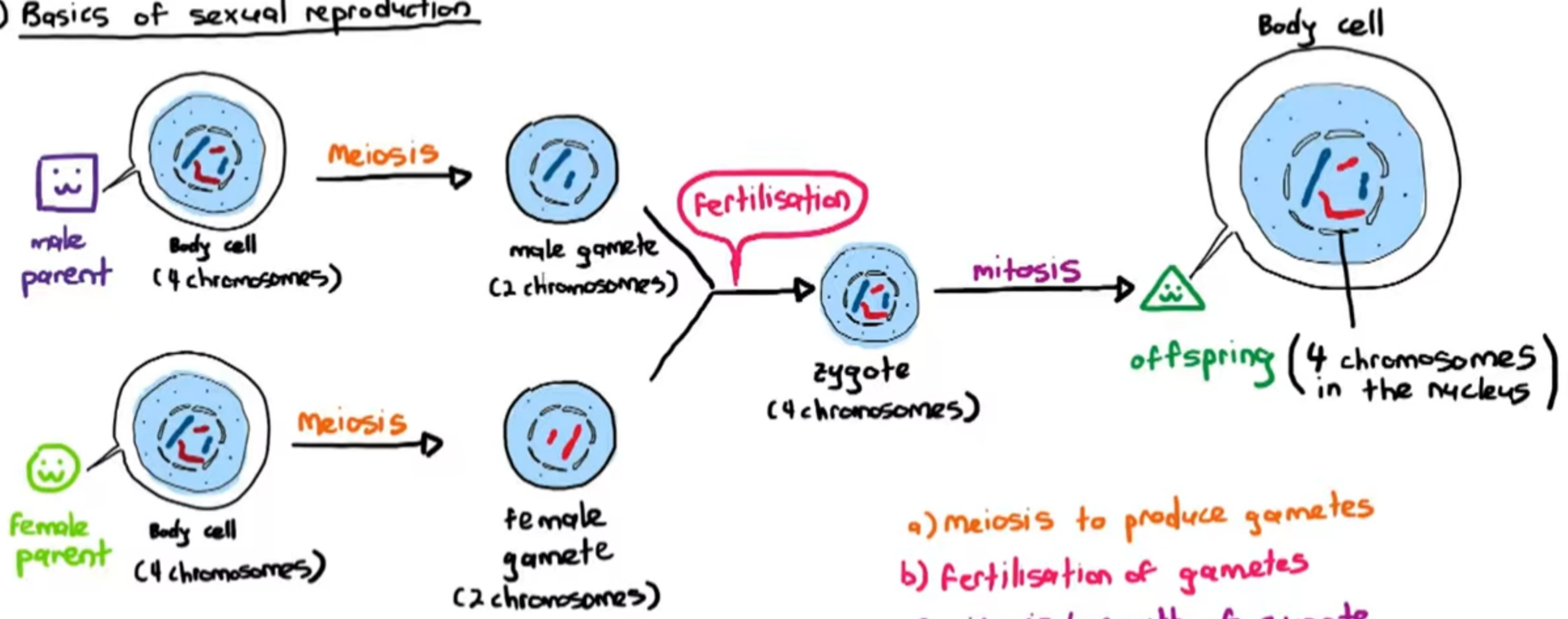
Chapter 16: Inheritance

① Basics of sexual reproduction

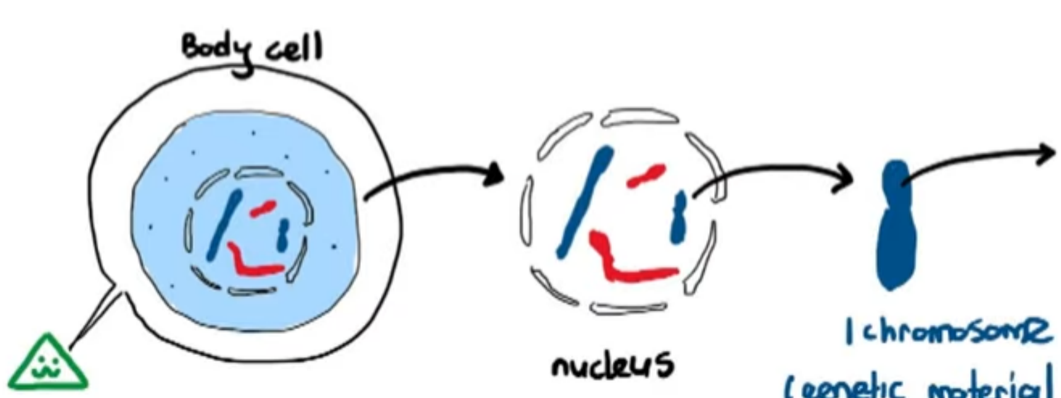


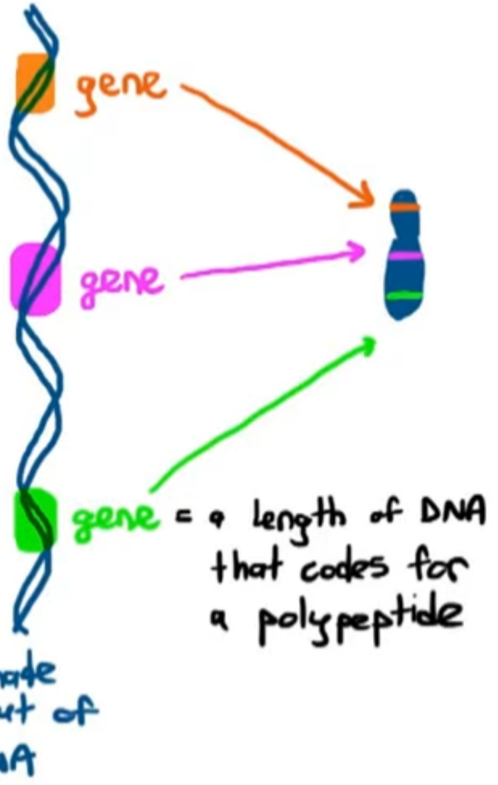
* gamete = sex cells

a) meiosis to produce gametes
b) fertilisation of gametes
c) mitosis / growth of zygote to produce a genetically different offspring!!

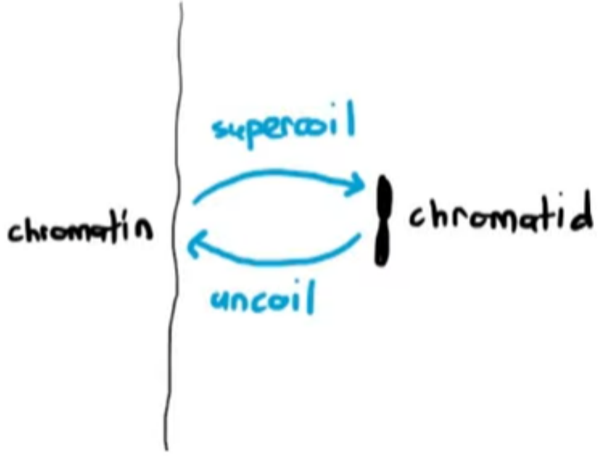
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Chromosomes



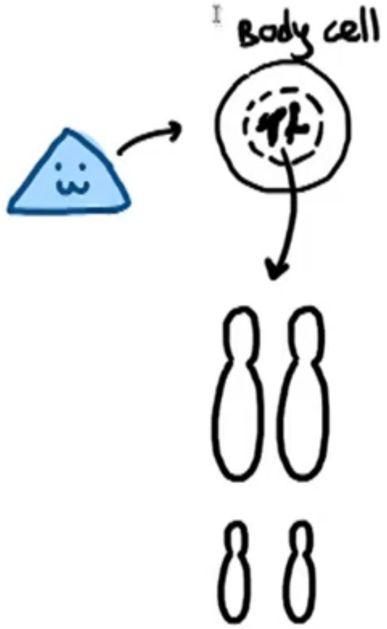


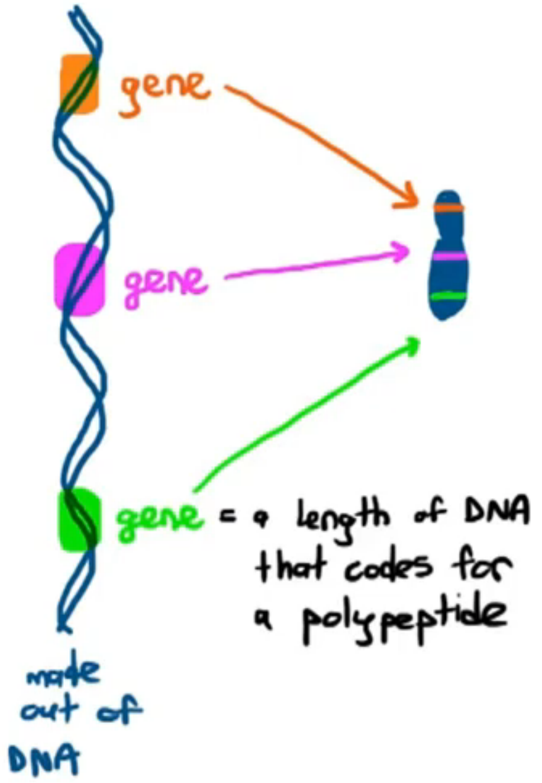
Revision



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Haploid & Diploid cells, Homologous chromosomes

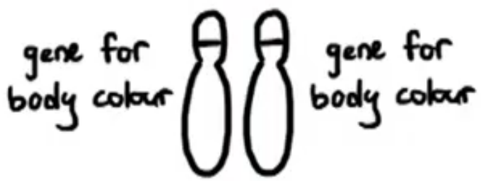




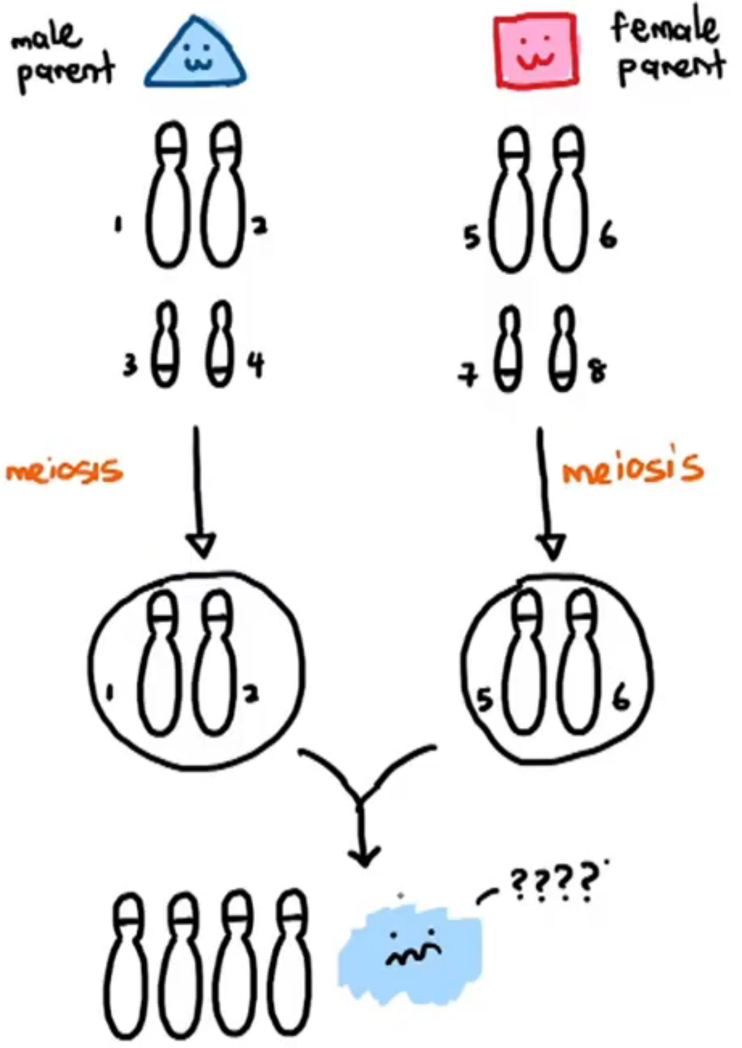
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Haploid & Diploid cells, Homologous chromosomes



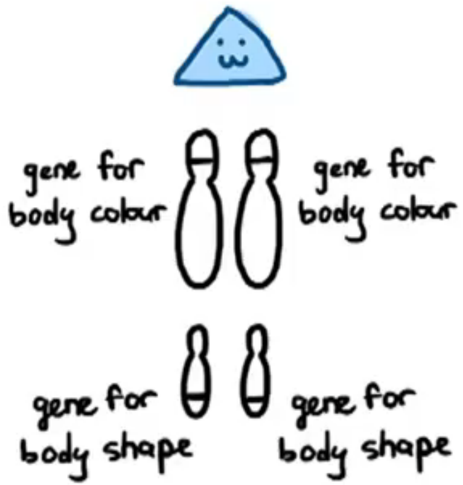


This organism has 4 chromosomes in its body cells!!

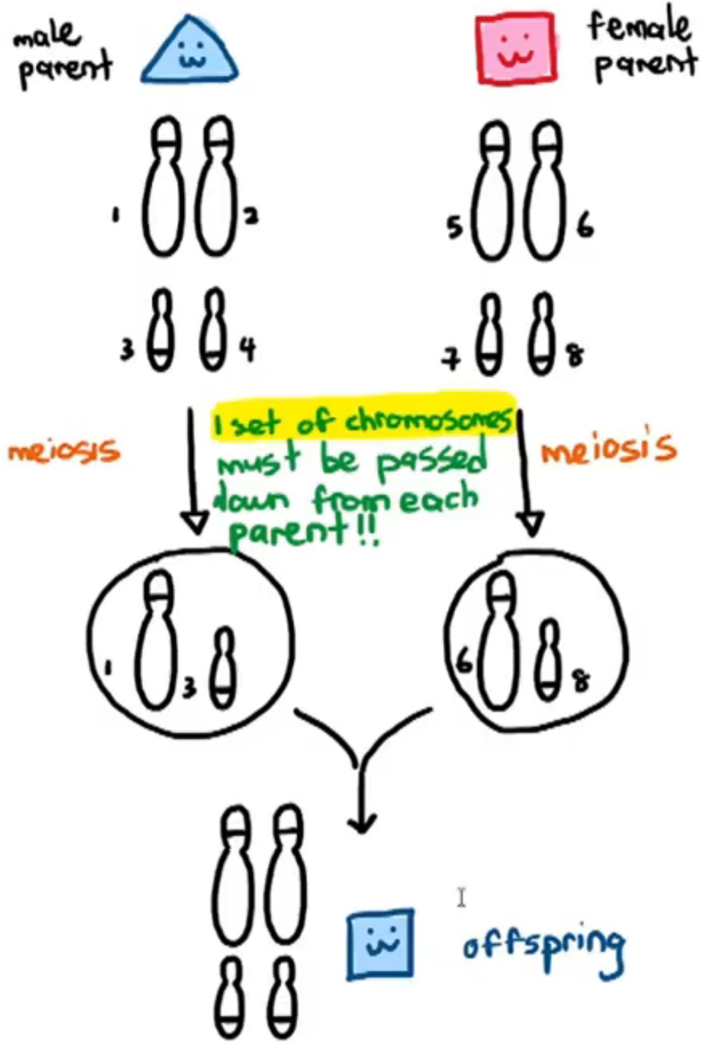


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Haploid & Diploid cells, Homologous chromosomes

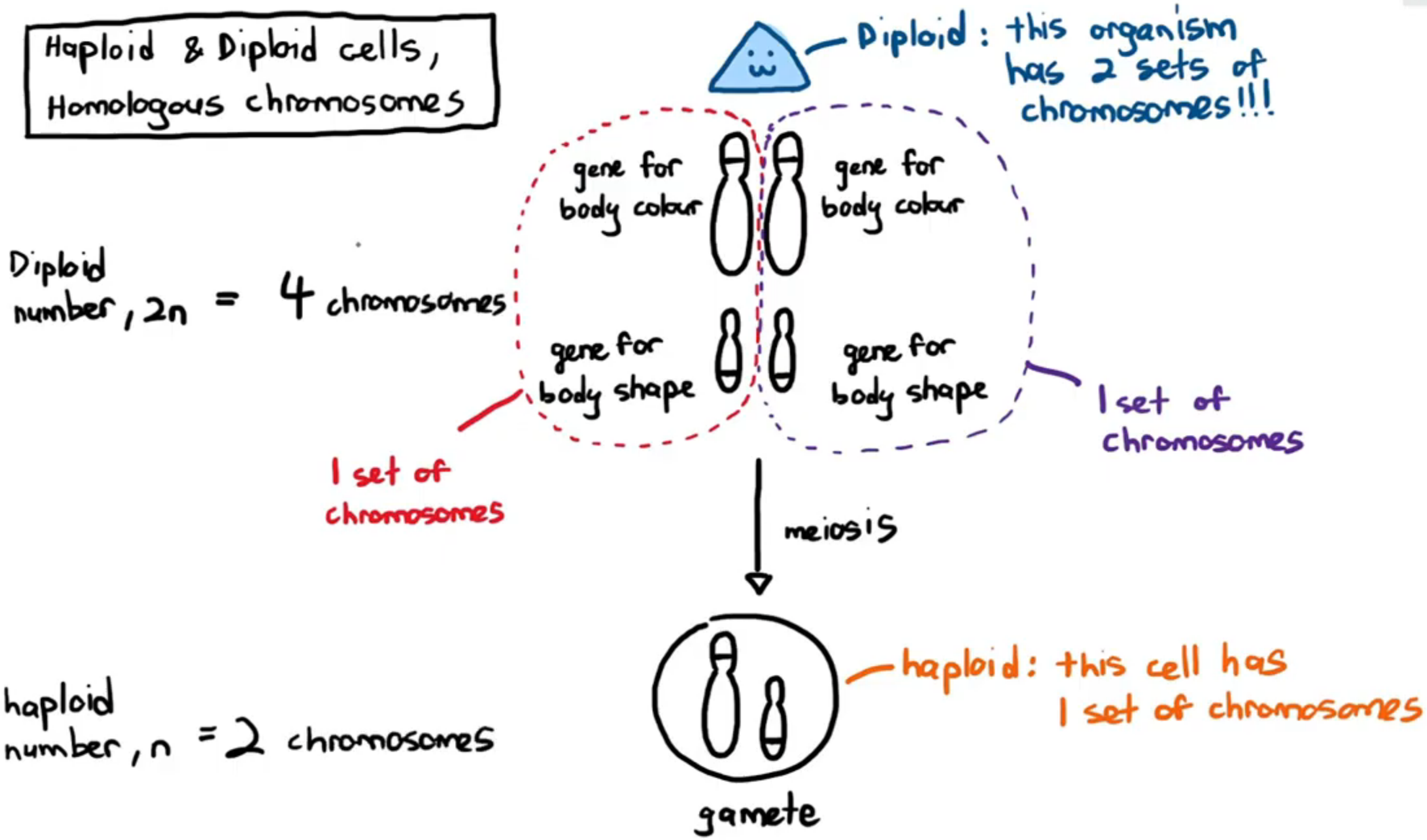


This organism has 4 chromosomes in its body cells!!



