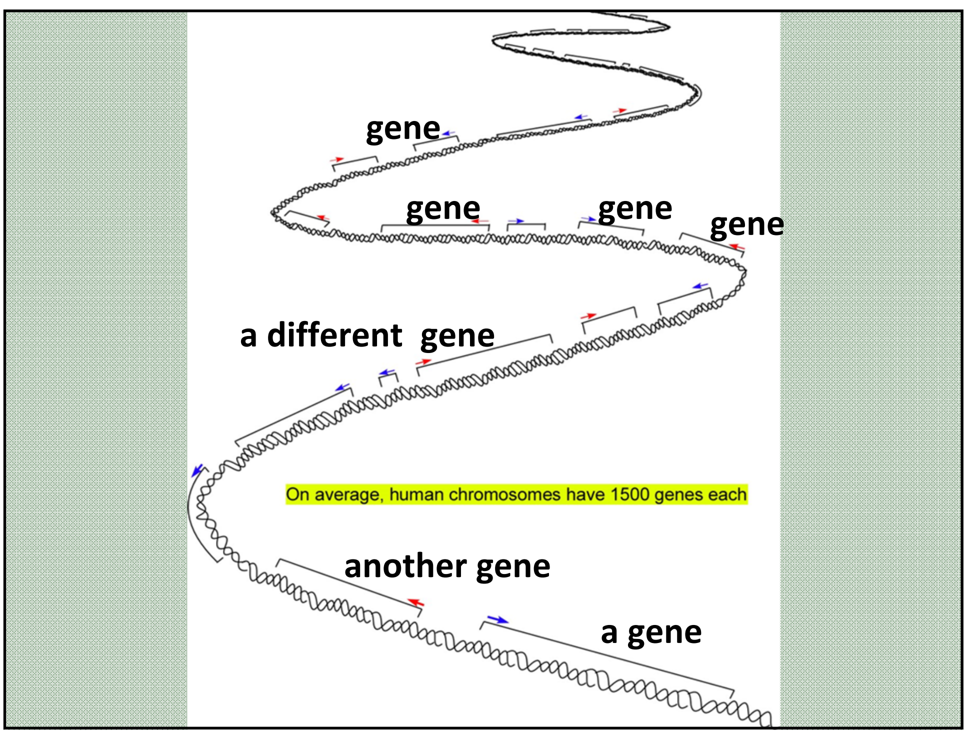


What are genes?

- Genes are short segments of **DNA** which contain the instructions for a trait in an organism
- Each chromosome has on average nearly 1000 **genes for a total of approximately 20,000 genes**

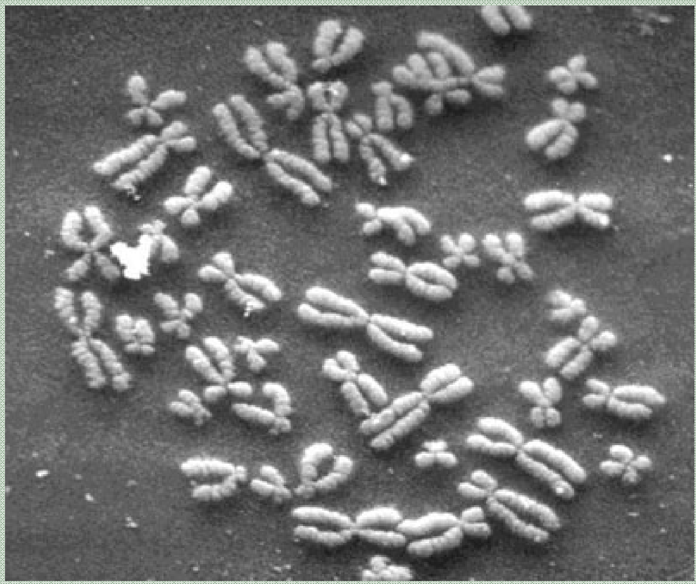
DeoxyriboNucleic Acid


1 chromosome
gene
gene
gene
gene


gene
gene
gene
gene
a different gene
On average, human chromosomes have 1500 genes each
another gene
a gene

FUN FACT

In the next 60 seconds your body will produce enough new DNA that if it was linked together, it would stretch 100,000 km



Introduction to Genetics

Did you know that

- Before heredity was understood - people use to think:
- That a giraffe came from the mating of a camel and a leopard?
- That an ostrich came from the mating of a camel and a sparrow?

Topics

- Introduction to Genetics and heredity
- Genetic terminology (glossary)
- Gregor Mendel – a brief bio
- Monohybrid crosses

What is genetics?

- The scientific study of heredity

Genetic Vocab

- **Heredity** - passing of traits from parent to offspring
- **Trait** – a genetic characteristic which is passed from parent to offspring e.g. eye colour

 34

Allele

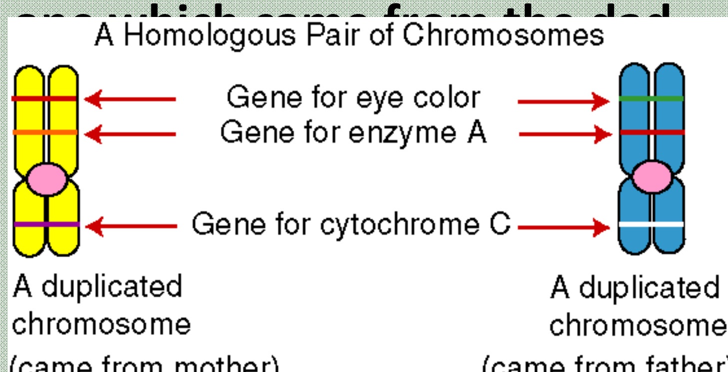
- Genes commonly have multiple different possible forms
- (e.g. different colors of a flower)
- Or different flavours of ice cream

Each variant of the gene is call an **ALLELE**
Above we see white, purple and yellow alleles for this type of flower.

 35

How does it work?

- **Each trait human has two genes – one which came from the mom and one which came from the dad**



Two ways to describe traits

- **Genotype** – states the two genes (alleles) that are present for the trait (e.g. Purple Purple, Purple white,white white, yellow white)
- **Phenotype** – states the physical appearance of the trait – the result of genes (e.g. purple flowers or white flowers)
- (and sometimes environment) e.g. Brown hair may lighten up due to exposure to the sun (genes and environment)
-

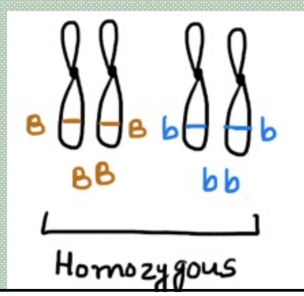
 37

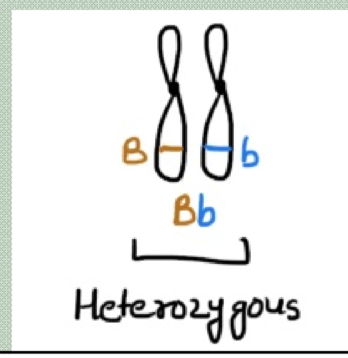
Genotype & Phenotype practice

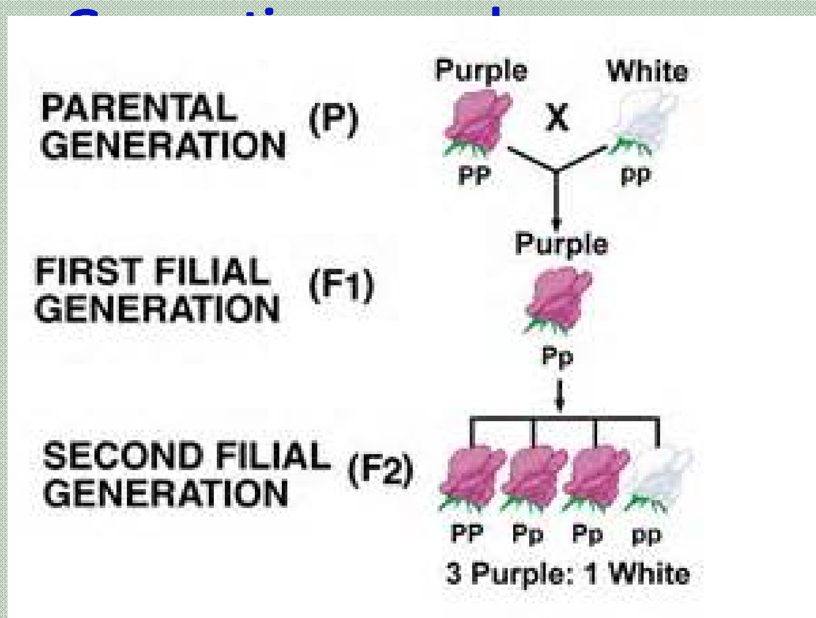
Genotypes	PP	pp
Phenotypes	purple	white

 38

- **MORE VOCAB**
- **Homozygous** – having identical genes (alleles) for a particular characteristic. (e.g. Purple purple, or white white)
- **Heterozygous** – having two different genes (alleles) for a particular characteristic. (e.g. Purple white)







History of Genetics

Gregor Mendel – Father of Genetics (1822-1884)

First person to describe the Laws governing Inheritance of Traits

 41

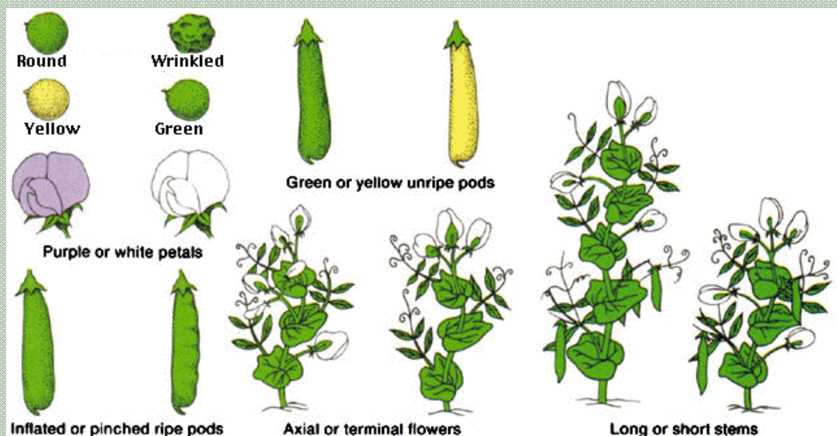
Mendel's Garden

Austrian Monk

- Between 1856 and 1863 Mendel grew and tested over 28,000 pea plants for inherited characteristics

Mendel's peas

- Mendel looked at seven traits or characteristics of pea plants which were controlled by a single gene:

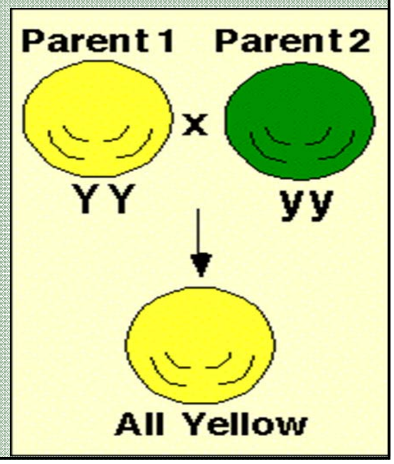


Mendel's experiments

- The first thing Mendel did was create a "pure" generation or true-breeding generation for that characterisitic
- This first group is the PARENTAL GENERATION

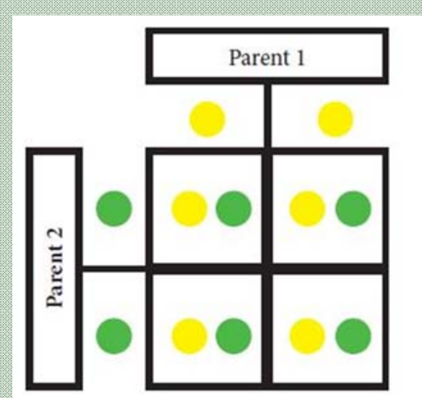
Mendel's First Cross

- When Mendel crossed pure yellow peas with pure green peas –> all the offspring were yellow



Results

- →**The offsprings of the pure yellow and pure green cross (F1 generation) each have one yellow and one green gene – BUT ALL OF THEM LOOKED YELLOW**



 46

Why were the offspring yellow? – Dominant and recessive genes

- **Dominant gene** – Dominant alleles turn off (mask) recessive alleles. In Mendel's peas - Yellow was dominant --so this is the colour seen in the offspring
- (Dominant genes are represented by a capital letter – e.g. Y for yellow)

- **Recessive gene** – the weaker gene, only seen if there is no dominant gene present.
- (Recessive genes are represented by a small letter version of the dominant gene e.g. y for green)

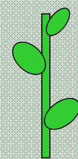
 47

Mendel's conclusions

- Characteristics are inherited.
- Characteristics (genes) may have multiple different forms called *alleles*
- Some alleles are dominant and some are recessive.

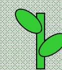
Practice - cross for stem length:

P = parentals
true breeding,
homozygous plants:



T T × *t t*

(tall) (short)

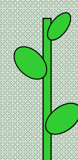


↓

F_1 generation
is heterozygous:

T *t*

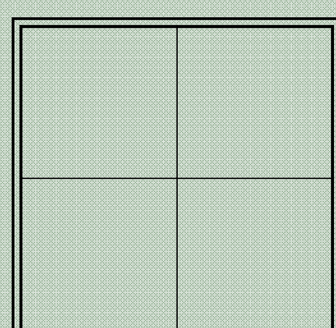
(all tall plants)



Punnett square

- A useful tool to do genetic crosses
- For a monohybrid cross, you need a square divided by four….
- Looks like a window pane…

We use the
Punnett square
to predict the
genotypes and phenotypes of
the offspring.



Using a Punnett Square

STEPS:

1. determine the genotypes of the parent organisms
2. write down your "cross" (mating)
3. draw a p-square

Parent genotypes:

TT and *t t*

Cross

T T × ***t t***

Punnett square

4. **"split" the letters of the genotype for each parent & put them "outside" the p-square**
5. determine the possible genotypes of the offspring by filling in the p-square
6. summarize results (genotypes & phenotypes of offspring)

T T × ***t t***

	T	**T**
t	**T *t***	**T *t***
t	**T *t***	**T *t***

Genotypes:
100% T t

Phenotypes:
100% Tall plants

Mendel's second cross – Monohybrid cross

- He allowed the F_1 generation to self-pollinate thus producing the F_2 generation.
- Did the recessive allele completely disappear?
- What happened when he crossed two tall pea hybrid (F_1) plants? (Tt)

Monohybrid cross→ F_2 generation

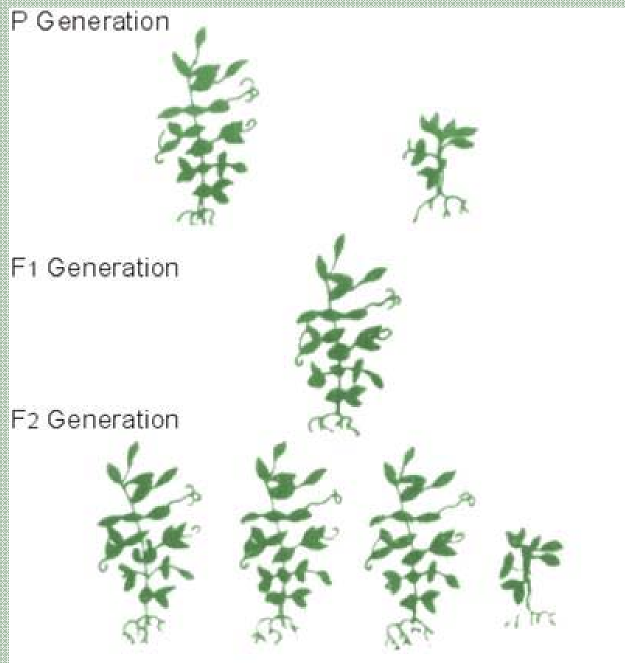
- If you let the F1 generation self-fertilize, the F2 generation would be:

T *t* × **T *t***
(tall) (tall)

	T	***t***
T	**T T**	**T *t***
t	**T *t***	***t t***

Genotypes:
1 TT= Tall
2 T*t* = Tall
1 *tt* = short
Genotypic ratio= 1:2:1

Phenotype:
3 Tall
1 short
Phenotypic ratio= 3:1



Experiment of Mendel's monohybrid ratio

Another example: Flower color

For example, flower color:

P = purple (dominant)

p = white (recessive)

If you cross a homozygous Purple (PP) with a homozygous white (*pp*):

P P × *p p*

↓

P *p*

ALL PURPLE (P*p*)

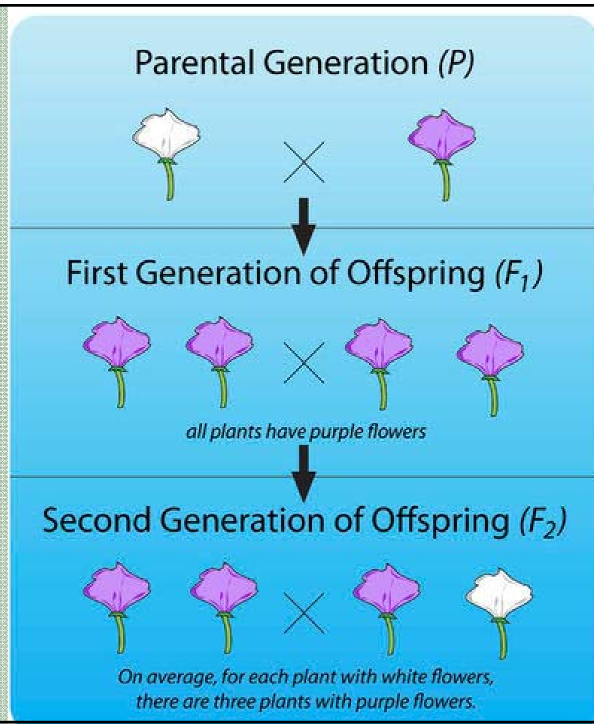
Cross the F1 generation → F2
Monohybrid cross

P *p* × P *p*

	P	***p***
P	**P P**	**P *p***
p	**P *p***	***p p***

F2 Genotypes:
1 PP
2 Pp
1 pp

F2 Phenotypes:
3 Purple
1 White



Did you know that?

Dominant alleles are not necessarily better or more common than a recessive allele.

Some dominant alleles are definitely less desirable

Dominant Allele Disorders

Achondroplasia

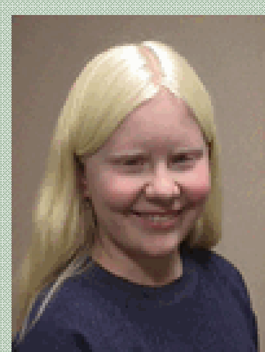
- Dwarfism
- Person grows no taller than 4’4

Dominant Allele Disorders

Polydactyly
- The presence of more than the normal number of fingers or toes.
- Can usually be corrected by surgery

Recessive Allele Disorders

Albinism
- **Lack of pigment in skin, hair, and eyes**
- Mutation in one of several genes which provide the instructions for producing one of several proteins in charge of making melanin.