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Haploid & Diploid cells, Homologous chromosomes

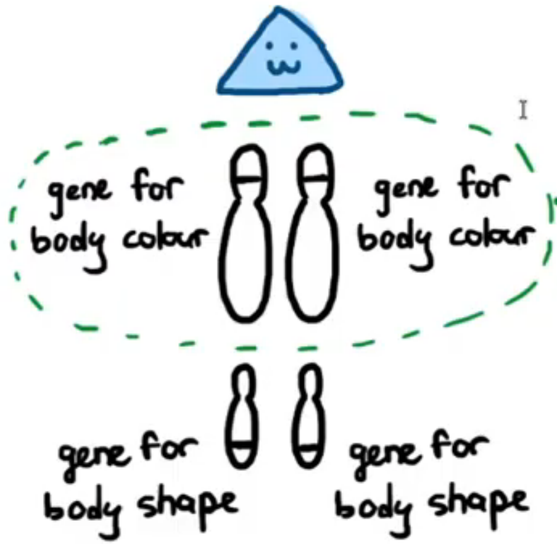


Diploid number, $2n$ = 4 chromosomes

haploid number, n = 2 chromosomes

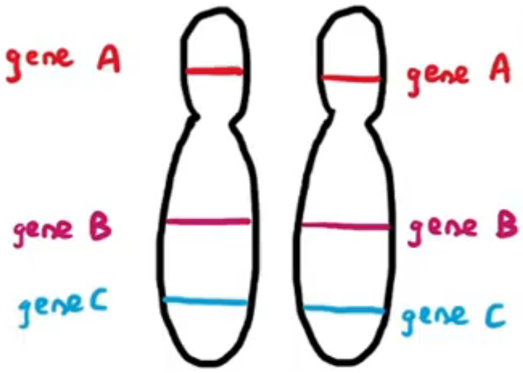
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Haploid & Diploid cells, Homologous chromosomes



Homologous chromosomes

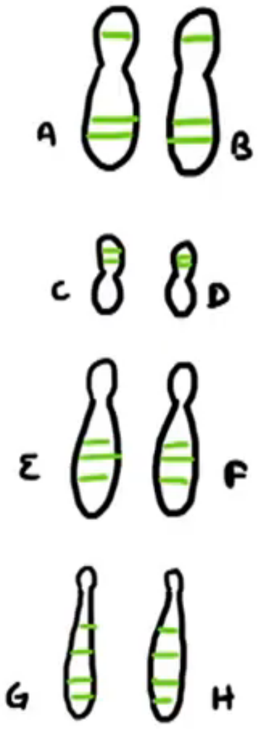
- same length
- same position of centromere
- same gene loci (position)



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Summarize it!!!





Diploid number, $2n = 8$

Haploid number, $n = 4$

List out 1 set of chromosomes
- ACEG
- BDFH

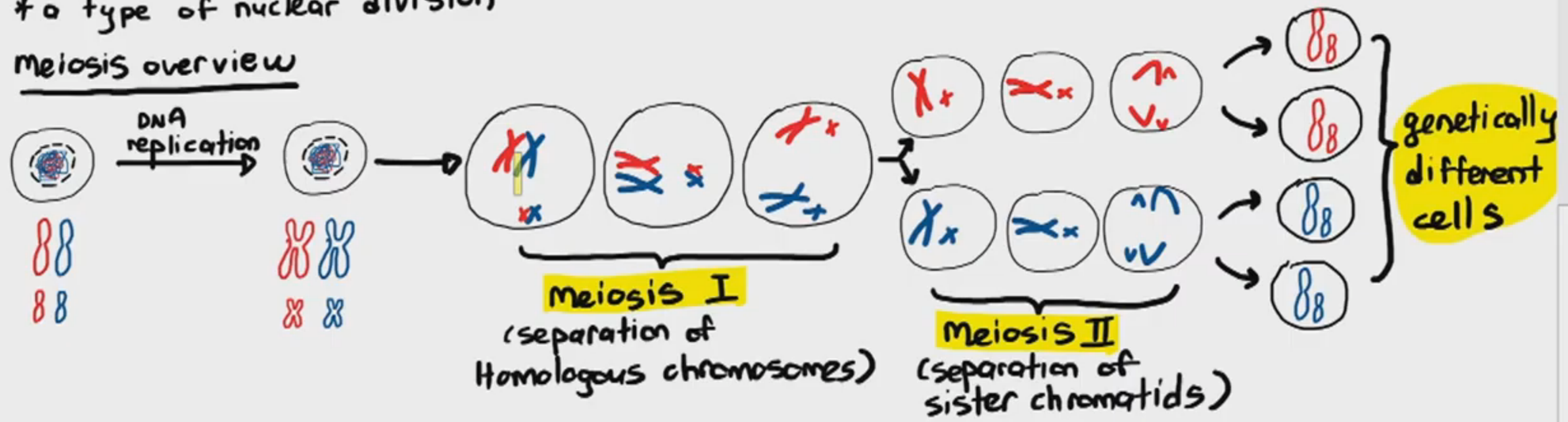
Identify a homologous pair
- AB
- CD
- EF
- GH

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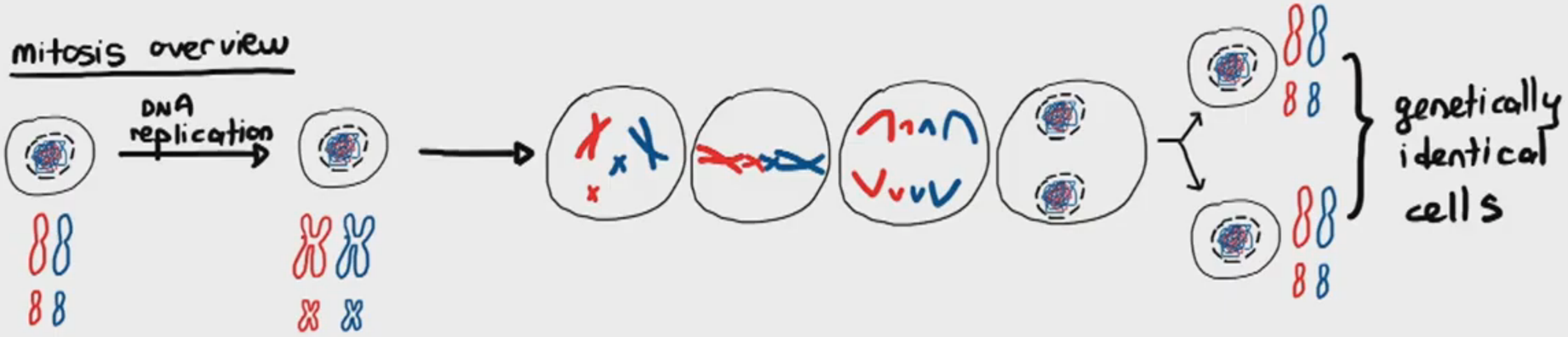
Meiosis

* a type of nuclear division

Meiosis overview



Mitosis overview

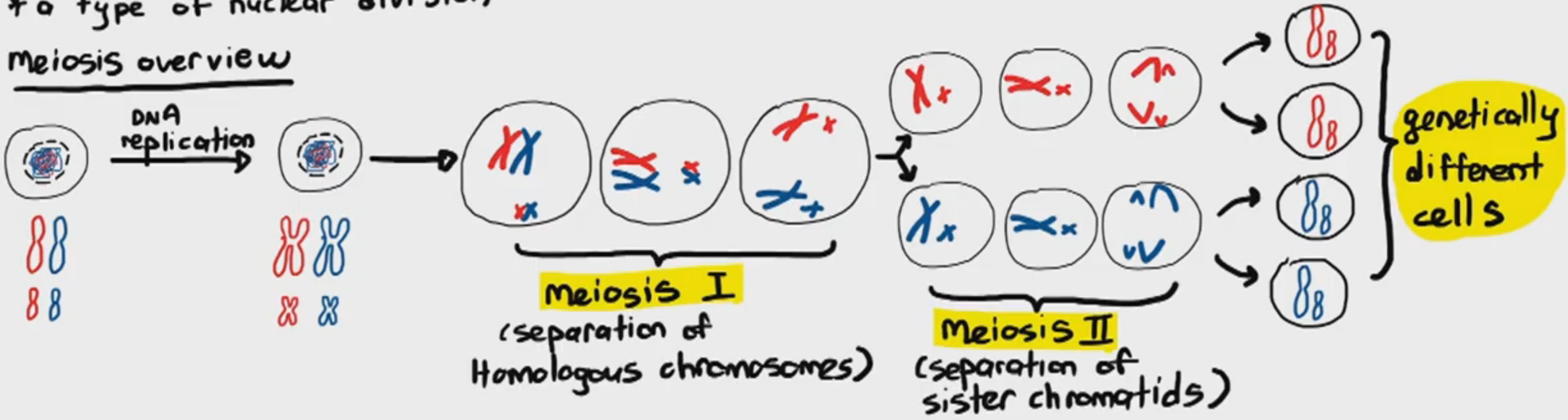


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Meiosis

* a type of nuclear division

Meiosis overview



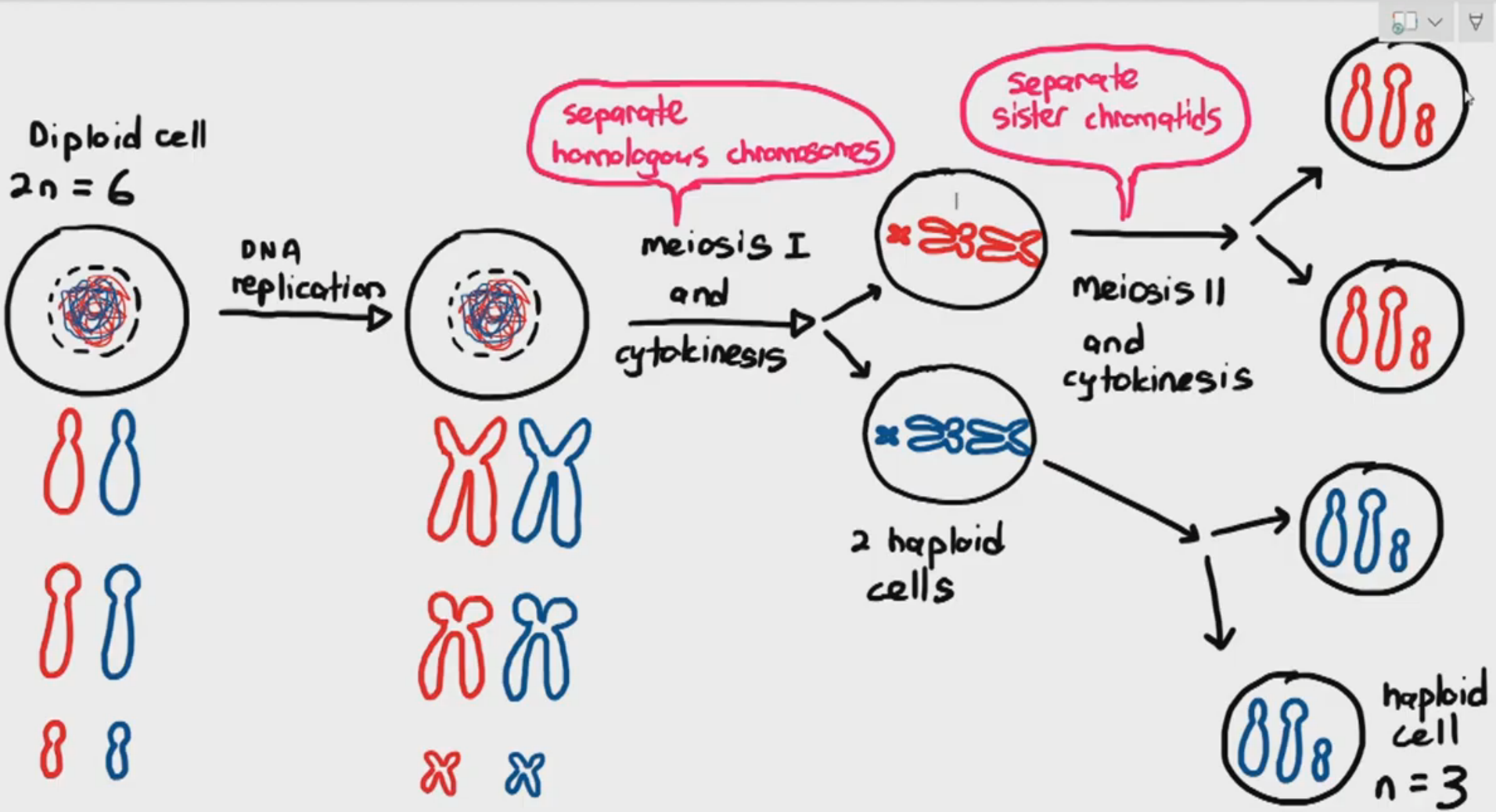
A type of reduction division !!!

* halves the number of chromosome in the nucleus
* changes a diploid cell (2 sets of chromosomes) into a haploid cell (1 set of chromosomes)

Purpose??

* to produce gametes for sexual reproduction!!!

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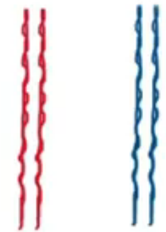


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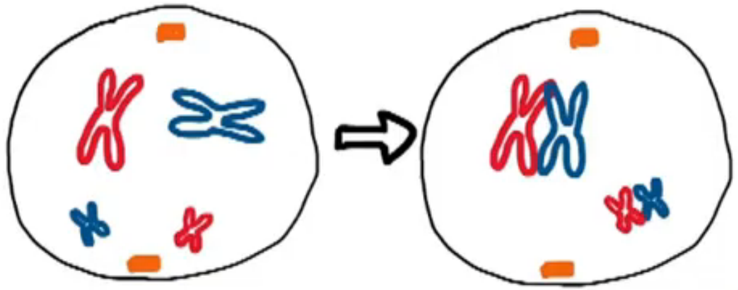
Meiosis I

① Prophase I





* nuclear membrane & nucleolus disappear
* supercoiling to form sister chromatids
* centrioles move to opposite poles



* Homologous chromosomes pair up = synapsis
* Form a **bivalent**
* **cross-over** may occur (explained later)



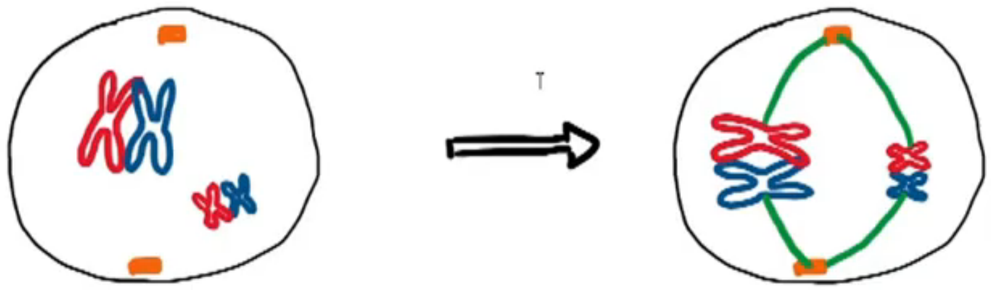
synapsis



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Meiosis I

② Metaphase I

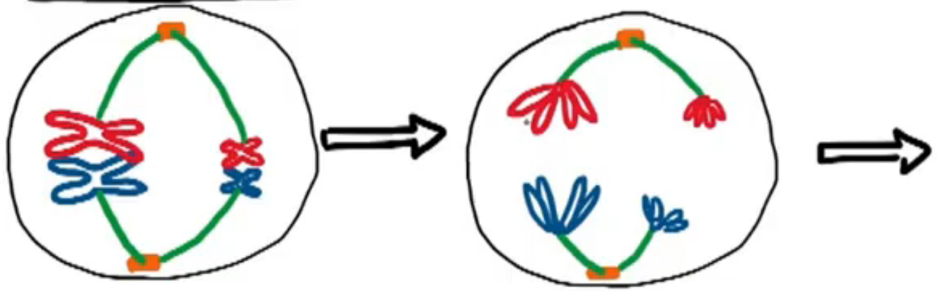


- ★ Bivalents line up along the equator
- ★ **Random assortment** (explained later)
- ★ spindle fibres attach to the centromeres

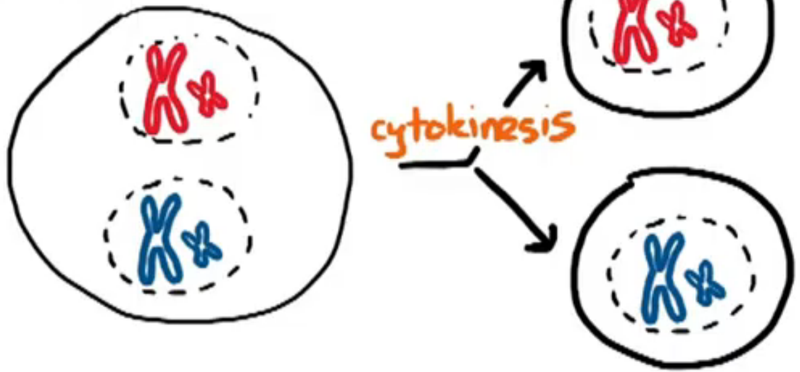
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Meiosis I

③ Anaphase I



④ Telophase I

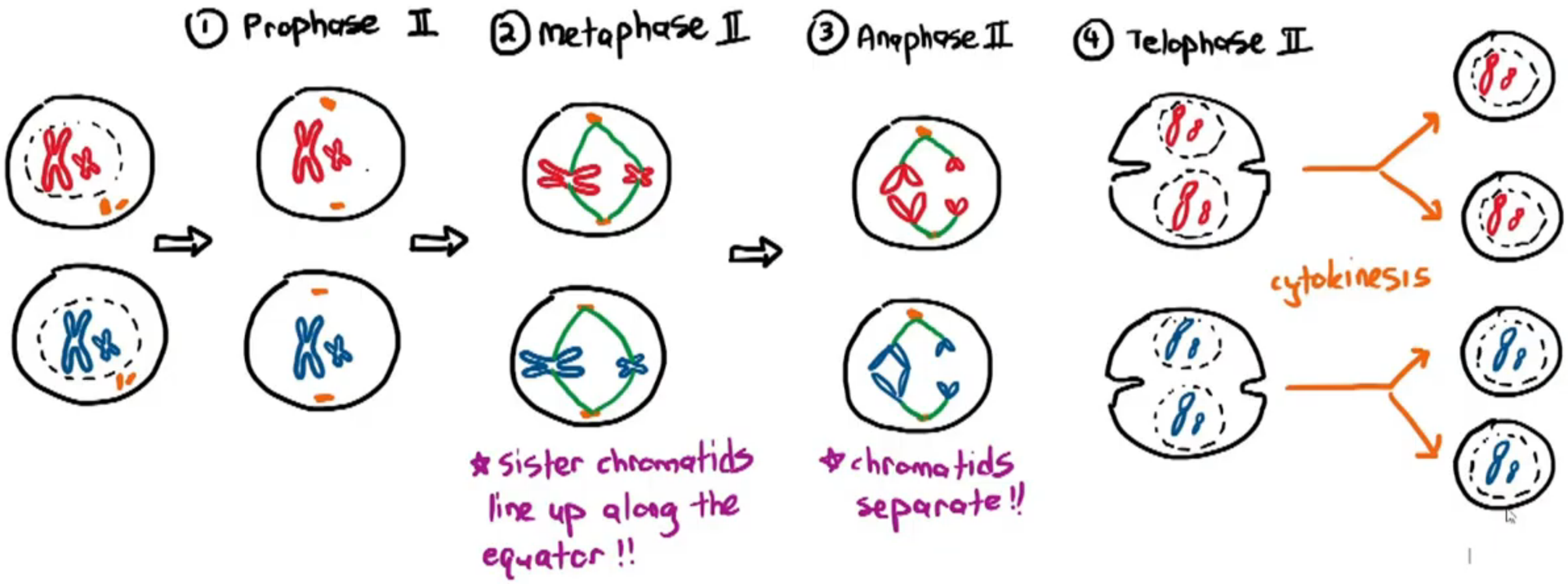


★ Homologous chromosomes separate to their opposite poles!!