Recessive Allele Disorders

Cystic Fibrosis (CF)

- Caused by recessive allele on chromosome 7 carried by 2.5% of Europeans
- Small genetic change (removes one Amino Acid) → changes protein

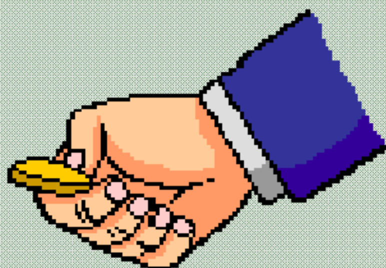
Inheritance pattern of CF

IF two parents carry the recessive gene of Cystic Fibrosis (*c*), that is, they are heterozygous (C *c*), one in four of their children is expected to be homozygous for *cf* and have the disease:

C C = normal
C *c* = carrier, no symptoms
c c = has cystic fibrosis

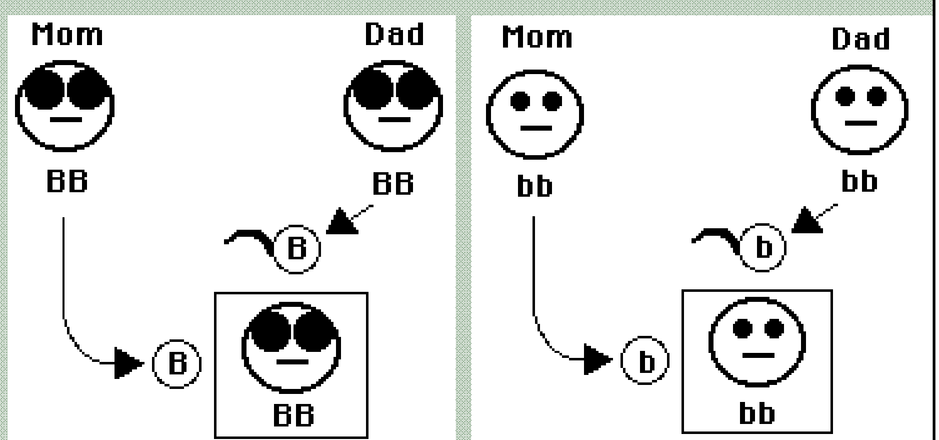
	C	***c***
C	**C C**	**C *c***
c	**C *c***	***c c***

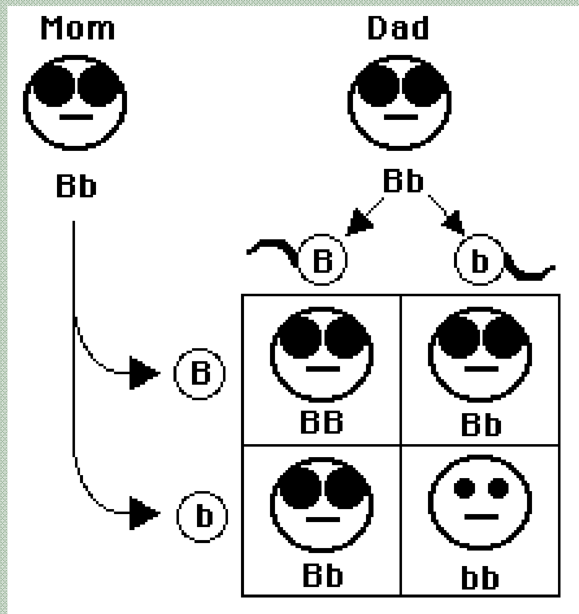
Probability



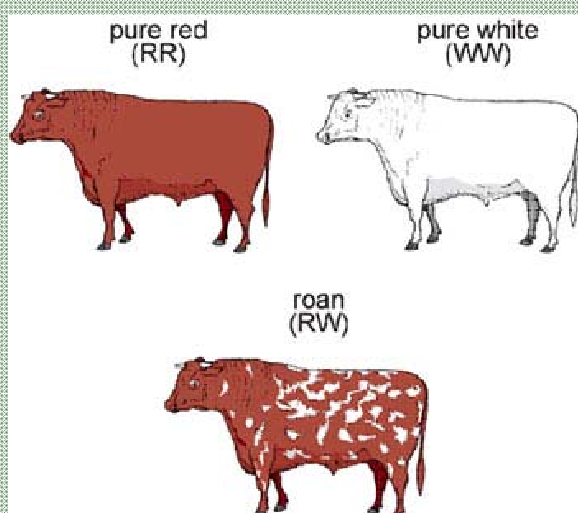
- The likelihood of a particular event occurring. Chance
- Can be expressed as a fraction or a percent.
- Example: coin flip.

Punnett square review:





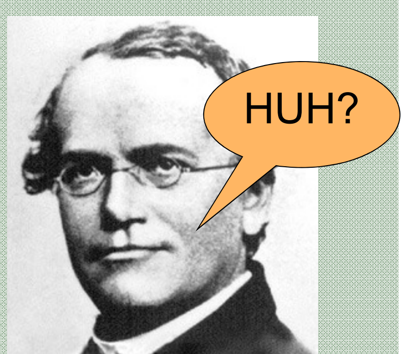
Genetics beyond Mendel



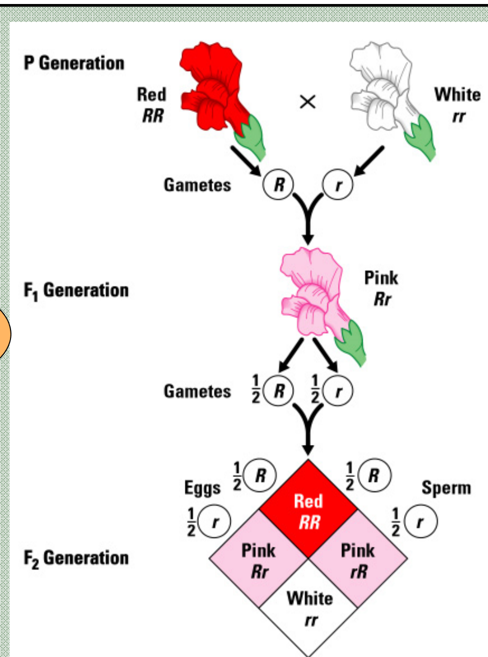
Some exceptions to Mendel's principles:

- Some alleles are **neither** dominant nor recessive.
- Many traits are controlled by **more than one gene** (polygenic traits)

- Snapdragons



http://www.dobermann-review.com/info/genetics/mendels_genetic_laws/Gregor%20Mendel.jpg



http://faculty.pnc.edu/pwilkin/incompdominance.jpg

Today's Goal:

Explain the difference:

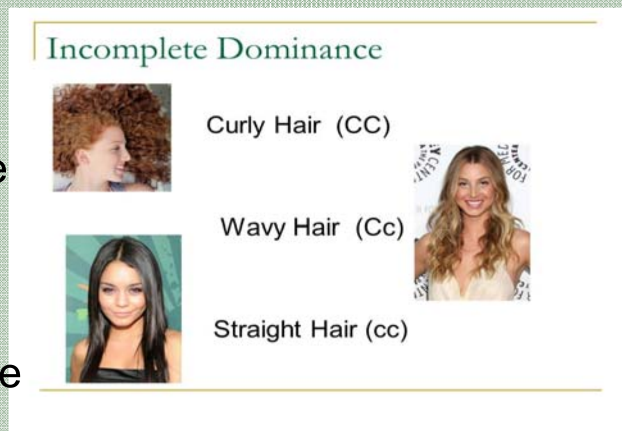
incomplete dominance	co-dominance

Incomplete Dominance

- Neither allele is dominant
- When two different alleles are present → a new - intermediate phenotype which is a mixture (blending) of the two
- (Straight hair + curly hair → wavy hair)

Incomplete Dominance

Neither allele is dominant
When two different alleles are present → an intermediate phenotype which is a mixture (blending) of the two

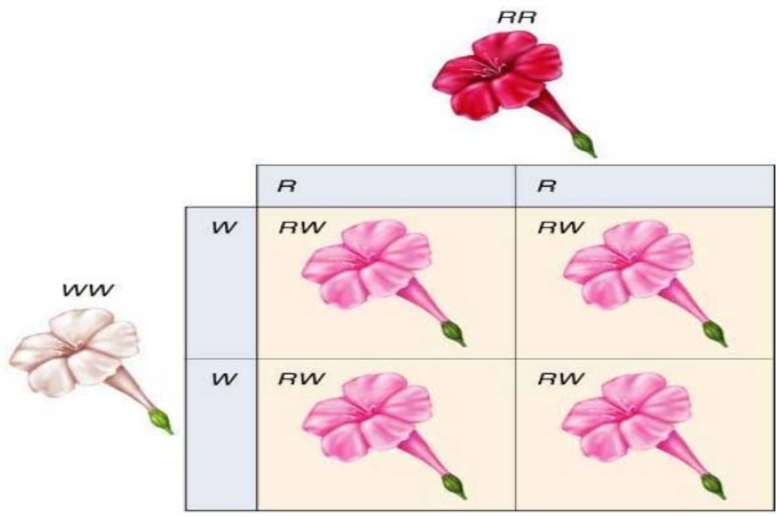


Four-o' clock flowers

- Incomplete dominance
- Neither Red (R)
- or White (W) is dominant

When a homozygous red flower (RR)
Mix with a homozygous white flower (WW), the alleles blend in the hybrid (RW) to produce pink flowers - so they have 3 phenotypes

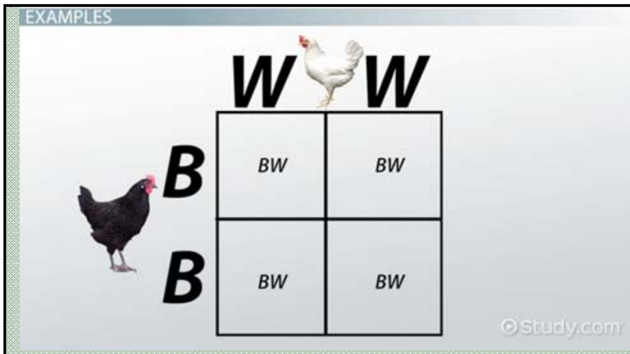
Incomplete Dominance

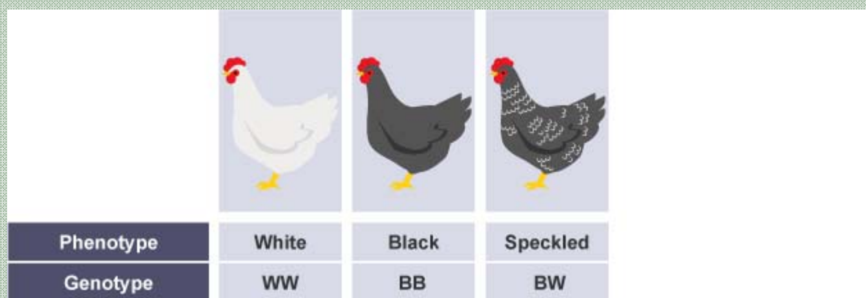


Andalusian Chickens

- Incomplete dominance
- Neither Black (B) or White (W) are dominant

The offspring of a black feathered chicken (BB) and a white feathered chicken (WW) are blue (BW)





Codominance

- Two alleles both are present in the phenotype
- Usually signified using superscripts.
- example: color of hair coat in cattle.
- c^rc^r = red hairs
- c^wc^w = white hairs
- c^rc^w = roan coat (mixture of both colors)
- heterozygous phenotype (e.g. RW) you will see both phenotypes clearly visible (will see red and white)

Shorthorn Cattle

- Co- dominance
- Homozygous red (RR)
- Homozygous white (WW)

The offspring of will have red hairs and white hairs (RW) (sometimes called Roan)

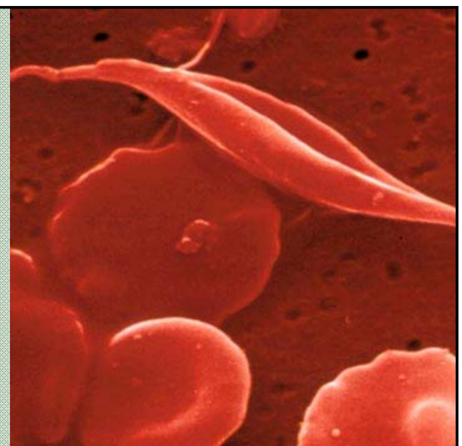
Roan Horse : Note – both red and white hairs

Codominance in flowers

Note:
Both Pink and white petals can be seen

Sickle- Cell Anemia

- Co- dominance
- Caused by an abnormal Hemoglobin, the protein that red blood cells use to carry oxygen



Normal hemoglobin is (RR)
Sickle Cell shaped blood cells (SS)
People who are carriers (heterozygous) for the disease there is a mixture of both normal and sickle cell (RS)

Problem: Codominance

- Show the cross between an individual with sickle-cell anemia and another who is a carrier but not sick.

GENOTYPES:
- NS (2) SS (2)
- ratio 1:1

PHENOTYPES:
- carrier (2); sick (2)
- ratio 1:1

	N	S
S	NS	SS
S	NS	SS

Let's Stop and Think…

- Let's say there are two alleles for the hair color trait- red and blue
  - What would be the resulting phenotype of a heterozygous pair if the alleles showed incomplete dominance?
    - A. Red
    - B. Blue
    - C. Purple
    - D. Red and Blue patches
    - Answer - purple

Let's Stop and Think…

- Let's say there are two alleles for the hair color trait- red and blue
  - What would be the resulting phenotype of a heterozygous pair if the alleles showed codominance?
    - A. Red
    - B. Blue
    - C. Purple
    - D. Red and Blue patches
    - **Red and Blue patches**

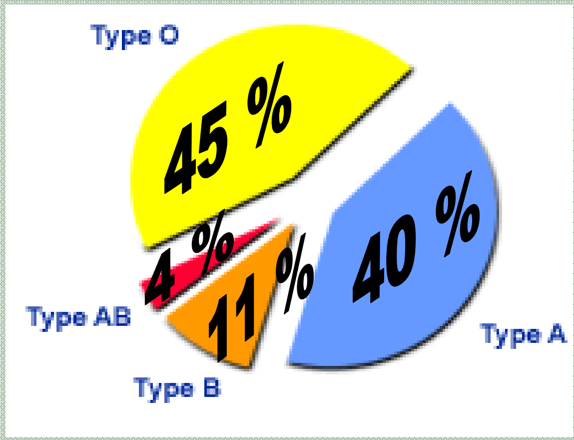
MULTIPLE ALLELISM

- When there is more than 2 alleles possible for a given gene.
- Allows for a larger number of genetic and phenotypic possibilities.
- Human blood types: A,B,O and AB

How common are the different blood types?

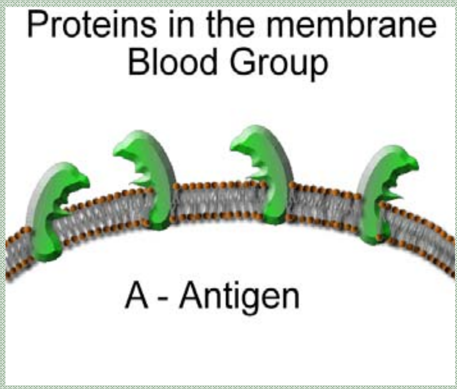
A and B are codominant to each other.

Both A and B are dominant over O.

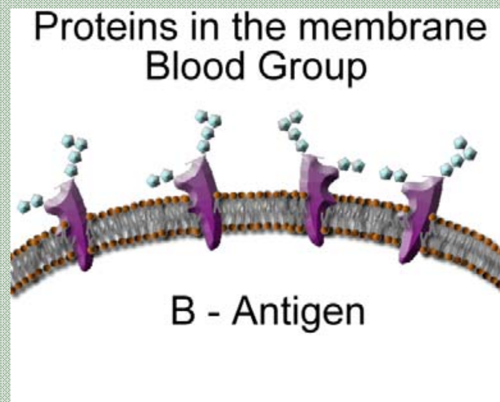


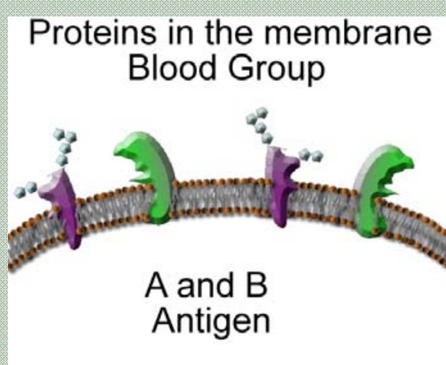
Human Blood types:

- TYPE A
- Allele = I^A
- Red Blood cells have type A antigens (proteins) on the surface.

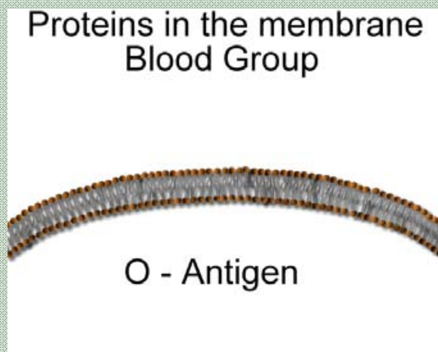


- TYPE B
- Allele = I^B
- Red Blood Cells have type B antigens (proteins) on their surface



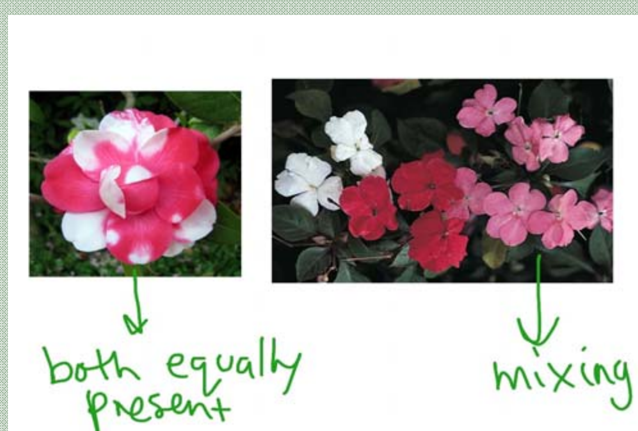


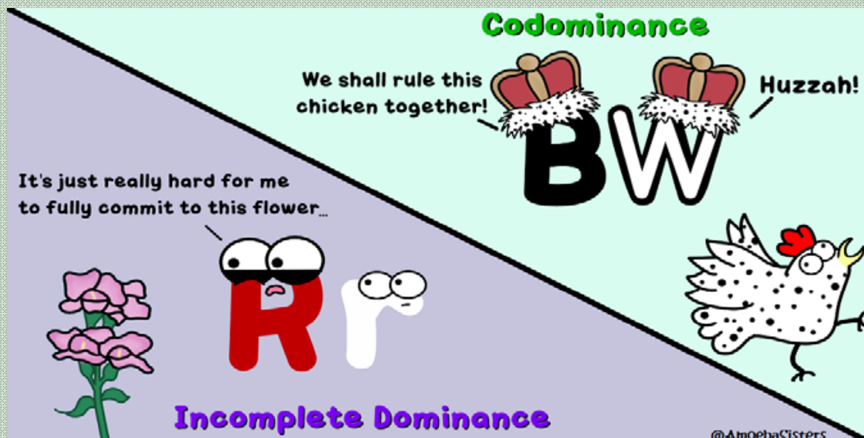
- TYPE AB
- genotype = I^AI^B
- Blood cells contain both types of antigens (proteins)
- A and B are ….
- Codominant



- TYPE O
- Allele = i
- No antigens (proteins) on the surface of the blood cells
- i is recessive to A and B

Which is co-dominance?
Which is incomplete dominance?





PRACTICE QUESTIONS

1. In a certain case a woman's blood type was tested to be AB. She married and her husbands blood type was type A. Their children have blood types A, AB, and B. What are the genotypes of the parents?

Mom - I^AI^B

Dad – $I^A i$

2. In a certain breed of cow the gene for red fur, ***R***, is **codominant** with that of white fur, ***W***. What would be the genotypes and phenotypes of the offspring if you breed a red cow and a white bull?

Genotypes – all red and white

Phenotypes – all roan (some red and some white hairs

What would they be if you breed a red & white cow with a red & white bull?

Genotypes – 1 red, 2 red and white, 1 white

Phenotypes -1 red, 2 roan (red and white), 1 white

3. A rooster with grey feathers is mated with a hen of the same phenotype. Among their offspring 15 chicks are grey, 6 are black and 8 are white. What is the simplest explanation for the inheritance of these colors in chickens?

As there are three phenotypes, this is likely incomplete dominance, with the grey rooster being a blend of the black and white – genotype BW

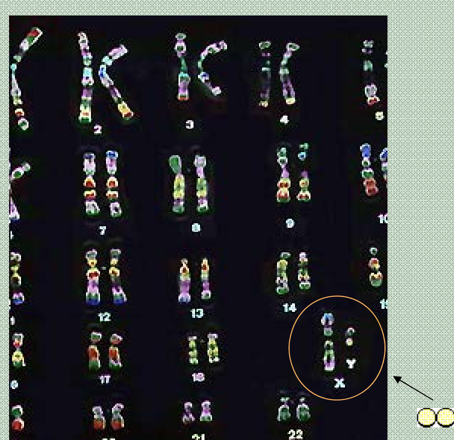
b. What offspring would you expect from the mating of a grey rooster and a black hen?