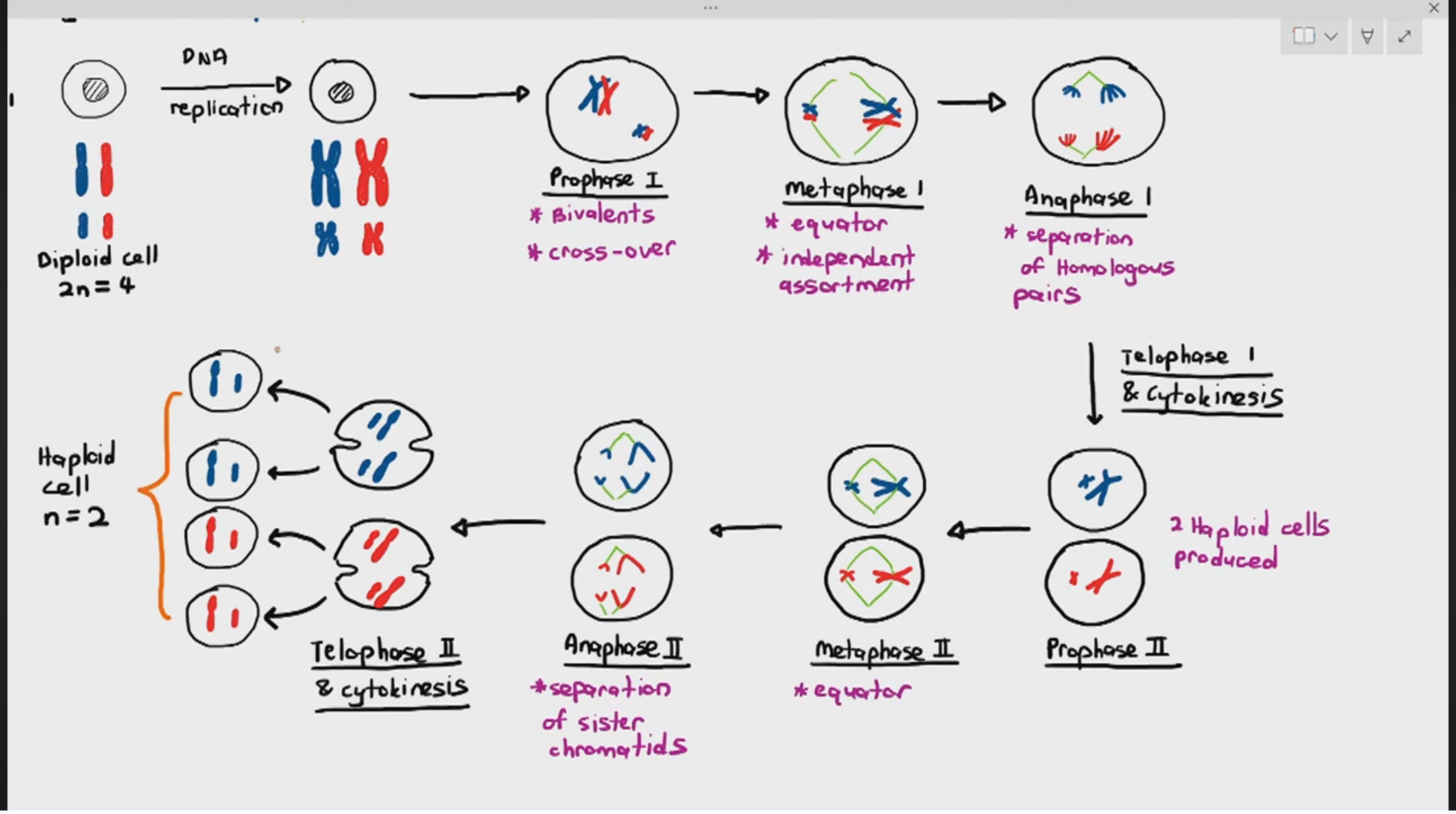
2 Haploid cells!!!

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Meiosis II



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Genes & Alleles



gene: length of DNA that codes for a polypeptide

Transcription → mRNA → Translation → Polypeptide (protein) → affects our characteristics



gene that affects fur colour

Transcription → mRNA → Translation → enzyme (Polypeptide)

substrate

characteristics

Brown pigments in the fur



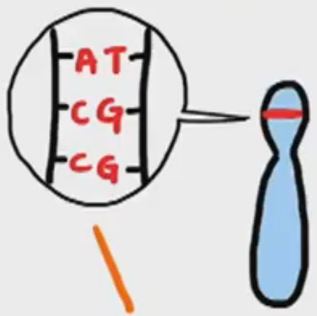
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Alleles

* A variety of the gene
* Different version of one gene



characteristics



gene that affects fur colour

Transcription

mRNA

Translation

substrate

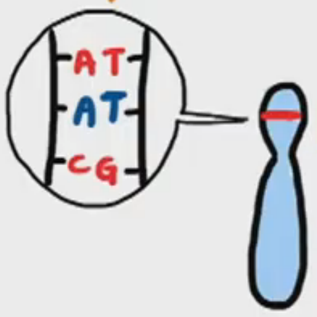
enzyme (Polypeptide)

Brown pigments in the fur

Brown fur

Different version

1 gene



gene that affects fur colour

Transcription

mRNA

Translation

substrate

no products = no Brown pigments

white fur

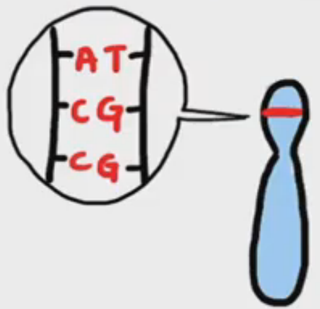
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Alleles

* A variety of the gene
* Different version of one gene



characteristics



gene that affects fur colour (B allele) = B →  Brown fur

They are both genes for fur colour, but affects organisms differently!!!

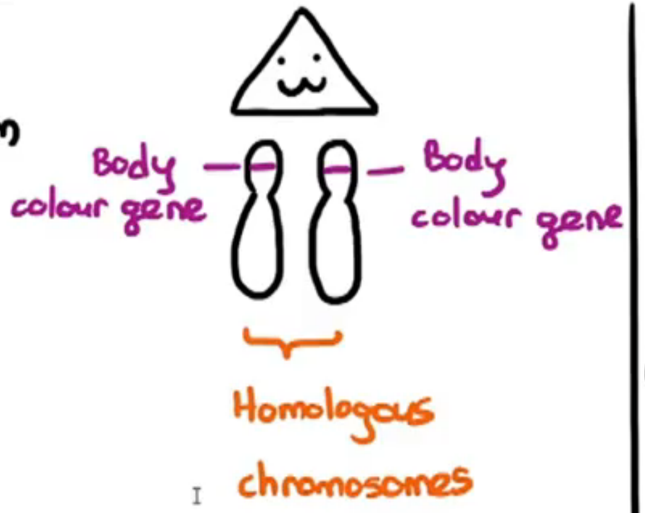


gene that affects fur colour (b allele) = b →  white fur

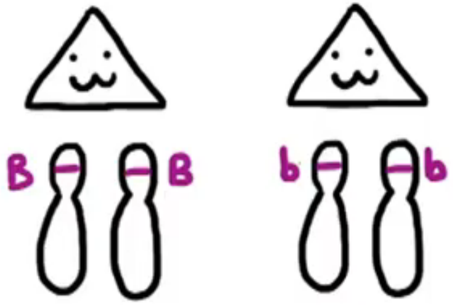
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The Basics of inheritance

1. Genotype : Alleles present in an organism
2. Phenotype : observable features
3. Dominant allele
4. Recessive allele
5. Codominant
6. Homozygous
7. Heterozygous



Body colour gene
- B = Blue
- b = red



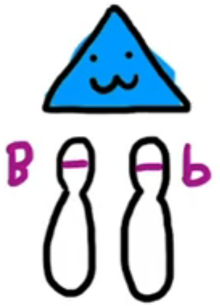
Genotype: BB bb

Phenotype: Blue Red

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The Basics of inheritance

1. Genotype
2. Phenotype
3. Dominant allele = the allele that is expressed if present in the genotype!!!
4. Recessive allele = the allele that is expressed
5. Codominant
6. Homozygous
7. Heterozygous



genotype: Bb

Phenotype: Blue!!!

Body colour gene
- B = Blue (Dominant allele)
- b = red





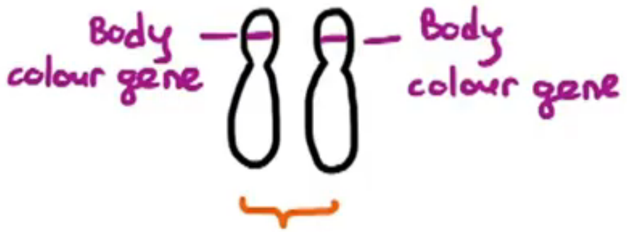


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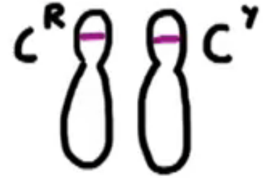
The Basics of inheritance

1. Genotype
2. Phenotype
3. Dominant allele
4. Recessive allele
5. Codominant : 2 different alleles affect the phenotype!!
6. Homozygous
7. Heterozygous









genotype: C^RC^Y

phenotype: red & yellow fur!!!!

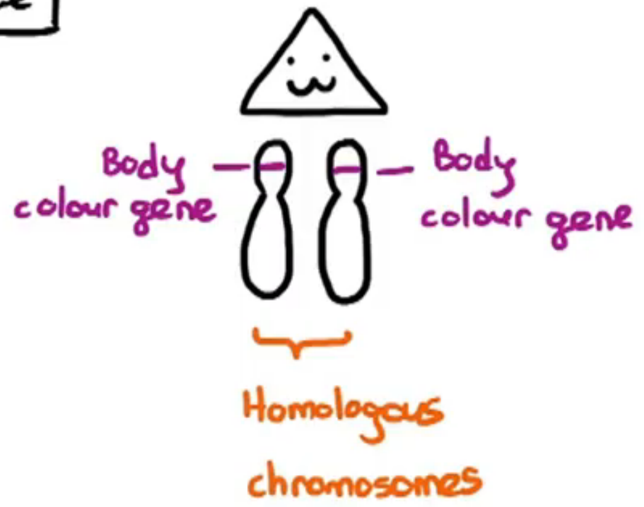
Body colour gene
- C^R = red
- C^Y = yellow

} codominant!!!

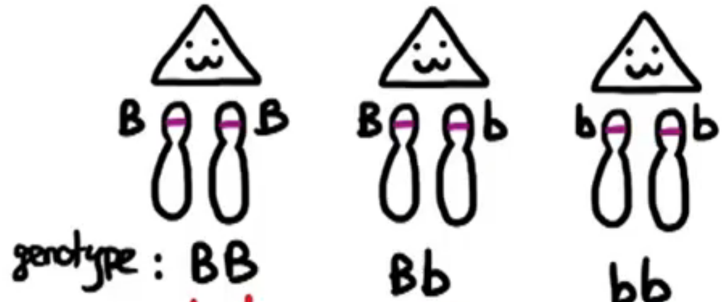
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The Basics of inheritance

1. Genotype
2. Phenotype
3. Dominant allele
4. Recessive allele
5. Codominant
6. Homozygous : same alleles in the genotype
7. Heterozygous : different alleles in the genotype



Body colour gene
- B = Blue
- b = red



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Gregor Mendel studied inheritance in the garden pea, *P. sativum*.

The flowers of *P. sativum* that he studied were either purple or white. The gene that controls flower colour has two alleles, **B** and **b**.

When Mendel crossed purple-flowered plants with white-flowered plants all the plants in the next generation had purple flowers.

(i) Table 4.1 shows five genetic terms that can be applied to Mendel's study of the inheritance of flower colour.

Complete Table 4.1 by stating an example of each genetic term. The first one has been completed for you.

Table 4.1

term	example in *P. sativum*
dominant trait	purple flowers
recessive allele	b
phenotype	purple flower
homozygous genotype	BB or bb
heterozygous genotype	Bb

[4]

Phenotype: purple or white

gene for flower colour
- B – purple
- b – white

genotype: BB bb Bb

Phenotype: Purple white Purple

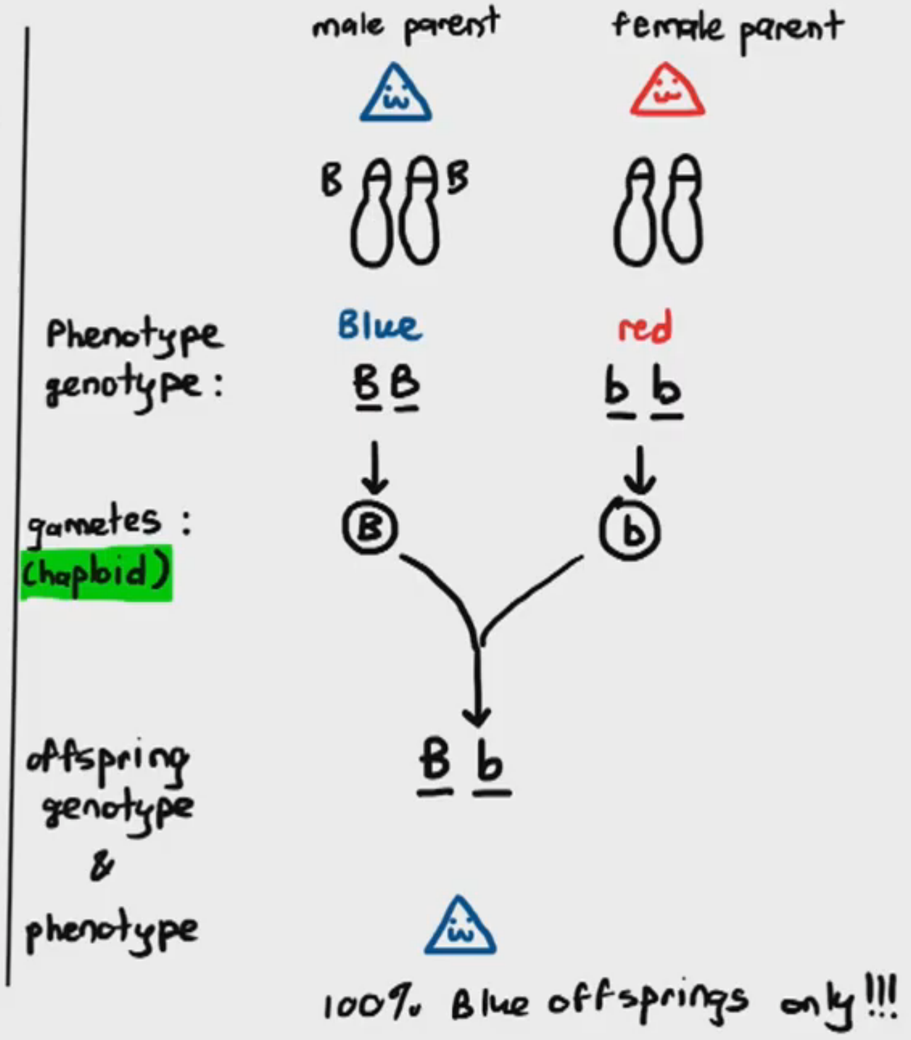
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Monohybrid inheritance

* inheritance of 1 gene

Eg

- gene that affects body colour
- gene has 2 alleles!!
  * B allele =  Blue
  * b allele =  red