50% of young will be BB (black) and 50% of the young would be BW (grey)

- A man with type AB blood marries a woman with type B blood whose father has type O blood. What are the chances that they have a child with type A blood?
- 50% chance of A type blood (1 AO and 1 AA)
- Type AB?
- 25% chance of AB blood

Sex Linked Traits

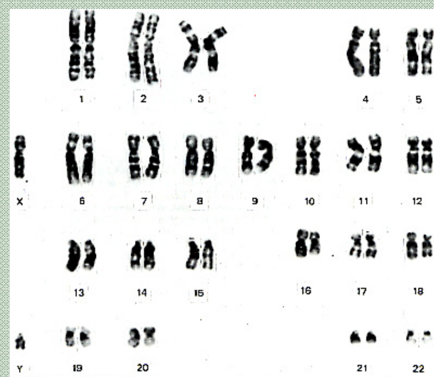
- Humans have 23 pairs of chromosomes.
- One pair of chromosomes is related to the sex of an individual , these chromosomes are called sex chromosomes



Sex Linked Traits

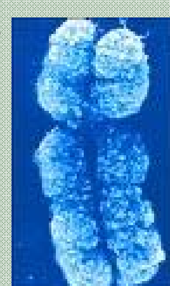
- The other 22 pairs of chromosomes are called autosomes (1-22)

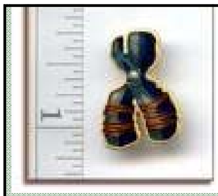
XY male
XX female



X chromosome

- The X chromosome contains genes that code for all aspects of femaleness and genes unrelated to gender.
- Including genes for:
  - Vision
  - Immunity





Y chromosome

- The Y chromosome is much smaller than the X.
- It carries a small number of genes, most of which are for “male characteristics”

Sex Linked Traits

- Traits controlled by genes which are located on the X and Y chromosome
- <u>X-linked genes</u> are genes found on the X chromosome, symbolized by X^r, X^R
- <u>Y-linked genes</u> are found on the Y chromosome, symbolized by Y^r, Y^R

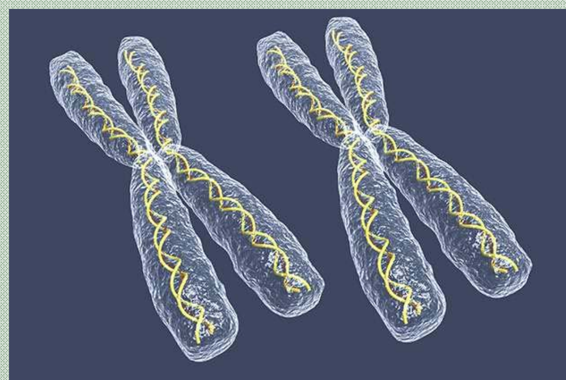
SEX-LINKED INHERITANCE

- Most known sex-linked traits are X-linked (carried on the X chromosome). This is probably because the X chromosome is much larger than the Y chromosome.

Sex Linked Traits

- males have one X chromosome
- Recessive sex linked traits (eg color blindness) are therefore expressed with one copy of the gene

- Females have two X chromosome
- Two copies of a recessive sex linked traits (eg color blindness) are necessary before a female is colour blind.

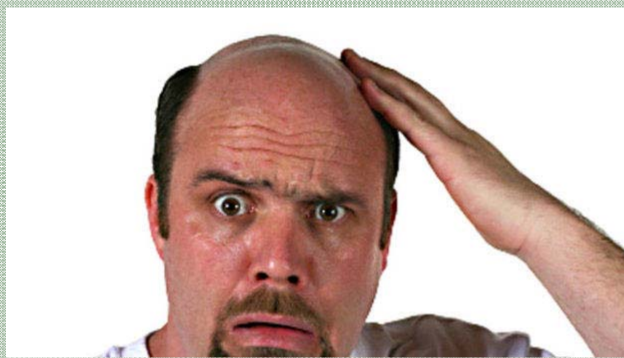


Carriers

- Carriers - a person that has one dominant and one recessive gene for a trait.
- Only women, with two X chromosomes can be carriers of sex linked traits.
- Ex. Color blind carrier $X^{\underline{C}}$ X^{c} ($\underline{C}$= normal, c= colorblind)

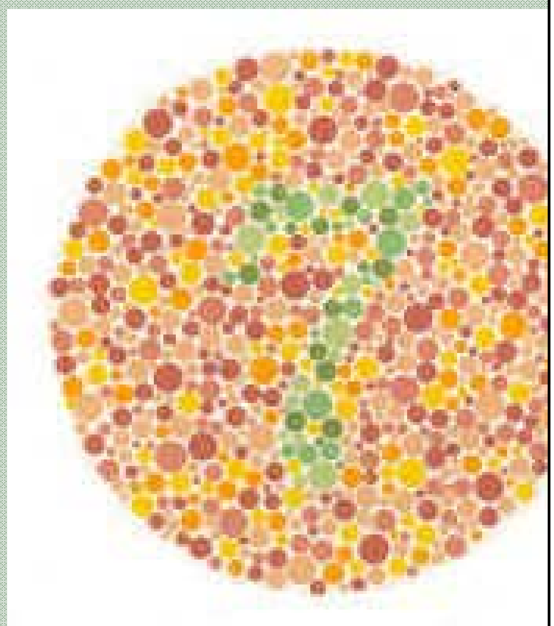
EXAMPLES OF SEX-LINKED TRAITS and DISORDERS

- Male pattern baldness, red-green colour blindness, myopia, night blindness, hemophilia



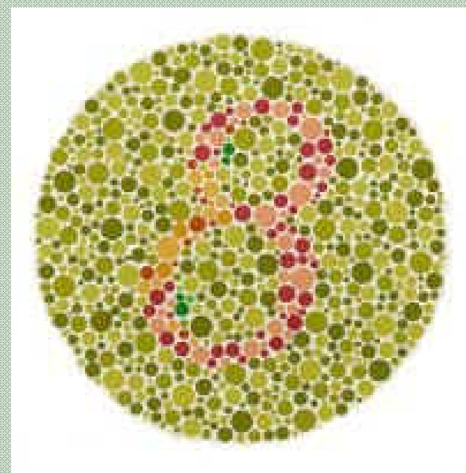
Colorblindness

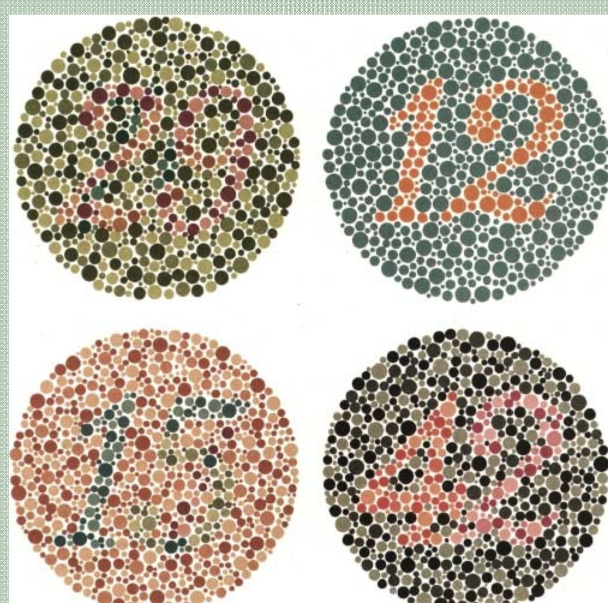
- A person with normal color vision sees a number seven in the circle above.
- Those who are color blind usually do not see any number at all.



Colorblindness

- <u>RED-GREEN COLORBLINDNESS</u>:
- People with red-green color blindness see either a three or nothing at all.
- Those with normal color vision see an 8.





Sex Linked Punnett Squares

- A colorblind male marries a normal female. What are the offspring genotypes and phenotypes? (C̲ = normal, c = colorblind)

	X^c	Y
$X^{\underline{C}}$		
$X^{\underline{C}}$		

Sex Linked Punnett Squares

- A colorblind male marries a normal female. What are the offspring genotypes and phenotypes?

(C̲ = normal, c = colorblind)

	X^c	Y
$X^{\underline{C}}$	$X^{\underline{C}}$ X^c	$X^{\underline{C}}$ Y
$X^{\underline{C}}$	$X^{\underline{C}}$ X^c	$X^{\underline{C}}$ Y

Sex Linked Punnett Squares

- A normal male (not colorblind) marries a carrier. What are the offspring genotypes and phenotypes?

	$X^{\underline{C}}$	Y
$X^{\underline{C}}$		
X^{c}		

Sex Linked Punnett Squares

- A normal male (not colorblind) marries a carrier. What are the offspring genotypes and phenotypes?

	$X^{\underline{C}}$	Y
$X^{\underline{C}}$	$X^{\underline{C}}$ $X^{\underline{C}}$	$X^{\underline{C}}$ Y
X^{c}	X^{c} X^{c}	X^{c} Y

Sex Linked Punnett Squares

- A normal male (not colorblind) marries a colorblind female. What are the offspring genotypes and phenotypes?

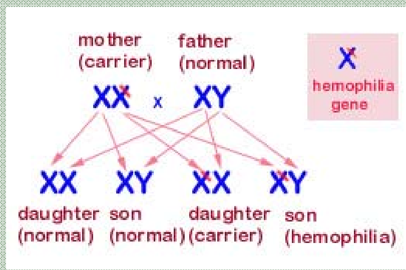
	$X^{\underline{C}}$	Y
X^c		
X^c		

Sex Linked Punnett Squares

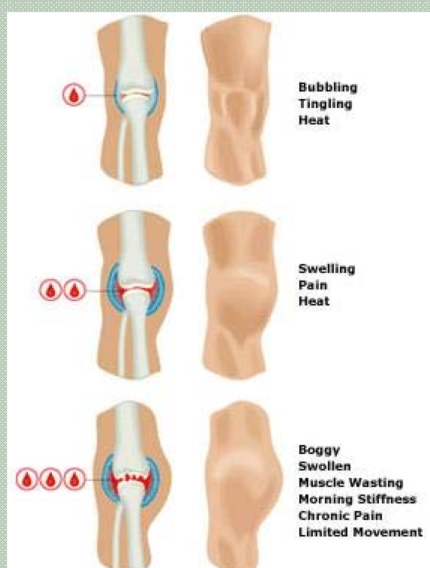
- A normal male (not colorblind) marries a colorblind female. What are the offspring genotypes and phenotypes?

	$X^{\underline{C}}$	Y
X^c	$X^{\underline{C}} X^c$	$X^c Y$
X^c	$X^{\underline{C}} X^c$	$X^c Y$

Hemophilia

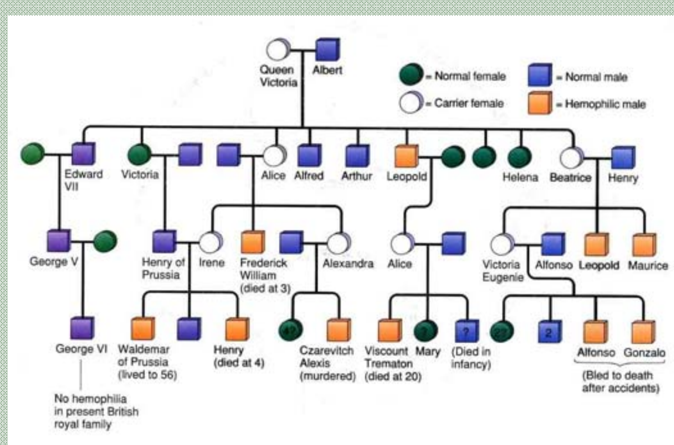


- Hemophilia is characterized by uncontrolled bleeding
- It is a sex linked disorder caused by errors in the DNA that codes for the proteins involved in clotting



Complications from hemophilia include: bruising and bleeding into the muscles, bleeding into the joints, infection, adverse reaction to transfusions and serious bleeding.

PEDIGREE OF QUEEN VICTORIA

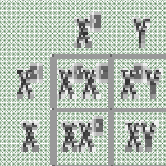


Czar Nicholas II & Family

- Cross a carrier mother with a hemophiliac father.

	X^H	X^h
X^H	X^HX^H	X^HX^h
Y	X^HY	X^hY

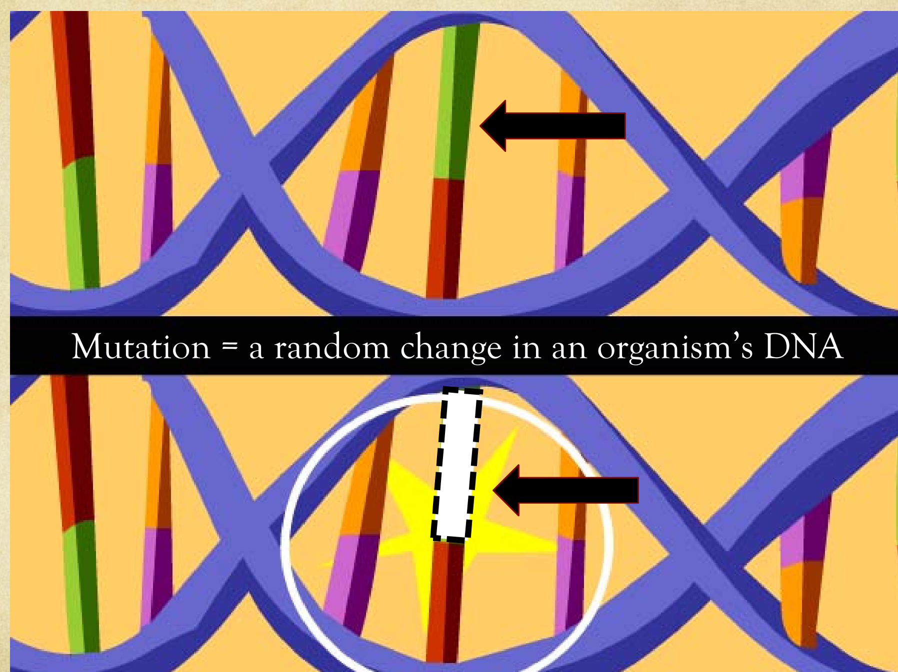
- What is the only way for a female to show a recessive sex-linked trait?
  - –She must inherit a recessive trait from both her mother and father. (her father must have the disorder)
- How does a male show a recessive sex-linked trait?
  - –He must inherit the recessive trait from his mother. He gets the Y from his father so it has no bearing on a sex-linked disorder.



Sex determination in other species

- TED Ed - Sex Determination

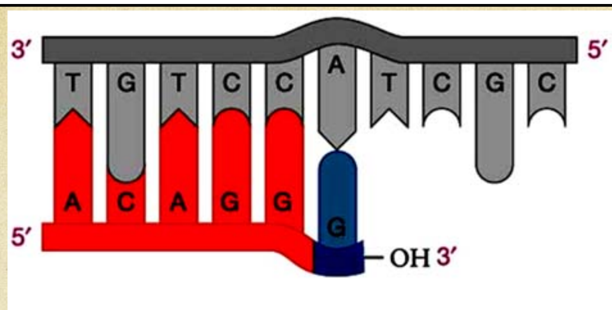
Mutations



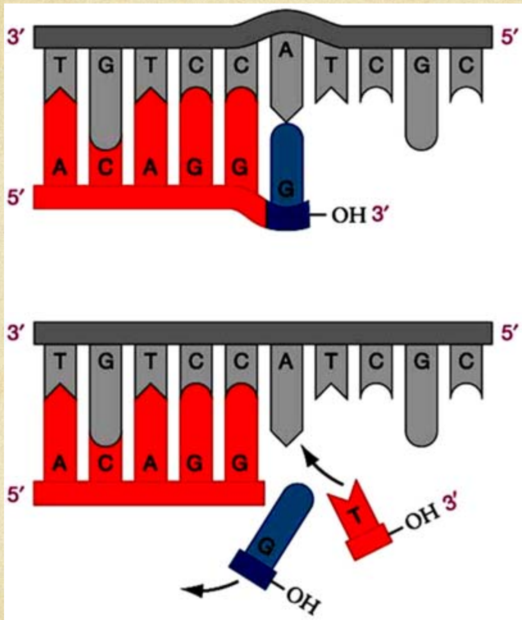
Definition of Mutation

1. A **random** **change** in an organism's DNA

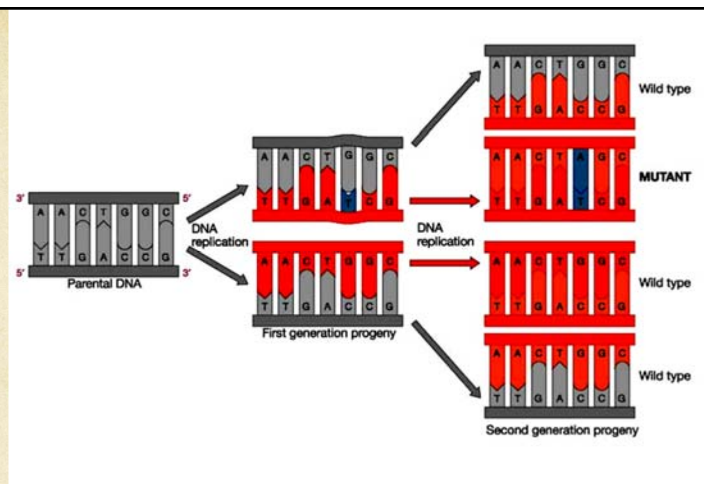
2. Can be **inherited** – passed down from a parent to their **offspring**



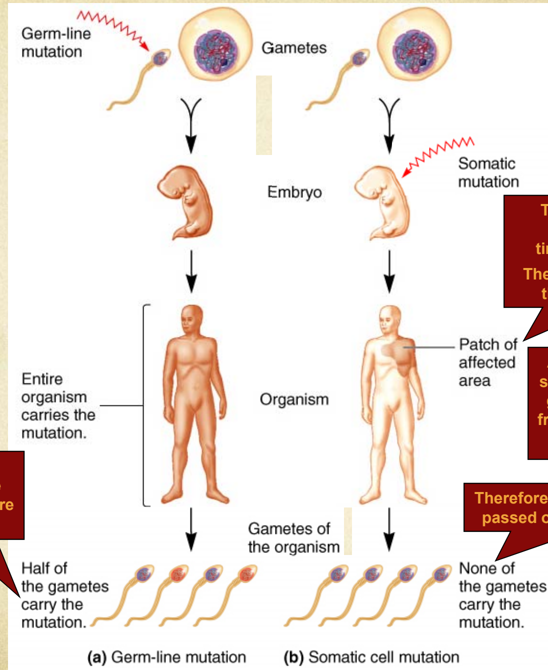
Sometimes mistakes occur when DNA is copied



Usually your body finds and corrects these mistakes



If the mistake is not corrected it becomes a mutation



The size of the patch will depend on the timing of the mutation

The earlier the mutation, the larger the patch

An individual who has somatic regions that are genotypically different from each other is called a genetic mosaic

Therefore, the mutation can be passed on to future generations

Therefore, the mutation cannot be passed on to future generations

Figure 16.4

16-22

Circle one!

#4. Mutations that occur in

[sex cells / body cells / any cell]

can be passed down to offspring.

HINT 1

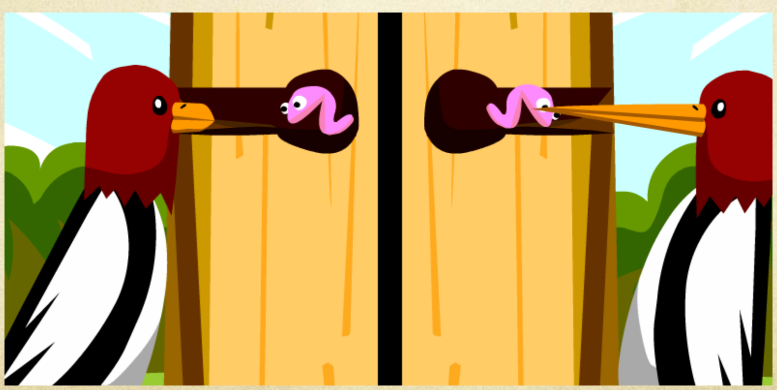
HINT 2

HINT 3

What Can Mutations Do?