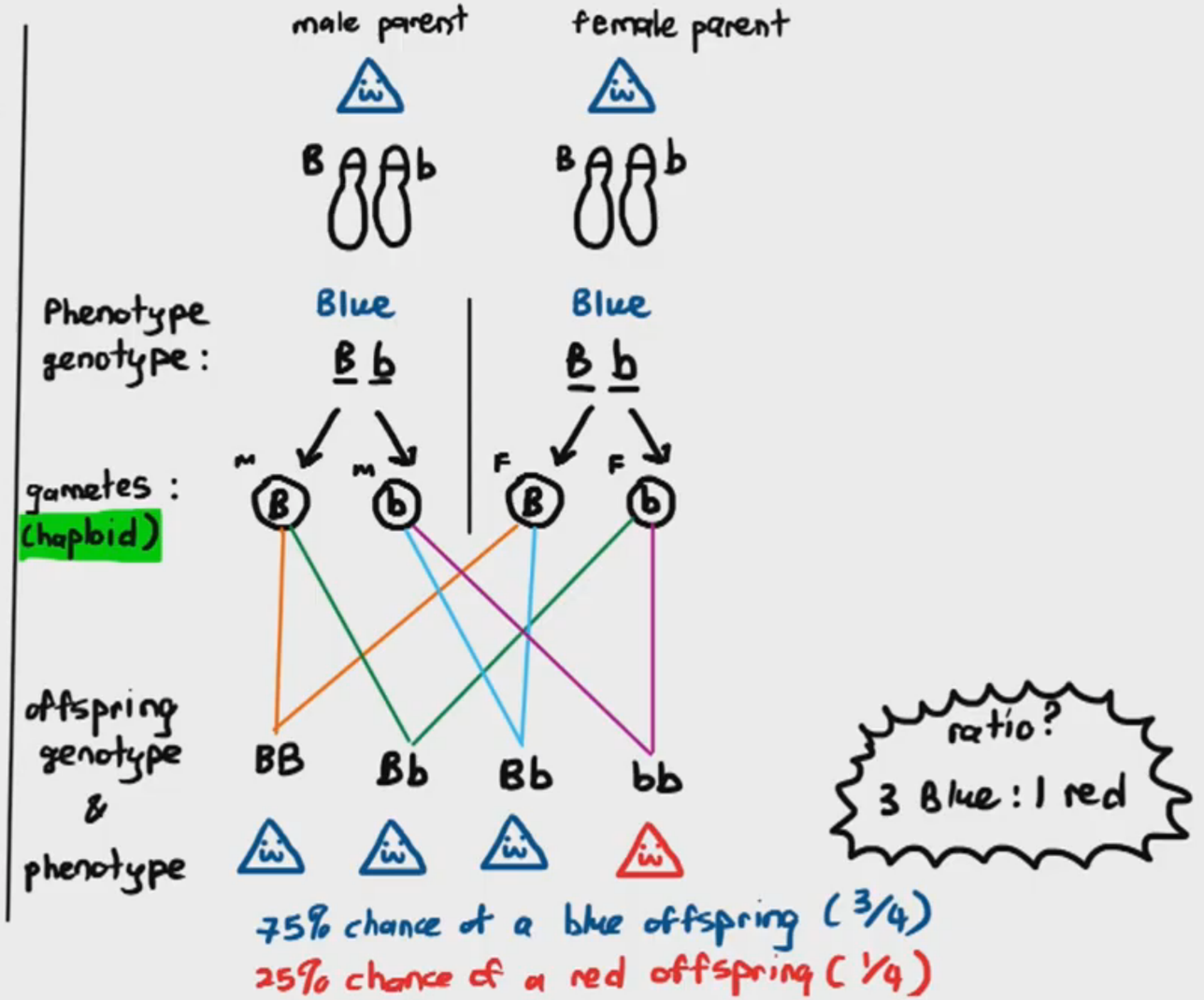
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Monohybrid inheritance

* inheritance of 1 gene

Eg

- gene that affects body colour
- gene has 2 alleles!!
  - * B allele = Blue
  - * b allele = red



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Monohybrid inheritance

* inheritance of 1 gene

Eg

- gene that affects body colour

- gene has 2 alleles!!

  * B allele = Blue
  * b allele = red

male parent



female parent



construct a Punnett square

Phenotype: Blue | Blue

genotype: B b | B b

gametes (haploid):



female gametes \ male gametes	B	b
B	BB Blue	Bb Blue
b	Bb Blue	bb red

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Monohybrid inheritance

* inheritance of 1 gene

Eg

- gene that affects body colour

gene has 3 alleles!!

* F^A = Blue
* F^B = red

} codominant

* f = orange – recessive

If an organism's genotype is F^AF^B, it will have a purple colour (phenotype)

Phenotype	red	Blue
genotype	$F^B\ f$	$F^A\ f$
gametes	F^B , f	F^A , f

Both parents are heterozygous

Punnett square

	F^B	f
F^A	F^AF^B Purple	F^Af Blue
f	F^Bf red	ff orange

1 purple : 1 blue : 1 red : 1 orange

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Monohybrid inheritance

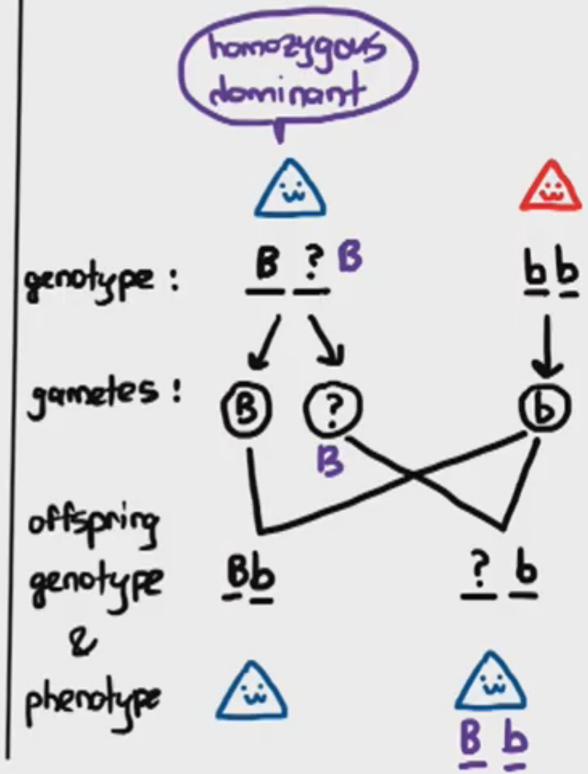
* inheritance of 1 gene

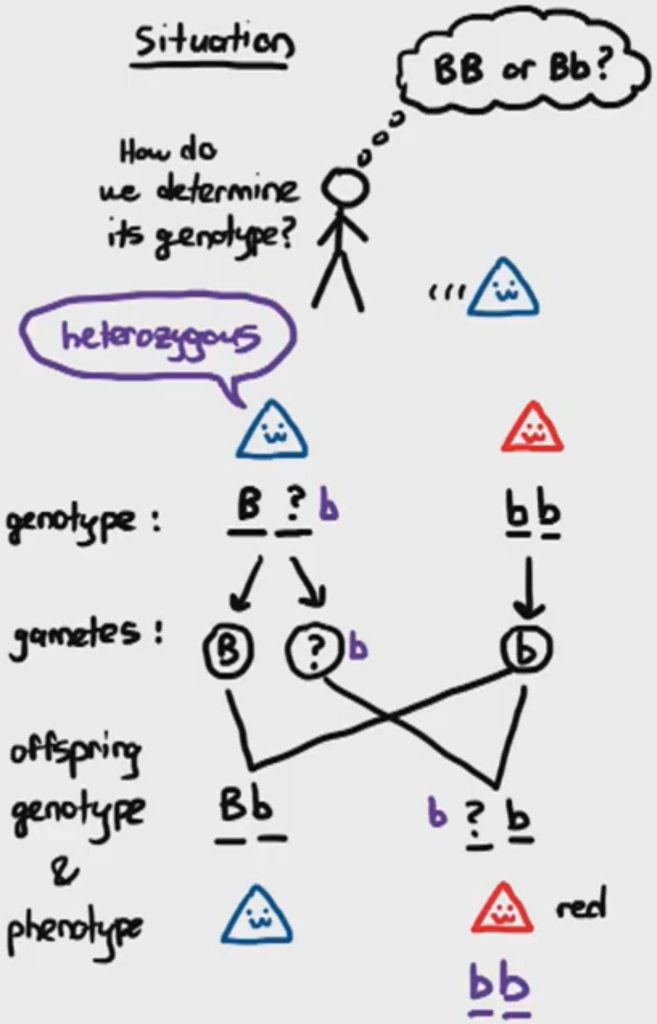
Eg

- gene that affects body colour
- gene has 2 alleles!!
  - * B allele = Blue
  - * b allele = red

Test cross

Breed the organism with a homozygous recessive organism!!

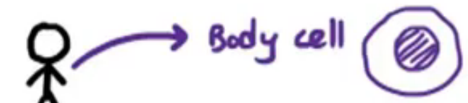




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Sex chromosomes and sex-linkage

male → Body cell

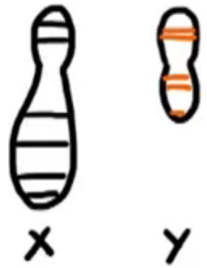


44 autosomes

2 sex chromosomes (XY)



=



Determines the biological sex!!

female → Body cell

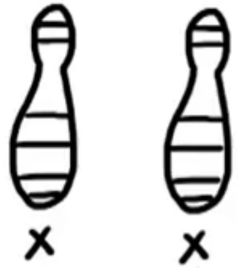


44 autosomes

2 sex chromosomes (XX)



=

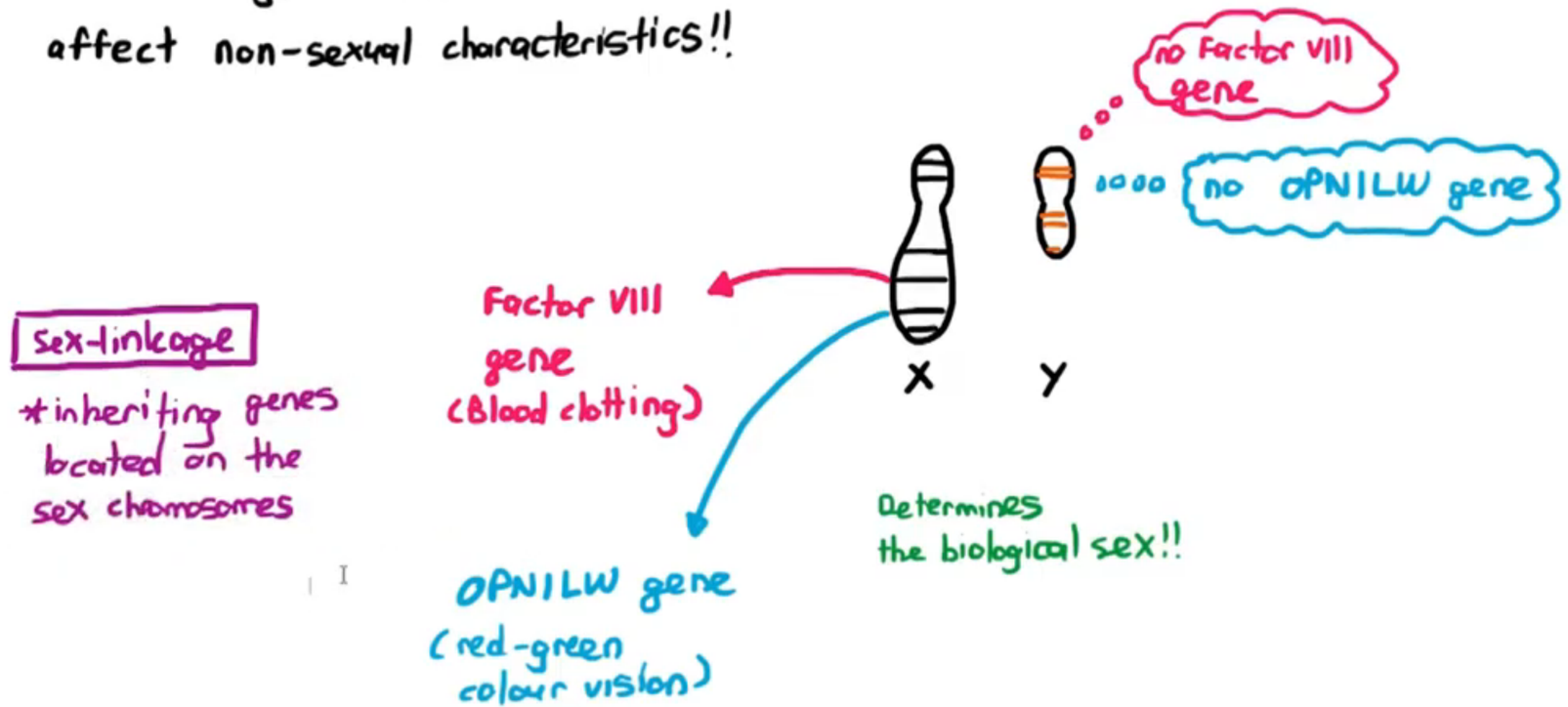


Determines the biological sex!!

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Sex chromosomes and sex-linkage

The sex chromosomes also have genes that affect non-sexual characteristics!!



Sex-linkage

*inheriting genes located on the sex chromosomes

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Sex-linkage

writing out genotypes & phenotypes

- The Factor VIII gene is located on the

X chromosome

It has 2 possible alleles



H allele = codes for normal F8 protein ⇨ normal blood clotting



h allele = codes for abnormal F8 protein ⇨ haemophilia

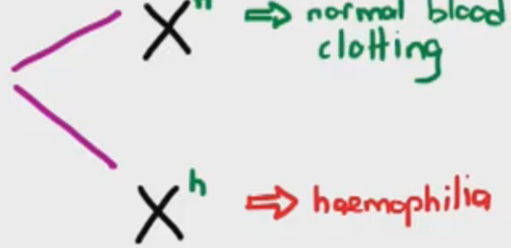
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Sex-linkage

writing out genotypes & phenotypes

- The Factor VIII gene is located on the X chromosome

It has 2 possible alleles



Females

Genotype: X^HX^H X^hX^h X^HX^h

Phenotype: Female, normal blood clotting | Female, haemophiliac | Female, normal blood clotting (carrier)

Males

Genotype: X^HY X^hY

Phenotype: male, normal blood clotting | male, haemophiliac

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- The Factor VIII gene is located on the X chromosome

It has 2 possible alleles

X^H ⇒ normal blood clotting

X^h ⇒ haemophilia

Phenotype: male, normal blood clotting — Female, normal blood clotting (carrier)

Genotype: X^HY — X^HX^h

gametes: X^H Y — X^H X^h

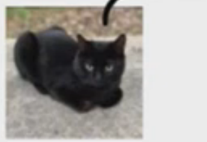
Punnett Square

female gamete \ male gamete	X^H	Y
X^H	X^HX^H female, normal Blood clotting	X^HY male, normal Blood clotting
X^h	X^HX^h female, normal ..... (carrier)	X^hY male, haemophiliac!

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gene for fur colour on X chromosome

- X^B - Black fur
- X^G - ginger fur

Genotype:	X^BX^B	X^GX^G	X^BX^G	X^BY	X^GY
Phenotype					
	Female	Female	Female	male	male

males cannot be tortoiseshell as they can only carry 1 allele!!

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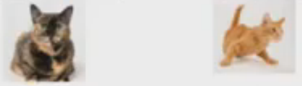
In some varieties of domestic cats the gene for fur colour is located on the **X** chromosome. This gene has two alleles. One allele codes for black fur and the other allele codes for ginger fur. The two alleles are codominant so a heterozygous cat will have fur with patches of black and ginger colours. A cat with fur of two colours is known as a tortoiseshell.

Using appropriate symbols, construct a genetic diagram to show the results of a cross between a female tortoiseshell cat and a male ginger cat.

symbols X^B – Black fur

X^G – Ginger Fur

parent phenotypes tortoiseshell female ginger male



parent genotypes X^BX^G X^GY

gametes: X^B X^G X^G Y

offspring genotype X^BX^G X^BY X^GX^G X^GY

and

phenotype tortoiseshell female | Black male | Ginger female | Ginger male

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Autosomal inheritance or sex-linked inheritance?

1. Oculocutaneous albinism (OCA) is a type of albinism. There are many different forms of OCA.

   OCA1A is one form of OCA, caused by a recessive mutation in the autosomal gene, *TYR*, coding for the enzyme tyrosinase. This enzyme is involved in the biosynthetic pathway that results in the production of melanin, the pigment responsible for the colour of hair, skin and eyes.

   gene is located on an autosome

2. Recessive mutations in a gene known as *PINK1*, located on chromosome 1, an autosome, are believed to be one cause of EOPD. A person with this form of EOPD has a homozygous recessive genotype.

   gene is located on an autosome

3. In the fruit fly, *Drosophila melanogaster*, two different genes control body colour and eye colour.

   - **G/g** are alleles of the body colour gene.
   - **G** results in grey body, **g** results in black body.

   - **R/r** are alleles of the eye colour gene.
   - **R** results in red eyes, **r** results in brown eyes.

   Each gene is autosomal.

   gene for eye colour } located on autosomes
   gene for body colour }

4. An inherited form of DI may be caused by faulty membrane receptors. These receptors are coded for by a sex-linked allele.

   gene is located on a sex chromosome (X or Y)

5. In *O. latipes*, females have two **X** chromosomes and males have an **X** and a **Y** chromosome.

   It was deduced that, in *O. latipes*:

   - the gene that controls body colour is located on the **X** chromosome **and** the **Y** chromosome
   - the gene that controls whether black spots are present or **not** is located on an autosome.

   gene for body colour on sex chromosome (X and Y)

   gene for black spots are on autosomes

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Autosomal inheritance or sex-linked inheritance?

1. Recessive mutations in a gene known as *PINK1*, located on chromosome 1, an autosome, are believed to be one cause of EOPD. A person with this form of EOPD has a homozygous recessive genotype.

gene is located on an autosome

2. An inherited form of DI may be caused by faulty membrane receptors. These receptors are coded for by a sex-linked allele.

gene is located on a sex chromosome

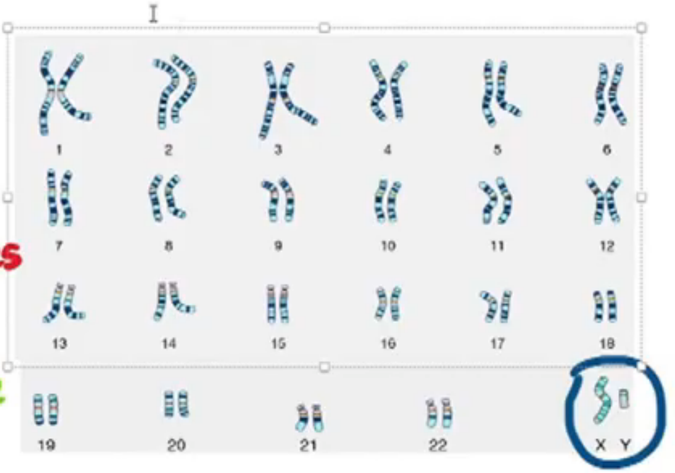
(X chromosome)

male

2 alleles

1 allele

X Y

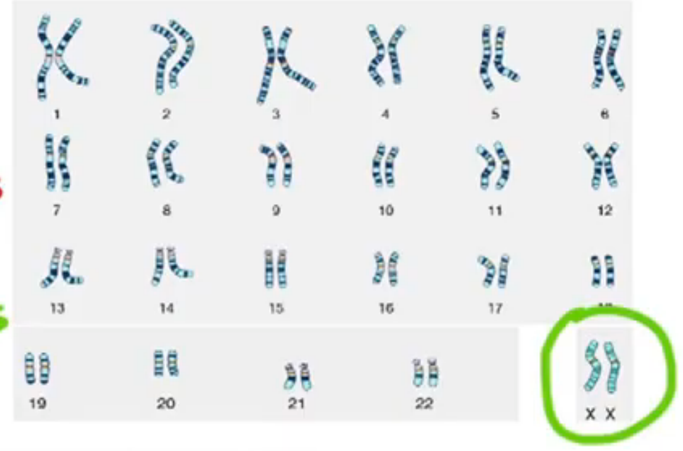


Female

2 alleles

2 alleles

X X



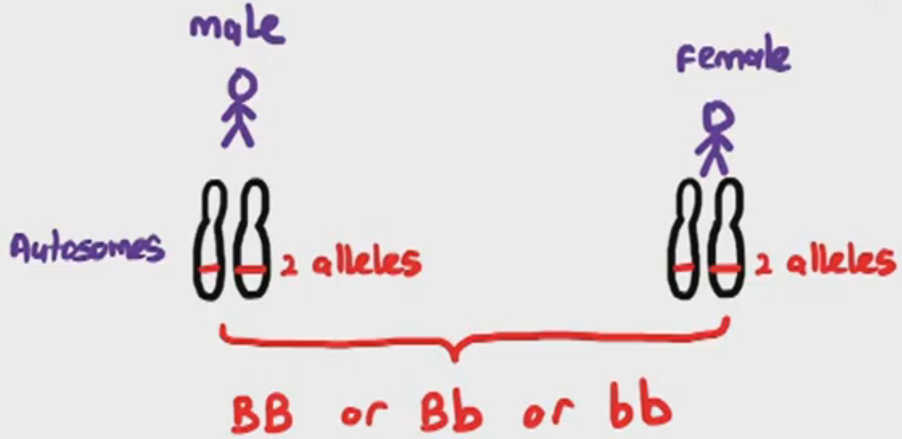
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Autosomal inheritance or sex-linked inheritance?

1 Recessive mutations in a gene known as *PINK1*, located on chromosome 1, an autosome, are believed to be one cause of EOPD. A person with this form of EOPD has a homozygous recessive genotype.

gene is located on an autosome

B allele
b allele



2 An inherited form of DI may be caused by faulty membrane receptors. These receptors are coded for by a sex-linked allele.

gene is located on a sex chromosome

(X chromosome) A allele
a allele



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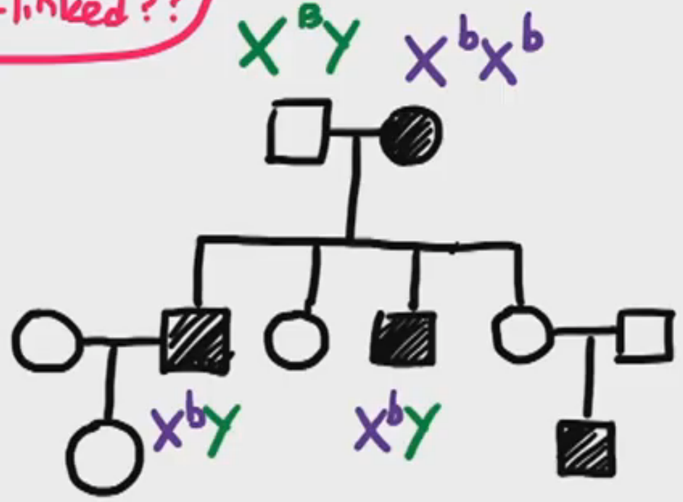
Family pedigree chart

gene < B - normal
b - recessive (have the disease)

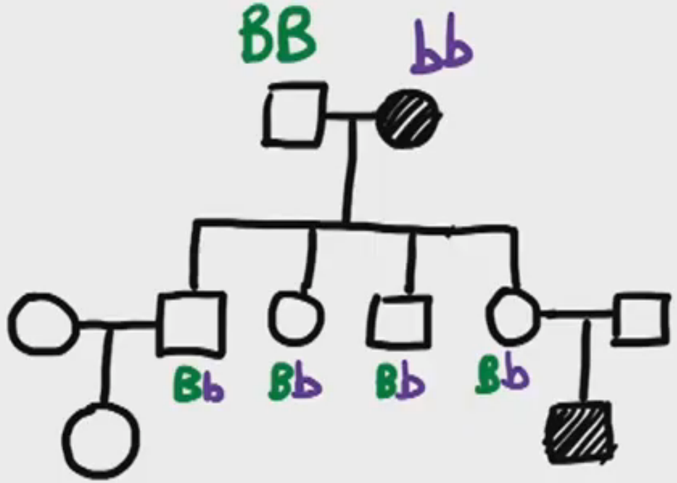
□ - male
○ - female

▨ ● have the disease

autosomal or sex-linked??



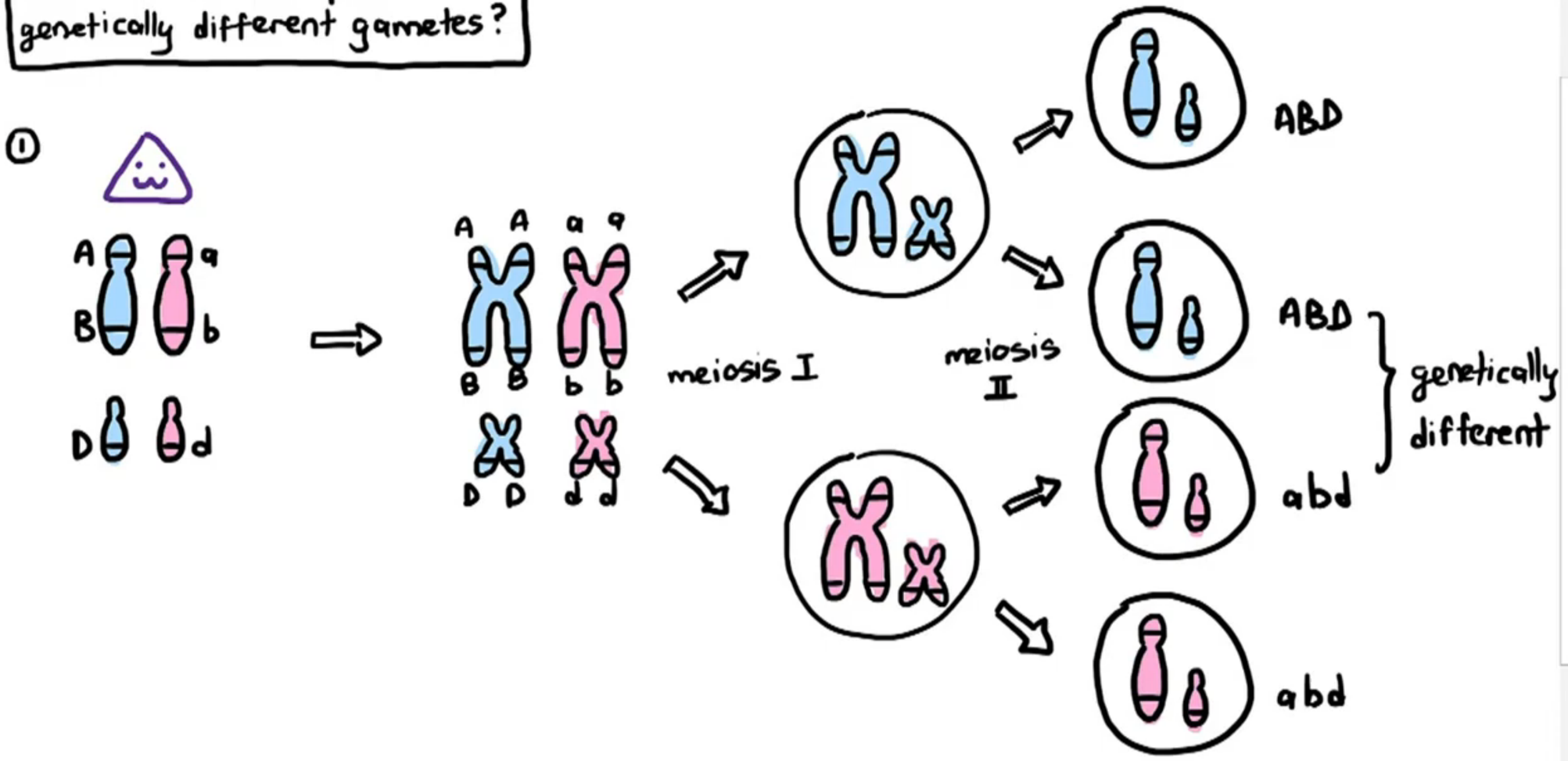
Probably sex-linked



Probably autosomal

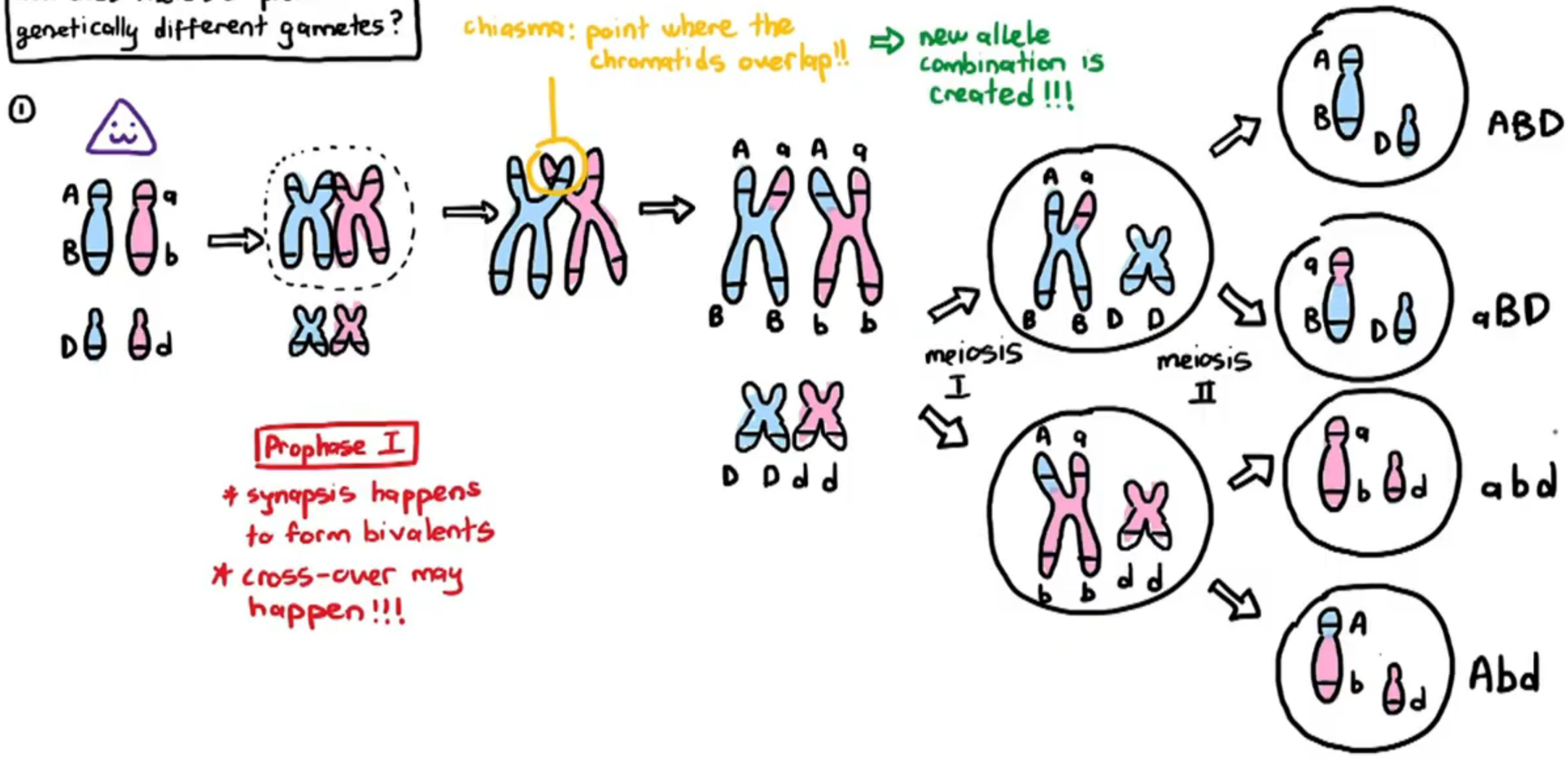
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How does meiosis produce genetically different gametes?



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How does meiosis produce genetically different gametes?

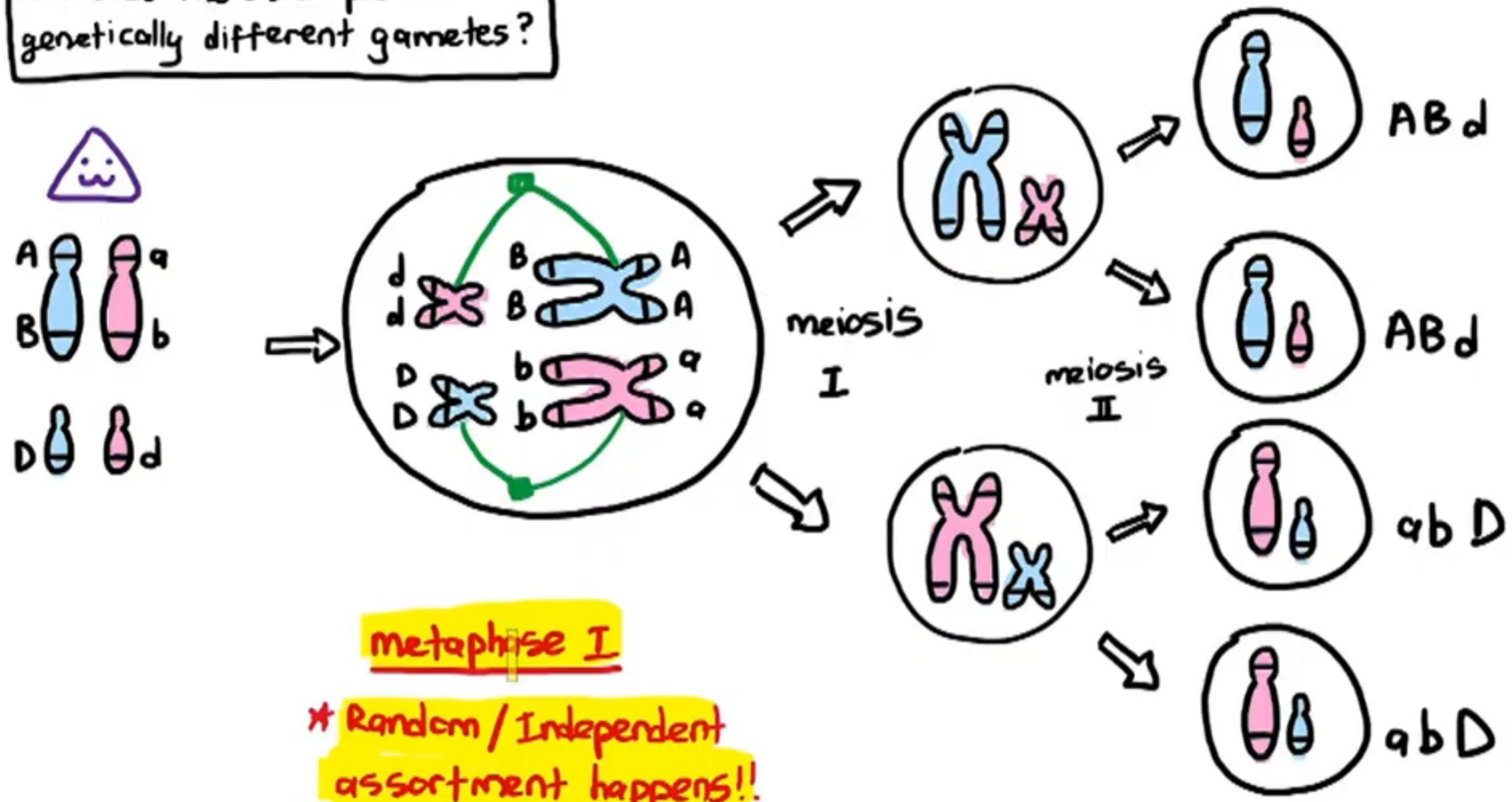


Prophase I

* synapsis happens to form bivalents
* cross-over may happen !!!

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How does meiosis produce genetically different gametes?