Mutations can be **POSITIVE (helpful)**

- Some mutations can provide an ***advantage*** which helps the organism survive



Mutations can be **NEUTRAL (not harmful, not helpful)**

- Some mutations do not effect the organism's survival (the mutation does not help or hurt the organism)

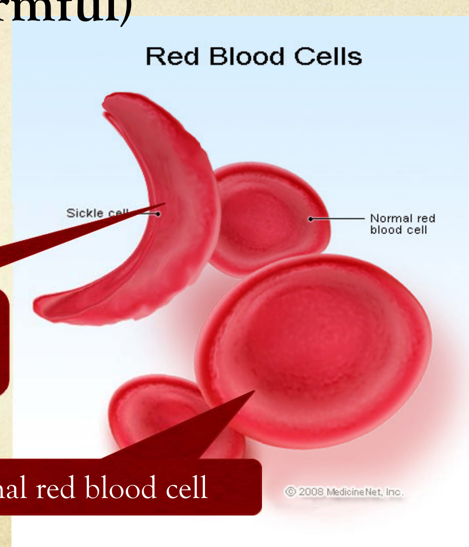
bright green feather **mutation**

Normal (dark green feathers)

syndactyly

Mutations can be **NEGATIVE (harmful)**

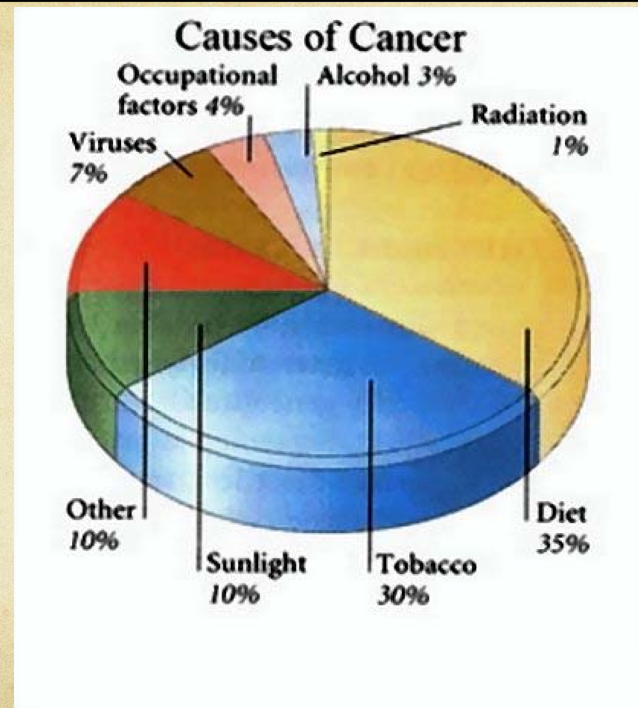
- Some mutations are harmful, and hurt the organism's chances for survival



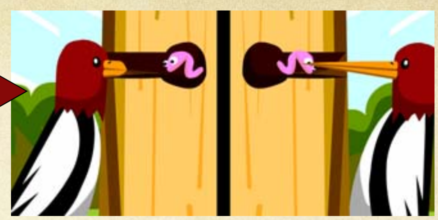
Mutated blood cell (person with sickle cell anemia)

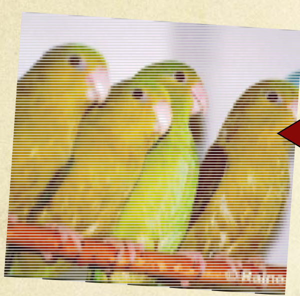
Normal red blood cell

Carcinogens



Some mutations can be helpful





Some mutations can have no effect (**NEUTRAL**)

Some mutations can be harmful

A mutation may be POSITIVE, or NEUTRAL, or NEGATIVE depending on the environment

Which bird would have the best chances of survival in a forest where all the leaves were BLUE?

What impact do DNA mutations have?

Mutation→

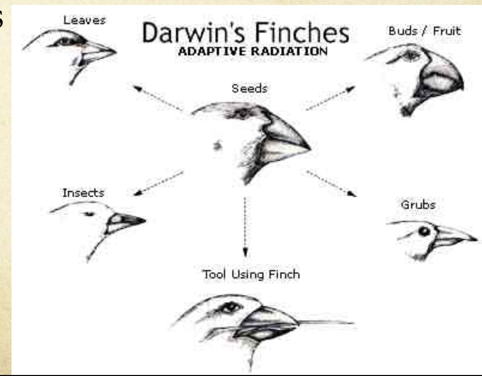
Genetic Diversity→

Natural Selection→

Evolution!

Natural Selection→ Evolution

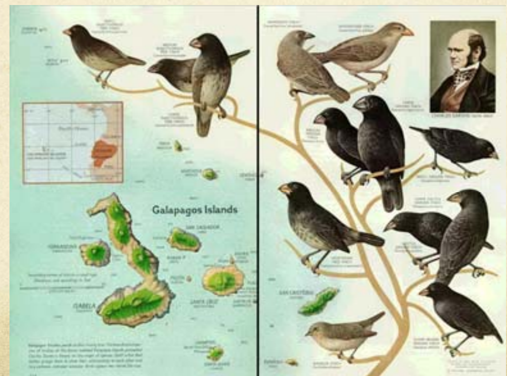
- Favorable traits are passed on through the generations
- Well-adapted individuals survive and reproduce



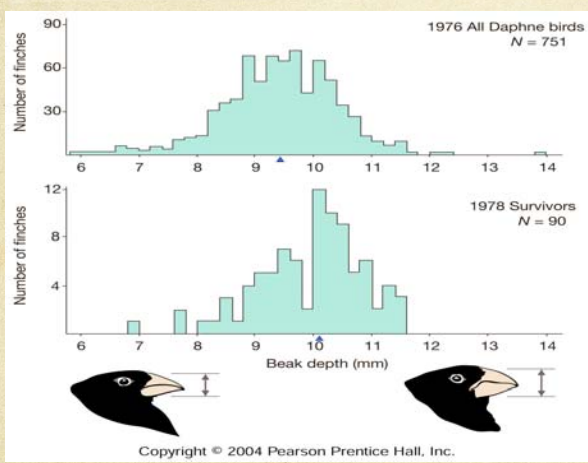
An example -- All arose from a single species

How did so many species evolve?

- Different environments
- And
- Changing environments

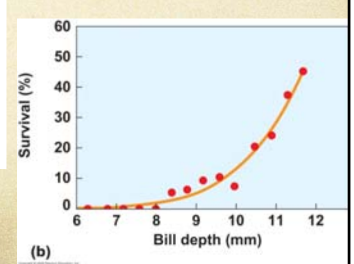


An example of change

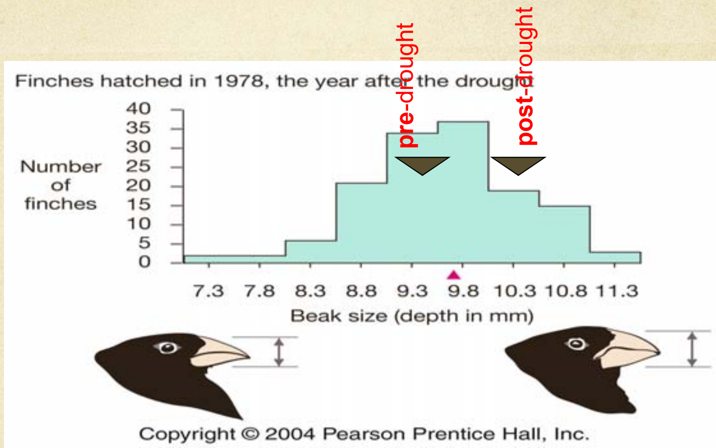


In 1978, there was a severe drought, small seeds declined more than large seeds.

Small beak birds have difficult to find seeds, and suffered heavy mortality, especially females.



Average beak size before and after drought
Beak size evolves



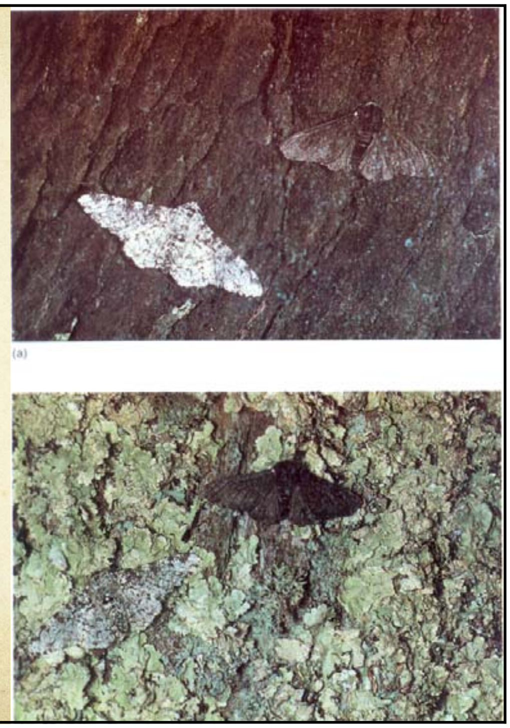
Conclusion: Nature selection indeed caused evolution in beak size

Other changes in response to the environment

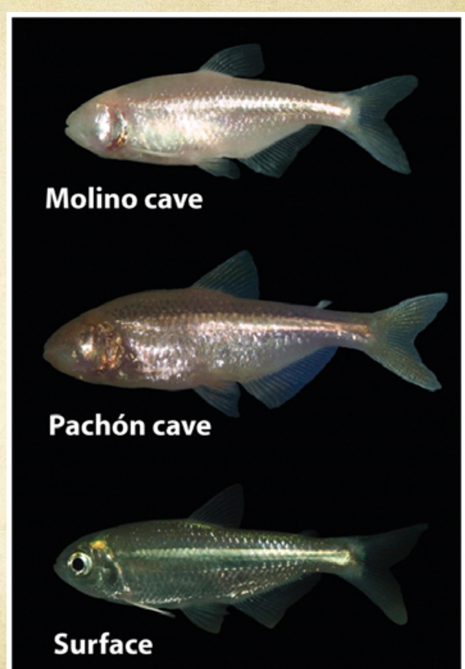
Peppered Moths in Great Britain

Before pollution – most of the moths were black and white speckled –bottom picture