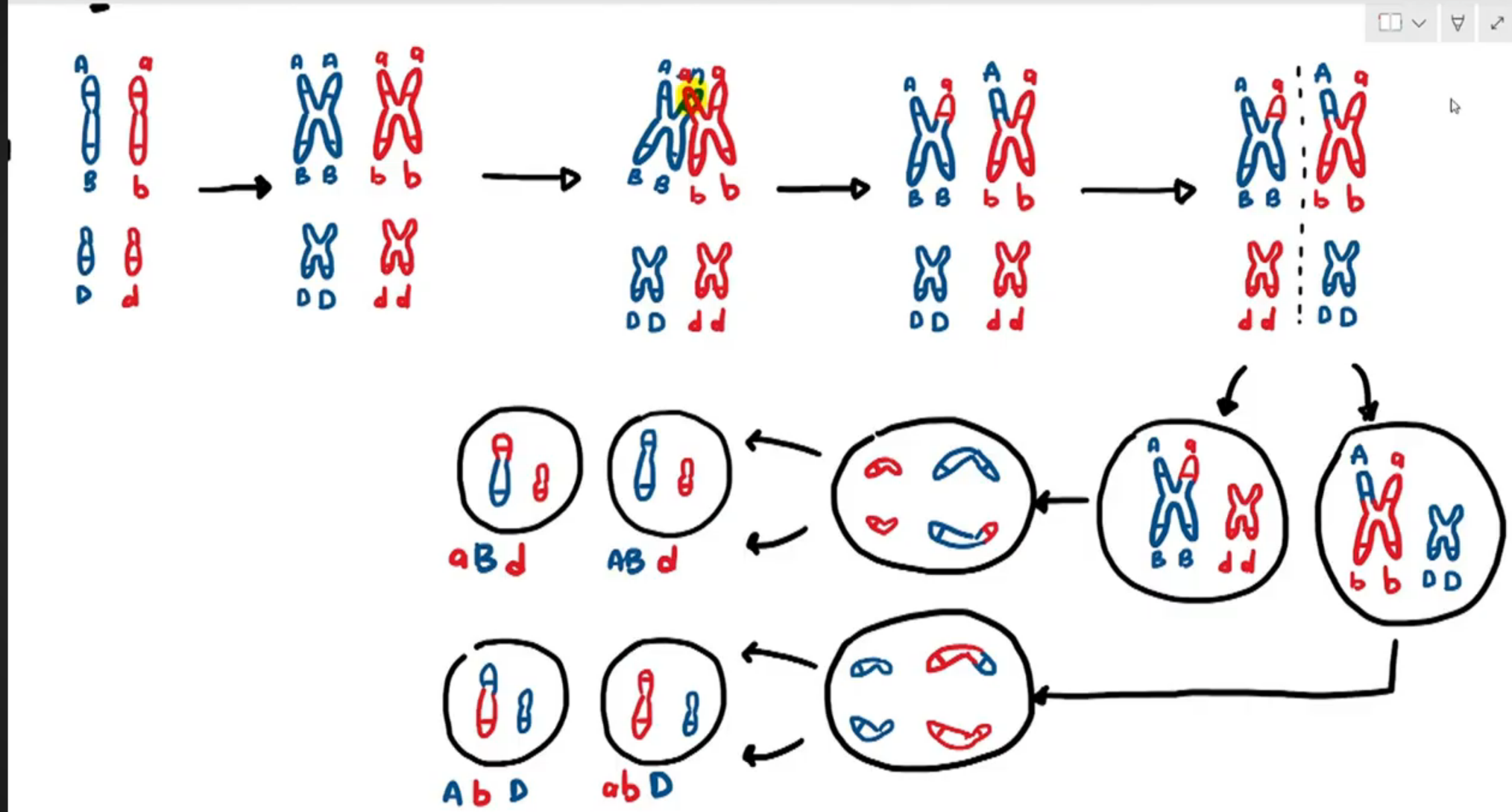


metaphase I

* Random / Independent assortment happens!!

(bivalents randomly arrange themselves along the equator)

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Dihybrid inheritance

* inheritance of 2 genes



gene for body colour

gene for body shape

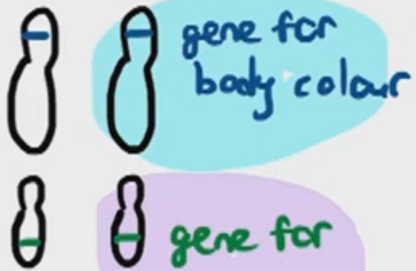


gene for fur colour

gene for blood type

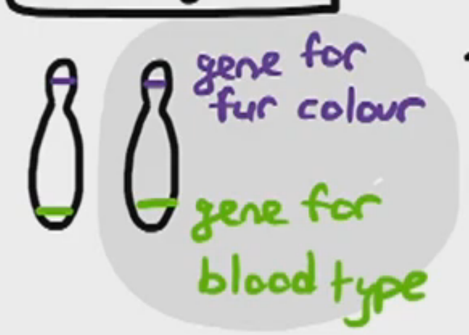


unlinked genes



2 genes are located on different chromosomes!!

Linked genes



2 genes are on the SAME chromosome at different loci!!

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Dihybrid inheritance: unlinked genes

* Gene 1 affects body colour
  - B - blue
  - b - red

* Gene 2 affects body shape
  - T - △
  - t - □

Genes 1 & 2 are **unlinked**
(located on different chromosomes)



	Homozygous Dominant	Homozygous recessive
Phenotype:		
genotype	BBTT	bbtt
gamete :	BT	b b + +

gametes:



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Dihybrid inheritance: unlinked genes

* Gene 1 affects body colour
  - B - blue
  - b - red

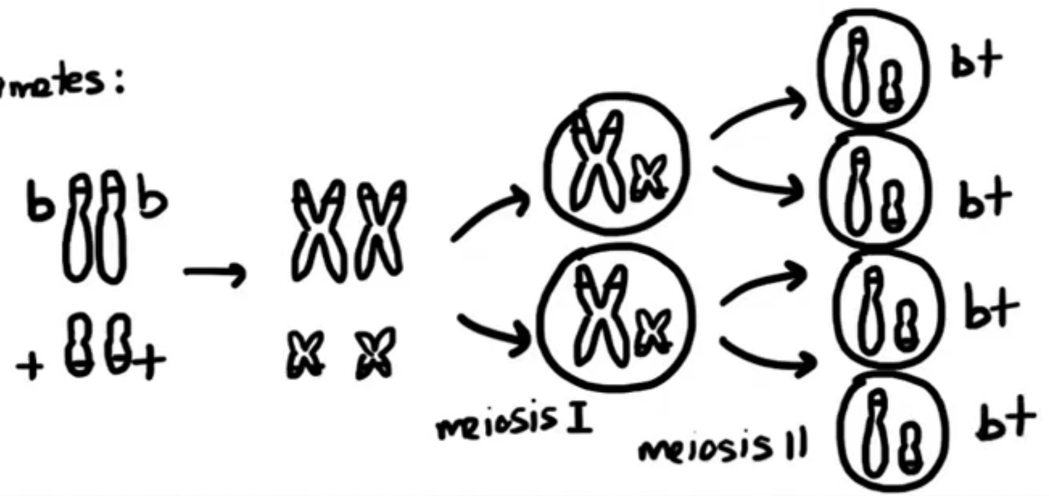
* Gene 2 affects body shape
  - T - △
  - t - □

Genes 1 & 2 are **unlinked**
(located on different chromosomes)



	Homozygous Dominant	Homozygous recessive
Phenotype:		
genotype	BBTT	bbtt
gamete :	(BT)	(bt)

gametes:



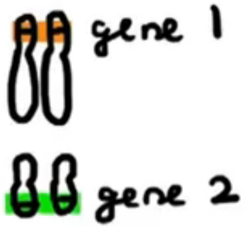
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Dihybrid inheritance: unlinked genes

* Gene 1 affects body colour
  - B - blue
  - b - red

* Gene 2 affects body shape
  - T - △
  - t - □

Genes 1 & 2 are **unlinked**
(located on different chromosomes)

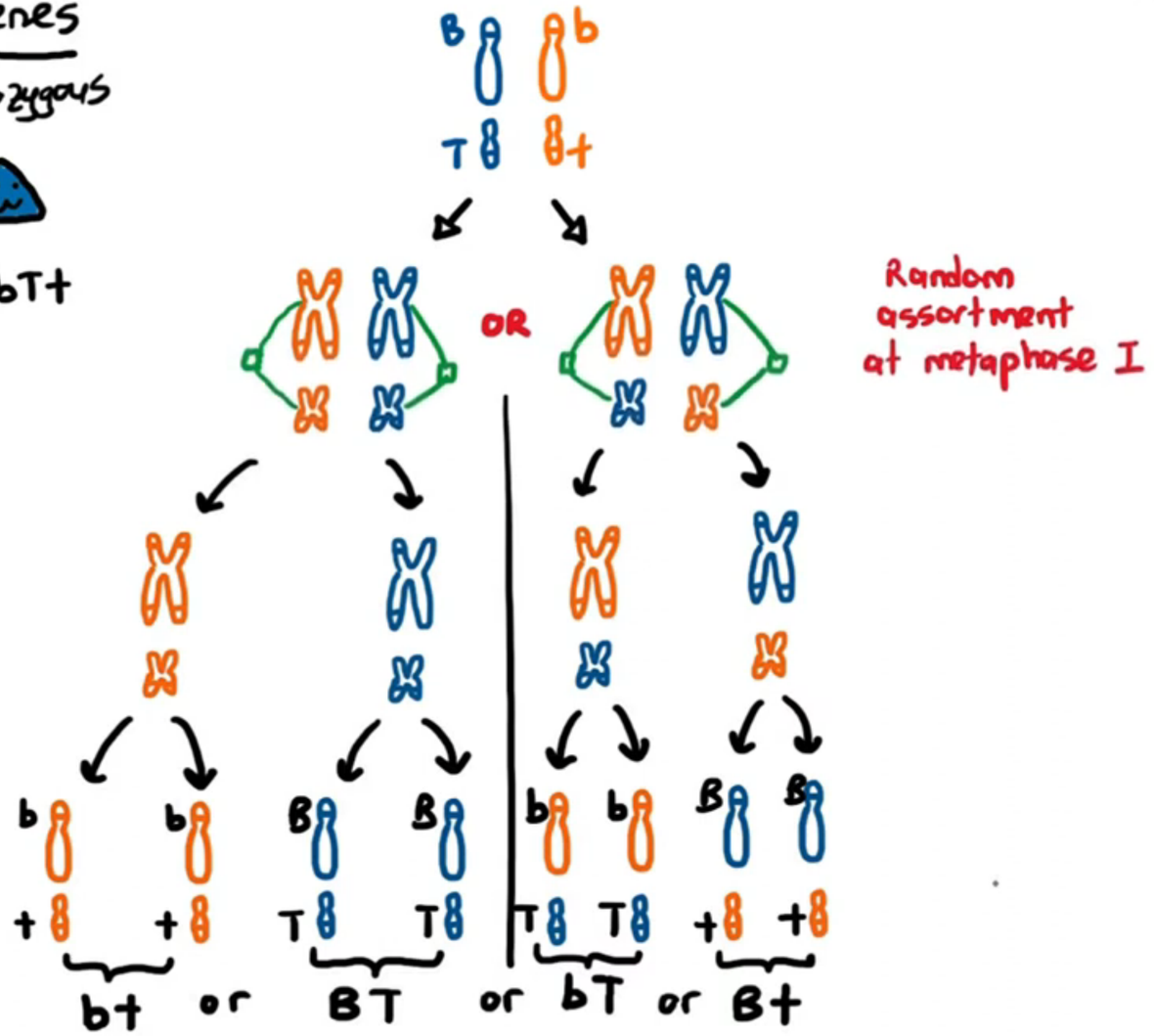


	Homozygous Dominant	Homozygous recessive
Phenotype:		
genotype	BBTT	bbtt
gamete :	BT	bt
	B T	b t
offspring genotype & phenotype	BbTt	 100% blue triangles!!

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Dihybrid inheritance: unlinked genes

	Heterozygous	Heterozygous
Phenotype:		
genotype:	BbT+	BbT+
gametes:	(bt) (BT) (bT) (B+)	



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Dihybrid inheritance : unlinked genes

Heterozygous | Heterozygous

Phenotype: 

genotype: BbT+ | BbT+

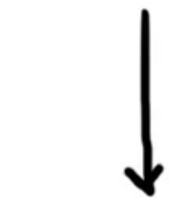
gametes: bt BT bT B+ | bt BT bT B+

offspring genotype & phenotype

	BT	B+	bT	b+
BT	BBTT	BBT+	BbTT	BbT+
B+	BBT+	BB++	BbT+	Bb++
bT	BbTT	BbT+	bbTT	bbT+
bt	BbT+	Bb++	bbT+	bb++

Dihybrid inheritance, unlinked genes

when 2 heterozygous parents are bred,



offsprings will usually show



9 : 3 : 3 : 1 ratio!!

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Fruit colour in courgettes is controlled by the gene **A/a**.
Fruit shape in courgettes is controlled by the gene **B/b**.

- A yellow fruit is produced when the dominant allele **A** is present.
- A round fruit is produced when the dominant allele **B** is present.

Genes **A/a** and **B/b** occur on different chromosomes.

genotype	fruit colour	fruit shape
aabb	green	long
AABB	yellow	round
AAbb	yellow	long
aaBB	green	round

gene for fruit colour: A - yellow; a - green

gene for fruit shape: B - round; b - long

Parent phenotype: yellow, round — Heterozygous

genotype: A a B b

Homozygous recessive: green, long

a a b b

gametes: AB, Ab, aB, ab — ab

offspring genotype: AaBb, Aabb, aaBb, aabb

&

phenotype: yellow, round; yellow, long; green, round; green, long

1 : 1 : 1 : 1

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Fruit colour in courgettes is controlled by the gene **A/a**.
Fruit shape in courgettes is controlled by the gene **B/b**.

- A yellow fruit is produced when the dominant allele **A** is present.
- A round fruit is produced when the dominant allele **B** is present.

Genes **A/a** and **B/b** occur on different chromosomes.

genotype	fruit colour	fruit shape
aabb	green	long
AABB	yellow	round
AAbb	yellow	long
aaBB	green	round

gene for fruit colour: A - yellow; a - green

gene for fruit shape: B - round; b - long

Parent phenotype: Heterozygous yellow, round × Heterozygous yellow, round

genotype: Aa Bb × Aa Bb

gametes: AB Ab aB ab × AB Ab aB ab

offspring genotype & phenotype

	AB	Ab	aB	ab
AB	AABB yellow, round	AABb yellow, round	AaBB yellow, round	AaBb yellow, round
Ab	AABb yellow, round	AAbb yellow long	AaBb yellow, round	Aabb yellow, long
aB	AaBB yellow, round	AaBb yellow, round	aaBB green, round	aaBb green, round
ab	AaBb yellow, round	Aabb yellow long	aaBb green, round	aabb green, long

9 yellow, round : 3 yellow, long : 3 green, round : 1 green, long

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Situation

* Gene 1 affects body colour
  - B - blue
  - b - red

* Gene 2 affects body shape
  - T - △
  - t - □



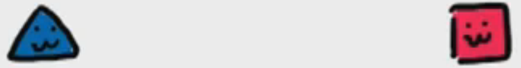
Phenotype: Blue, triangle

Possible genotypes:

- B B T T
- B b T t
- B B T t
- B b T T

Test cross

Breed the organism with a **homozygous recessive** organism!!



Genotype: B B T T × bb tt

Gametes: BT, BT, BT, BT × bt

Offspring genotype & phenotype:

BbTt | BbTt | BbTt | BbTt



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Situation

* Gene 1 affects body colour
  - B - blue
  - b - red
* Gene 2 affects body shape
  - T - △
  - t - □

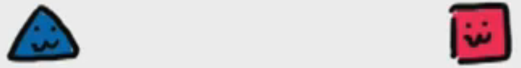


Phenotype: Blue, triangle

Possible genotypes:
- B B T T
- B b T t
- B B T t
- B b T T

Test cross

Breed the organism with a homozygous recessive organism!!



Genotype: B B T t bb tt

gametes: BT, Bt, Bt, BT bt

offspring genotype & phenotype:

BbTt	Bbtt	Bbtt	BbTt
			

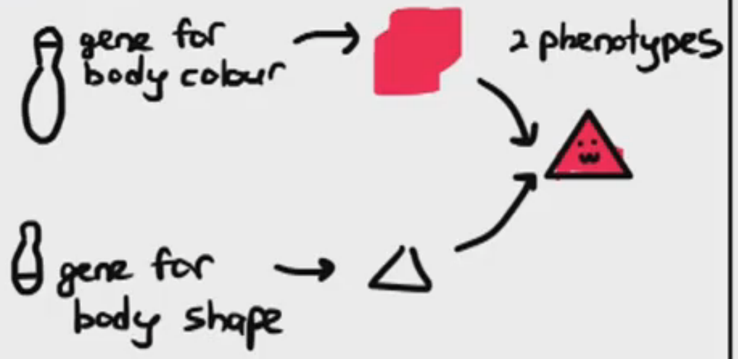
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Dihybrid inheritance: unlinked genes

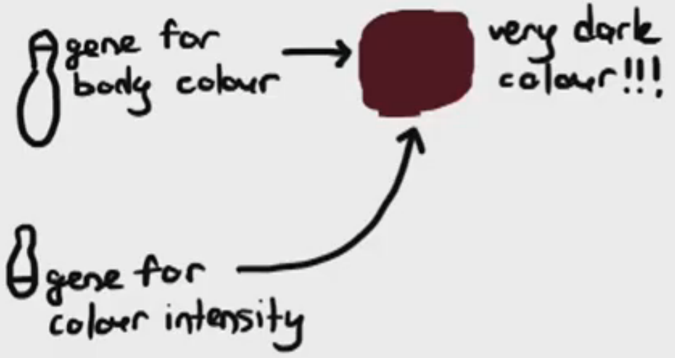
Epistasis

- 2 genes at different loci interact with each other to affect 1 phenotype

Not epistasis



Epistasis



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Dihybrid inheritance: unlinked genes

Epistasis

- 2 genes at different loci
  interact with each other
  to affect 1 phenotype

Flower colour in *I. purpurea* is controlled by **two** genes on **different** chromosomes.

Gene **R/r**, which codes for a protein involved in pigment production, has 2 alleles:

- the dominant allele, **R**, allows pigment production
- the recessive allele, **r**, prevents pigment production of any colour, resulting in white flowers.

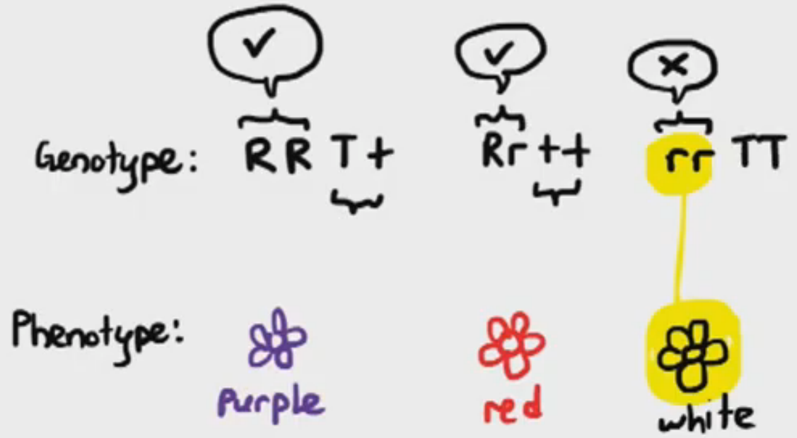
Gene **T/t**, which determines the type of pigment produced, has two alleles:

- the dominant allele, **T**, results in purple flowers
- the recessive allele, **t**, results in red flowers.

gene 1 < R - ✓ pigments
r - X pigments = white

Flower colour controlled by 2 genes (unlinked)

gene 2 < T - purple
t - red



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(b) Complete Fig. 3.2 to show the results of a cross between two *I. purpurea* plants that are **heterozygous at both loci**.

parental genotypes: RrTt × RrTt

parental gametes: (RT) (Rt) (rT) (rt) (RT) (Rt) (rT) (rt)

results of cross:
- show parental gametes in first column and top row
- show offspring genotypes and phenotypes in square boxes

parental gametes → / ↓	RT	Rt	rT	rt
RT	RRTT Purple	RRTt Purple	RrTT Purple	RrTt Purple
Rt	RRTt Purple	RRtt red	RrTt Purple	Rrtt red
rT	RrTT Purple	RrTt Purple	rrTT white	rrTt white
rt	RrTt Purple	Rrtt red	rrTt white	rrtt white

phenotypic ratios:

gene 1 < R - ✓ pigments; r - x pigments = white

gene 2 < T - purple; t - red

9 purple : 3 red : 4 white

not 9:3:3:1 as there are only 3 possible phenotypes!!

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(a) The stems of raspberry plants have spines.

Fig. 7.1 shows part of a raspberry plant.

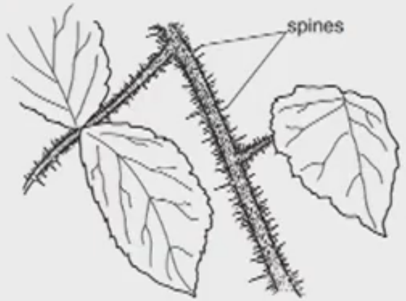


Fig. 7.1

The colour of the spines is controlled by two genes, **A**/**a** and **B**/**b**. The two genes are on different pairs of chromosomes.

- Allele **A** produces a pink anthocyanin pigment in the spines.
- Allele **B** has no effect by itself, but increases the colour produced by allele **A** to give red spines.
- Alleles **a** and **b** have no effect on colour.
- In the absence of anthocyanin, the spines are green.

State the colour of the spines of raspberry plants with the genotypes **Aabb** and **aaBB**.

Aabb .....

aaBB ..... [2]

Aa Bb

(✓ pink)

Red spines

1 < A = produces pink anthocyanin pigment

a = no effect

2 < B = makes the spine become red (if 'A' allele is present)

b = no effect

Genotype: Aa bb

(✓ pink)

no effect

aa BB

(✗ pink)

only influence 'A' allele

Phenotype: Pink spines

Green spines

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Dihybrid inheritance: Linked genes (Autosomal linkage)

Example

gene 1 affects plant height
- T - tall
- t - short

gene 2 affects flower colour
- R - red
- r - white

Phenotype:

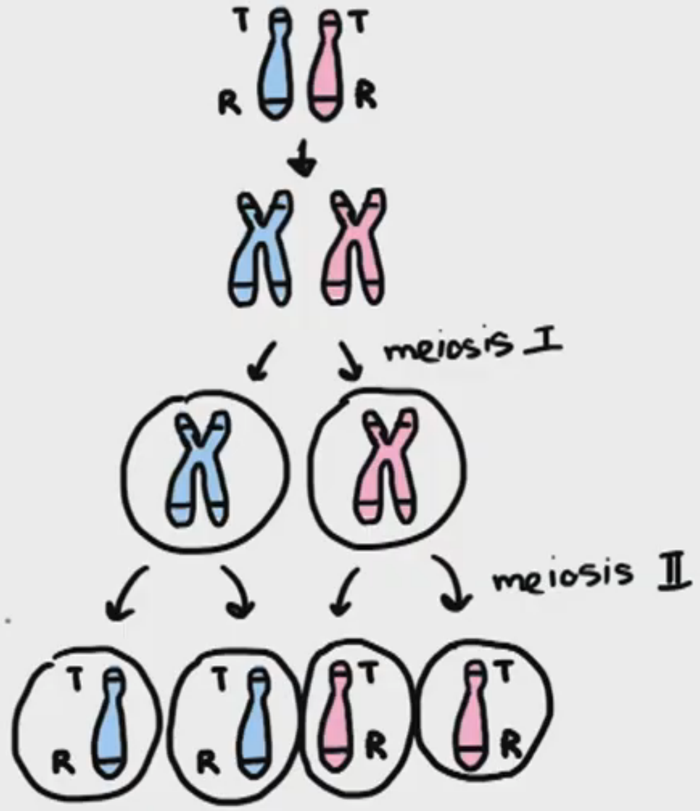


tall, red

Genotype: (TR)(TR)



Gametes: (TR)



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Dihybrid inheritance: Linked genes (Autosomal linkage)

Example

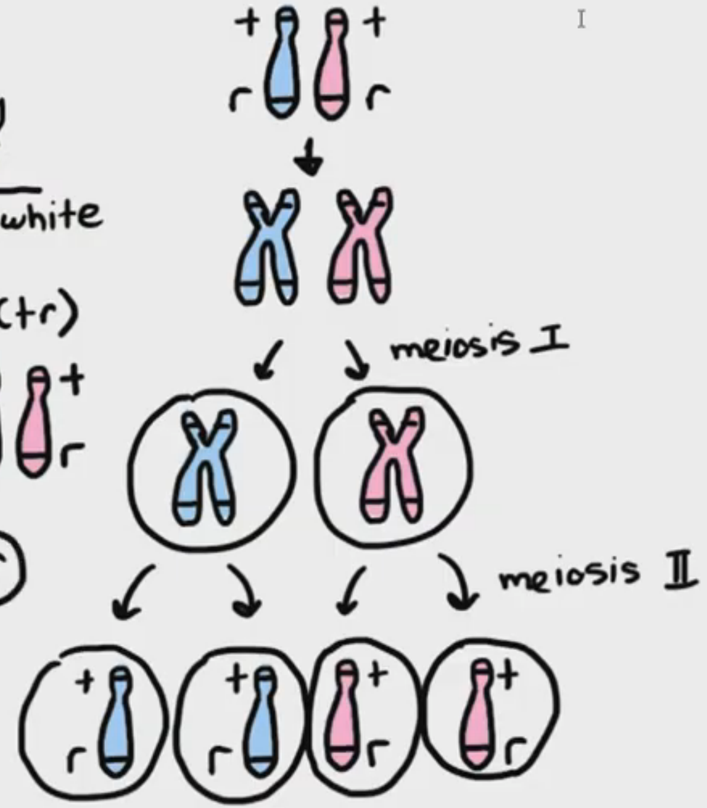
gene 1 affects plant height: T - tall, t - short

gene 2 affects flower colour: R - red, r - white

Phenotype: tall, red × short, white

Genotype: (TR)(TR) × (tr)(tr)

Gametes: TR × tr



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Dihybrid inheritance: Linked genes (Autosomal linkage)

Example

gene 1 affects plant height: T - tall, t - short

gene 2 affects flower colour: R - red, r - white

Phenotype: tall, red × short, white

Genotype: (TR)(TR) × (tr)(tr)

Gametes: TR × tr

offspring genotype & phenotype: (TR)(tr) — tall, red

100% !!

Heterozygous

Dihybrid inheritance: Linked genes (Autosomal linkage)

Phenotype: r Heterozygous

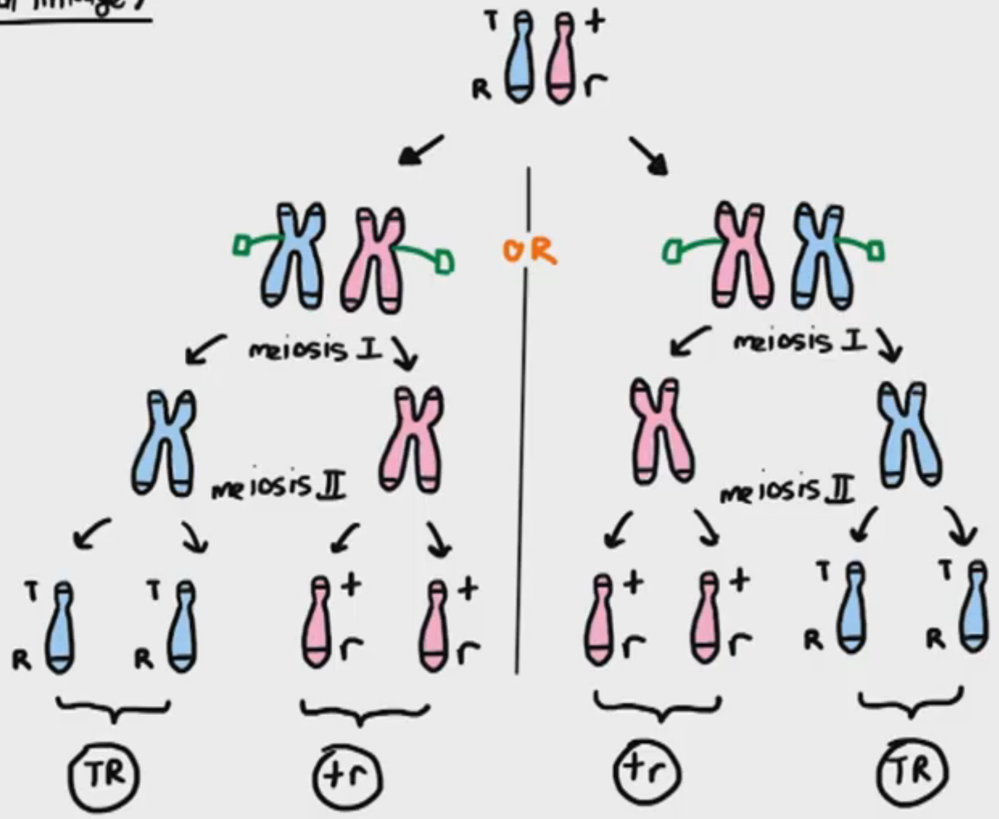


tall, red

Genotype: (TR)(+r)



Gamete:



RANDOM ASSORTMENT DOES NOT MATTER

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Dihybrid inheritance: Linked genes (Autosomal linkage)

Phenotype: r Heterozygous



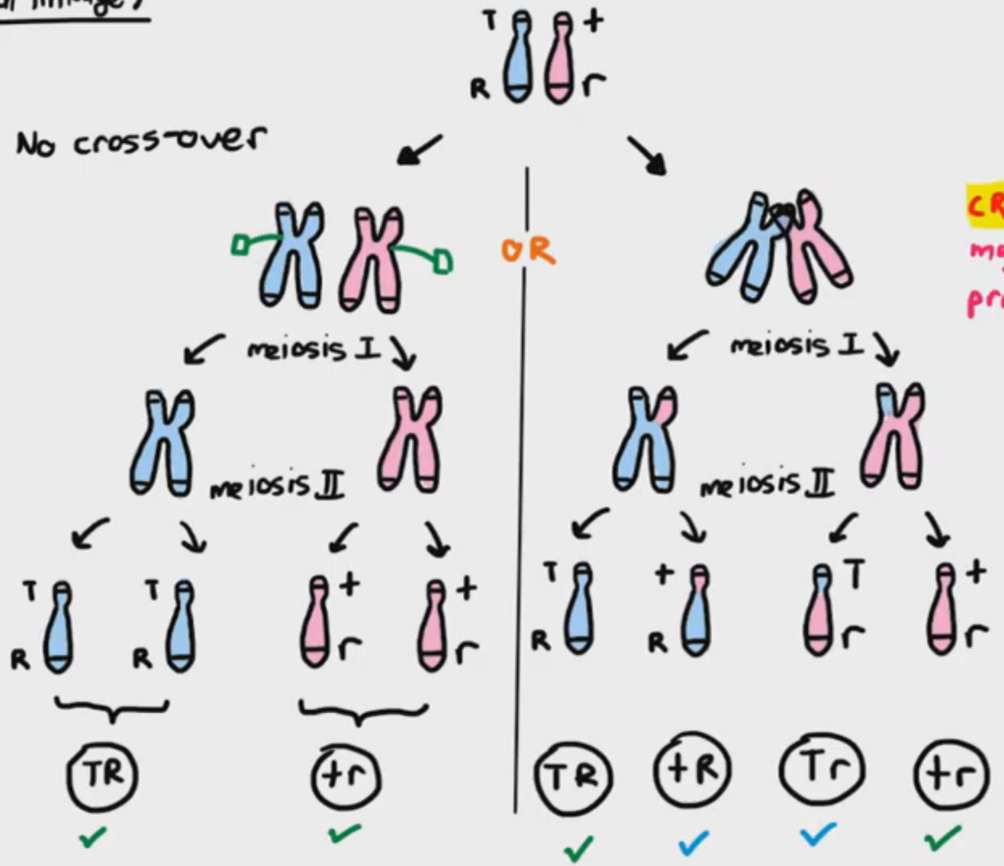
tall, red

Genotype: (TR)(+r)



Gamete: TR, +r, Tr, +R

more less



CROSS-OVER may happen at prophase I !!

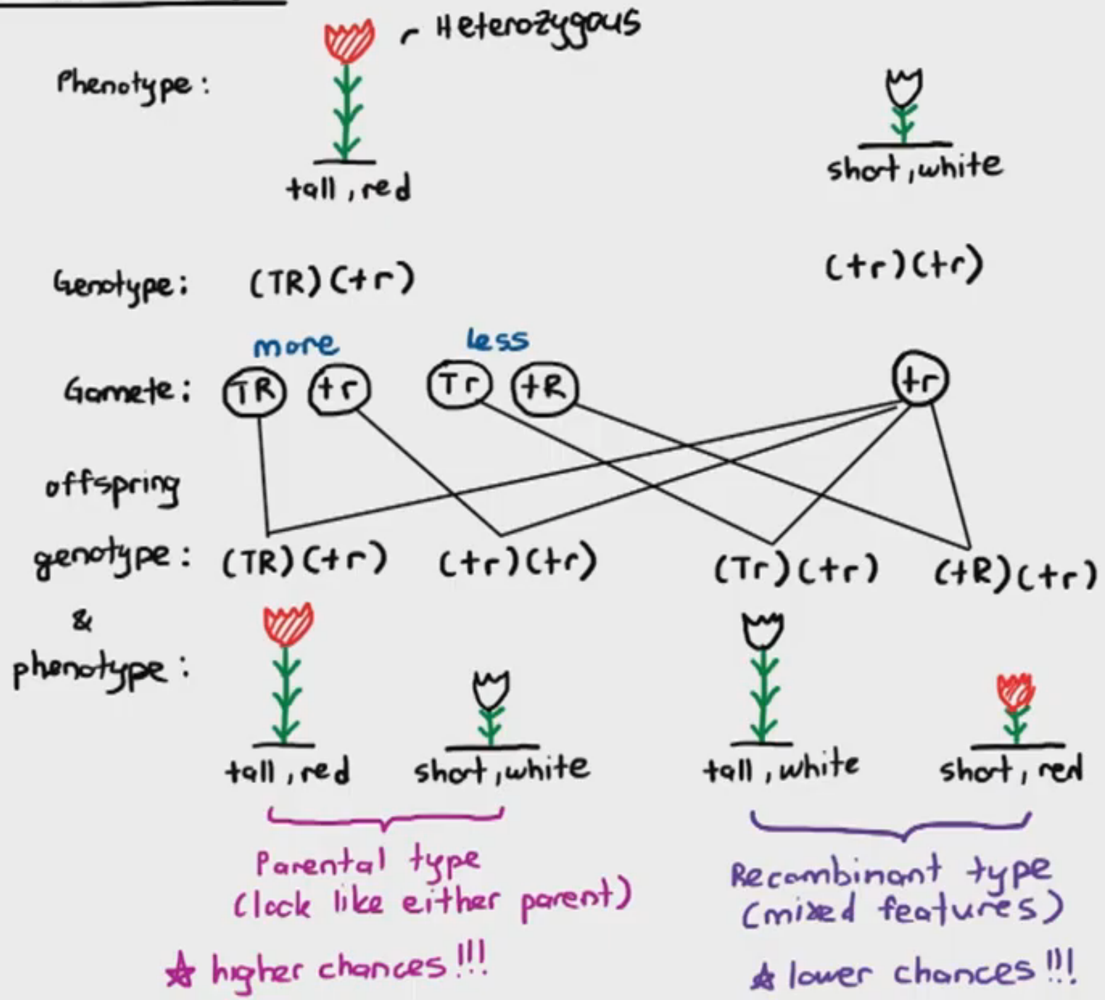
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Dihybrid inheritance: Linked genes (Autosomal linkage)

Example

gene 1 affects plant height: T - tall; t - short

gene 2 affects flower colour: R - red; r - white



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What if the exam question does not mention whether the genes are **linked or unlinked??**