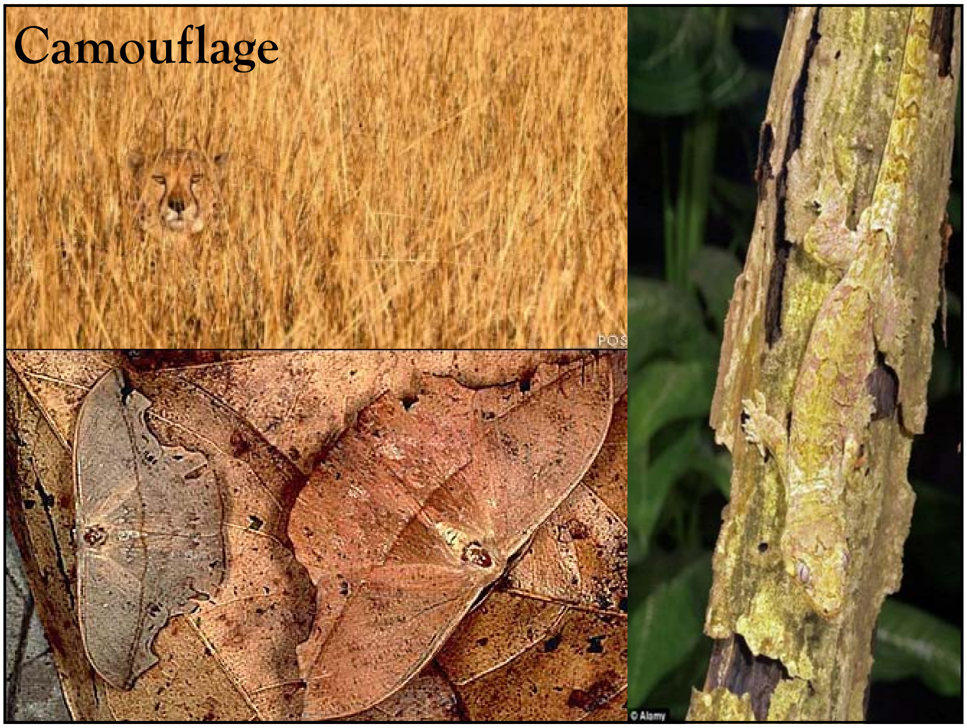
After pollution darkened tree trunks – the most common colour of the moths changed to a dark colour – upper picture



Evolution-Cave fish are most commonly albino and blind(gene inactivation)

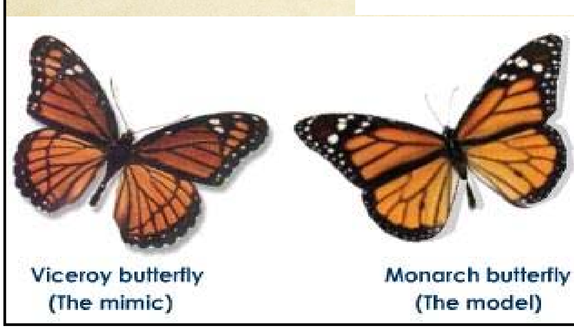


Camouflage



Mimicry

- an adaptation that allows an organism to "copy" its appearance of another organism!

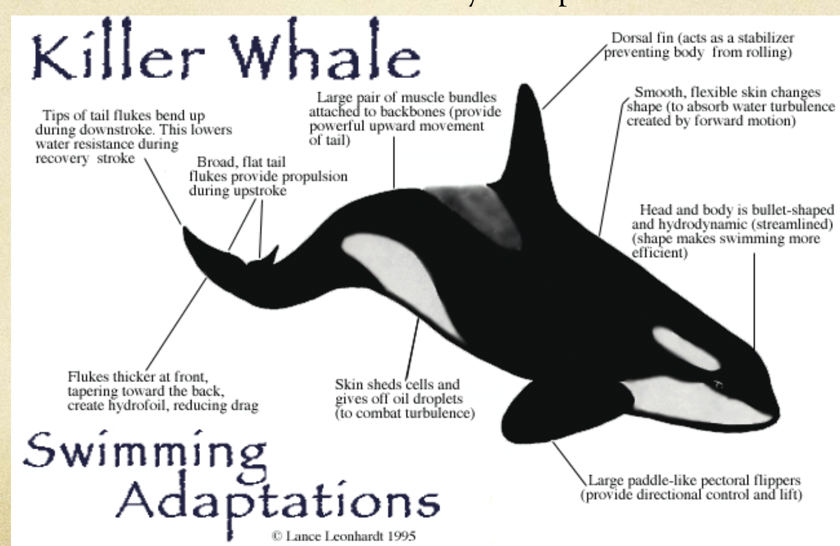


Remember!

- ORGANISMS **cannot** CHOOSE to genetically change to adapt to their environment.
- Genetic mutations occur in response to mutagens e.g. Radiation, Sunlight, some chemicals
- IF the mutation is ALREADY present **then** the organism can change.

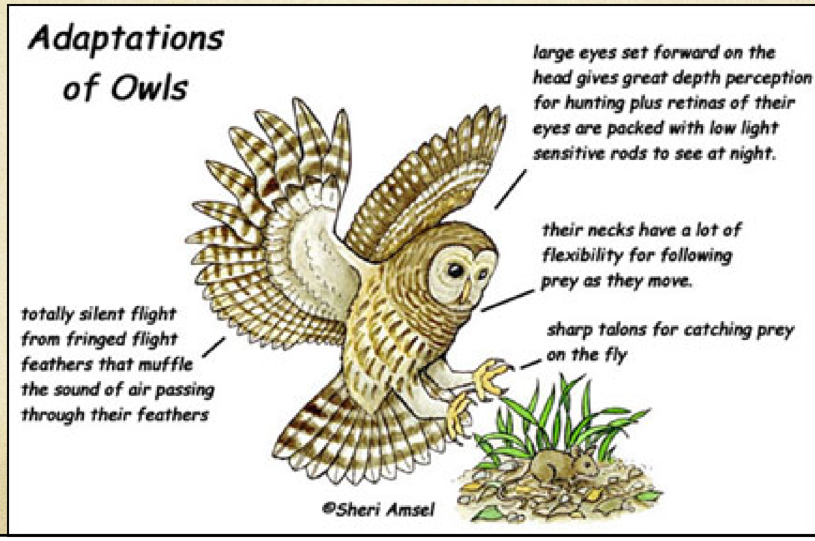
Adaptation

- Heritable variations that INCREASE an individual's chance of survival and ability to reproduce



Adaptation

- Could involve body parts or structure



Adaptation

- Could involve color (camouflage or mimicry)

Adaptation

- Eagles see clearly in the daytime and can hold enough air in their lungs to fly in high altitudes

If the mutation increases the probability of survival and reproduction it increases in the gene pool.

Review
How does DNA relate to evolution?

Mutation→

Genetic Diversity→

Natural Selection→

Adaptation→

Evolution!

How do Mutations Affect Populations?

1. **Mutation** – a ____________ _____________ in the DNA sequence
2. **Genetic Variety** – different types of ___________
3. **Natural Selection** – when a _________________ trait helps an organism _______________ AND _____________ it will get passed on to future generations and possibly enable the _______________ to ______________ (& maybe even ___________ over a ___________ period of time)
4. **Evolution** – when a _________________ adapts over a _______ period of time

1) Random changes in the DNA of an organism is known a_____

1. Variation
2. Mutation
3. Gene Flow
4. Sexual reproduction

2) Which of the following can a mutation cause?

1. Change in physical characteristic
2. Change in an organisms behavior
3. A change in the physiology of the animal
4. All of the above

3) Mutations can cause really noticeable changes in organisms

1. True
2. False

4) Mutations can be

1. Beneficial
2. Harmful
3. Have No affect
4. All of the above

5) What are some external causes of mutations?

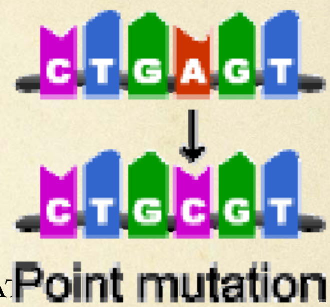
1. Chemicals
2. Radiation
3. Both 1 and 2
4. None of the above

6) Variation in a species is caused by what two things

1. Sexual Reproduction
2. Asexual Reproduction
3. Mutations
4. Adaptations

Gene Mutations

- Point Mutations – changes in one or a few nucleotides
  - Substitution
    - THE FAT CAT ATE THE RAT
    - THE FAT HAT ATE THE RAT
  - Insertion
    - THE FAT CAT ATE THE RAT
    - THE FAT CAT XLW ATE THE RAT
  - Deletion
    - THE FAT CAT ATE THE RAT
    - THE FAT ATE THE RAT

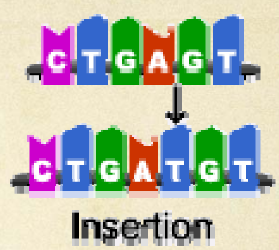


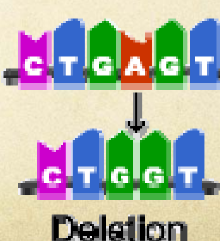
Gene Mutations

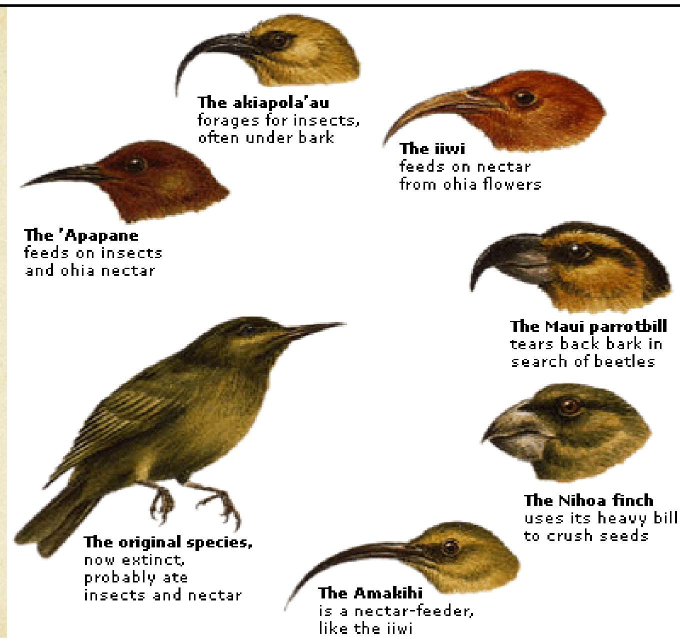
- Frameshift Mutations – shifts the reading frame of the genetic message so that the protein may not be able to perform its function.
  - Insertion
    - THE FAT CAT ATE THE RAT
    - THE FAT HCA TAT ETH ERA T

      H
  - Deletion
    - THE FAT CAT ATE THE RAT
    - TEF ATC ATA TET GER AT

      H







Forty nine species of honey creepers are thought to have arisen from one species