Example

gene 1 (body colour) < B – blue, b – red

gene 2 (body shape) < T – △, t – □

Heterozygous (unlinked)



genotype: BbTt

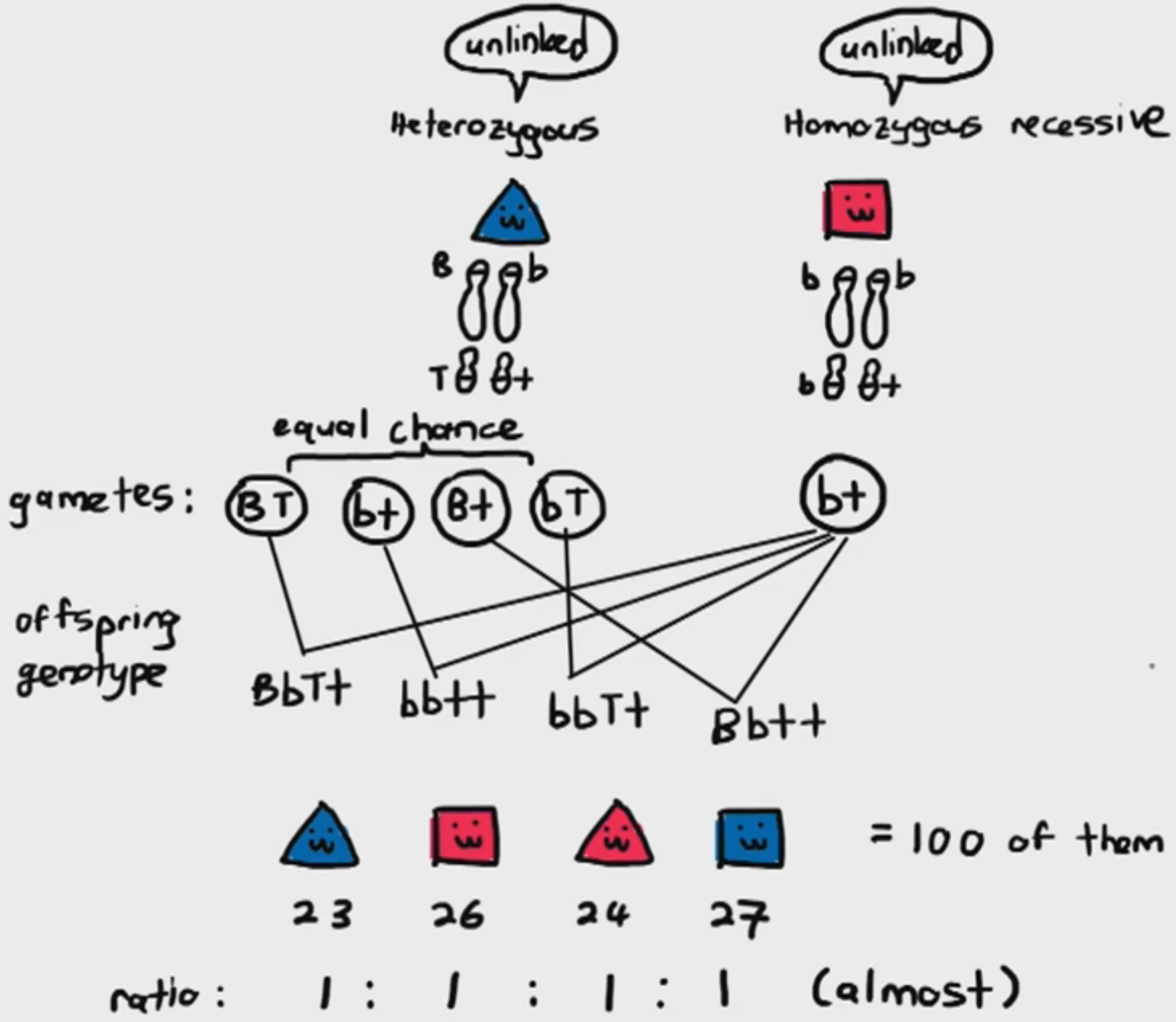
OR

Heterozygous (linked)



(BT)(bt)

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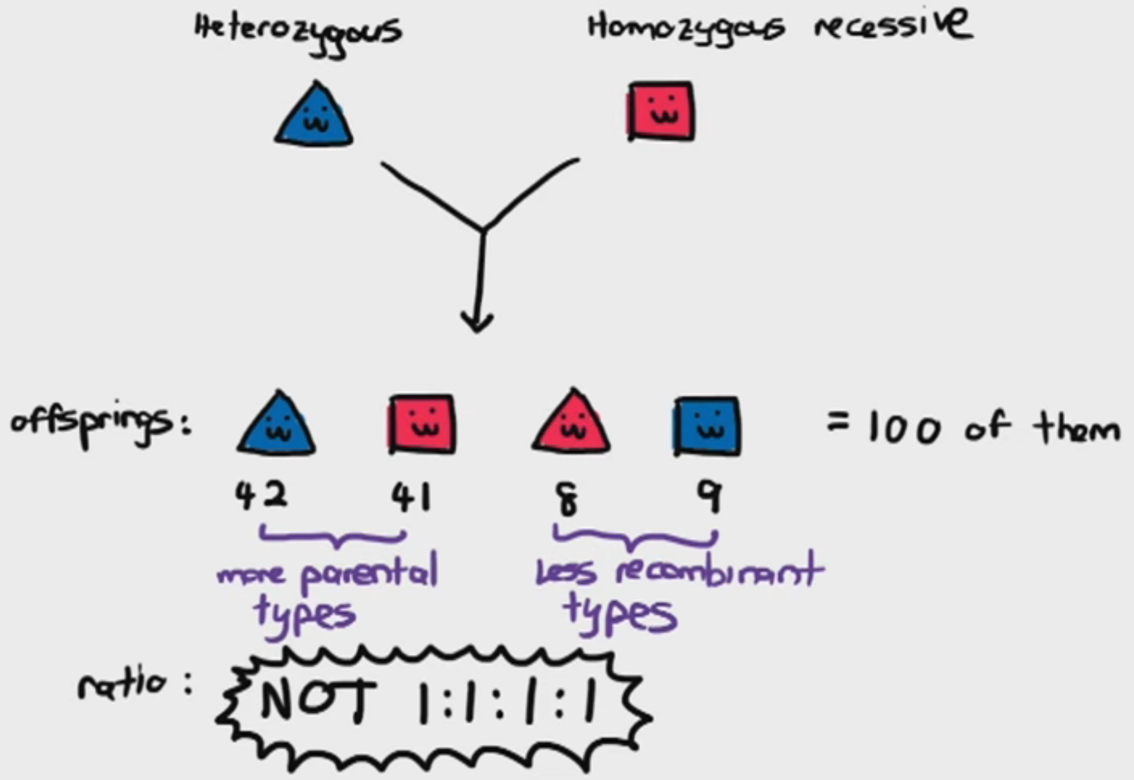


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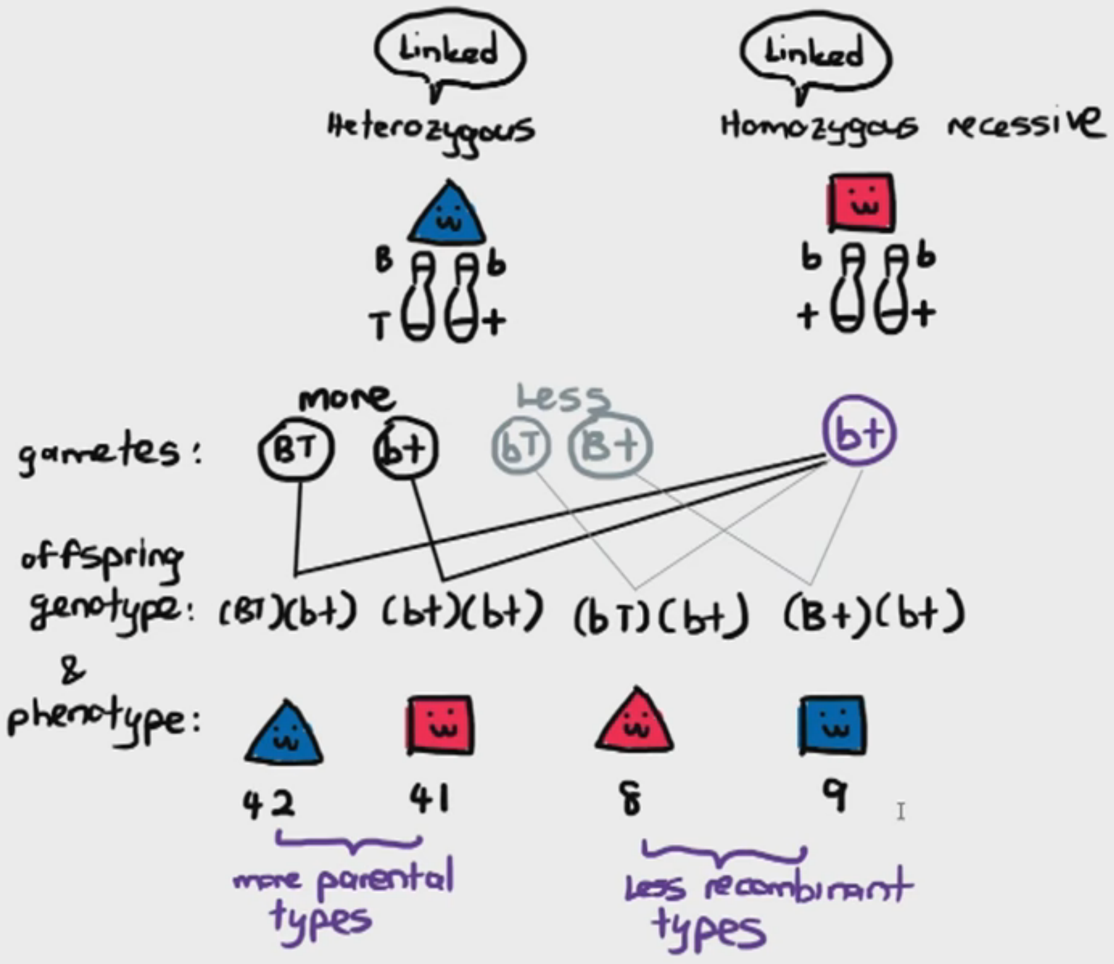
A heterozygous organism
was crossed with a
homozygous recessive organism.
The number of offsprings was determined....

gene 1 (body colour) < B - blue / b - red

gene 2 (body shape) < T - △ / t - □



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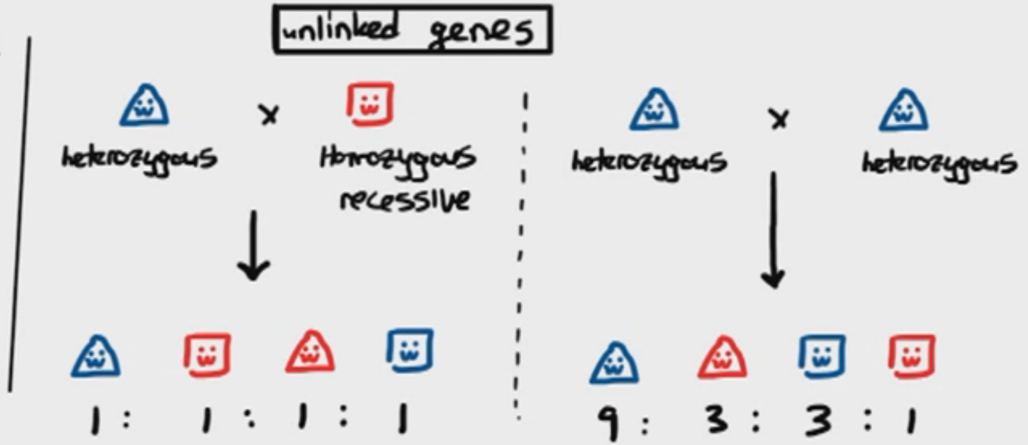
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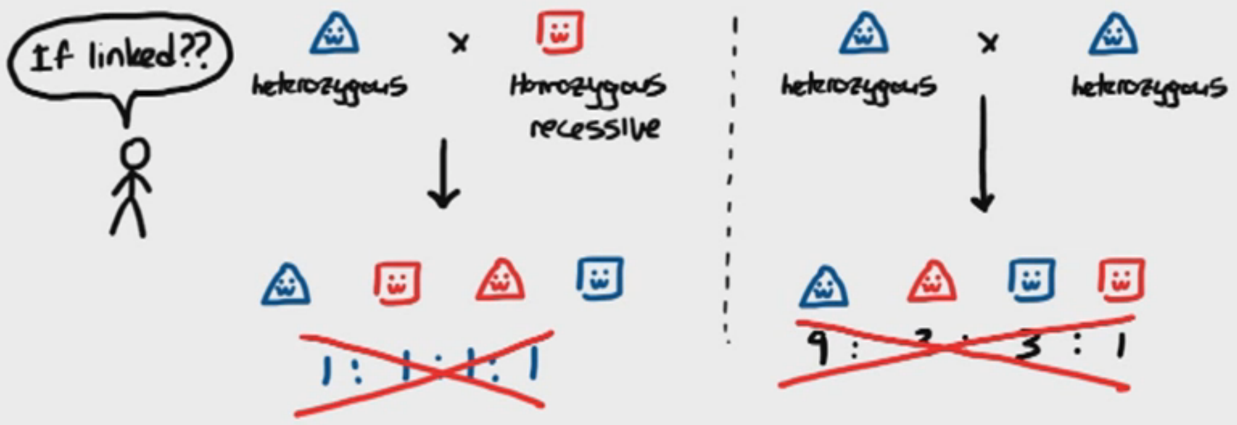
Long story short.....

in the case of dihybrid inheritance....

gene 1 (body colour) < B - blue, b - red

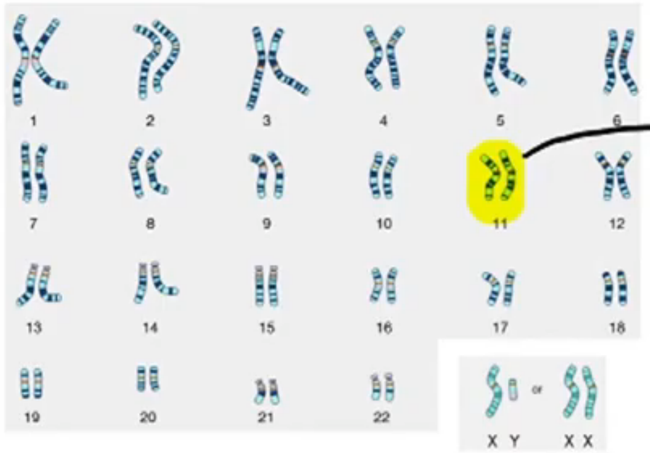
gene 2 (body shape) < T - Δ, t - □





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① TYR gene



GENE

TYR gene

codes for tyrosinase

Transcription and translation

PROTEIN

Tyrosinase

PHENOTYPE

affects skin, hair & iris colour!

Tyrosinase Function?

Tyrosine

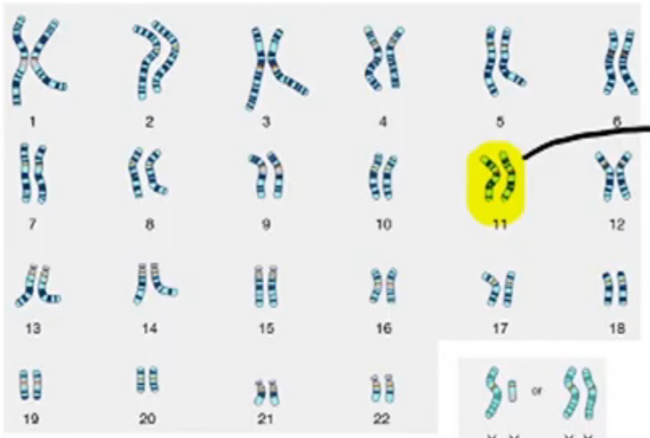
DOPA

Dopaquinone ⟹ melanin pigment

involved in the production of melanin pigments

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① TYR gene



GENE

mutated TYR gene

codes for tyrosinase

Transcription and translation

PROTEIN

Tyrosinase (non-functional)

PHENOTYPE



- Pale hair

- pinkish iris



- Pale skin

Albinism!!

Tyrosinase function?

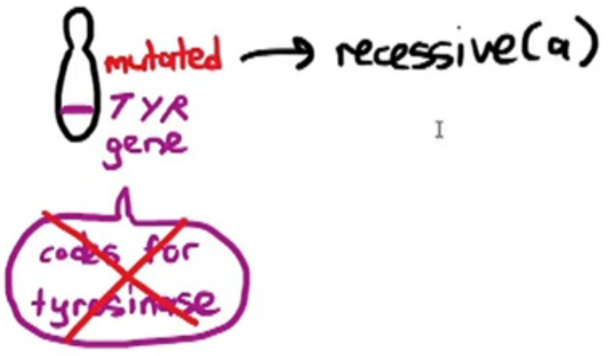
Tyrosine

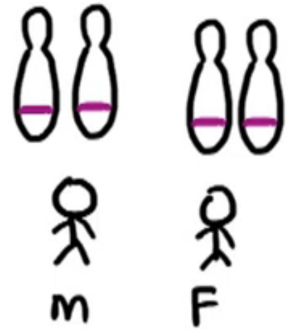


no melanin produced!!!

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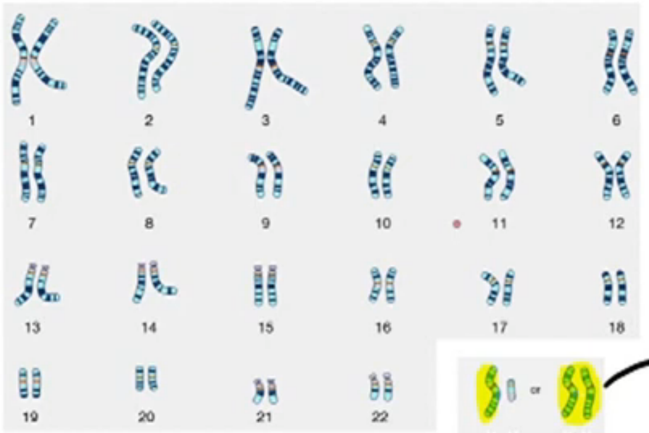




Genotype	AA	Aa	aa
Phenotype	normal melanin production		albinism

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2) F8 gene



→ Located on the X-chromosomes (sex-linked)



F8 gene → (Transcription and translation) → Factor VIII protein → normal blood clotting

GENE → PROTEIN → PHENOTYPE

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2) F8 gene

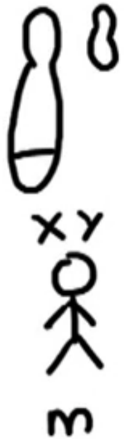


F8 gene — H allele = X^H

(normal)



mutated F8 gene — h allele = X^h



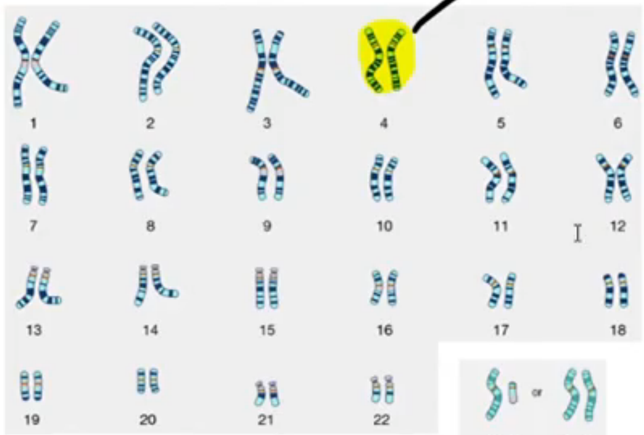


Genotype: X^HY or X^hY | X^HX^H or X^HX^h or X^hX^h

Phenotype: ✓ haemophilia | ✓ | ✓ (carrier) haemophilia

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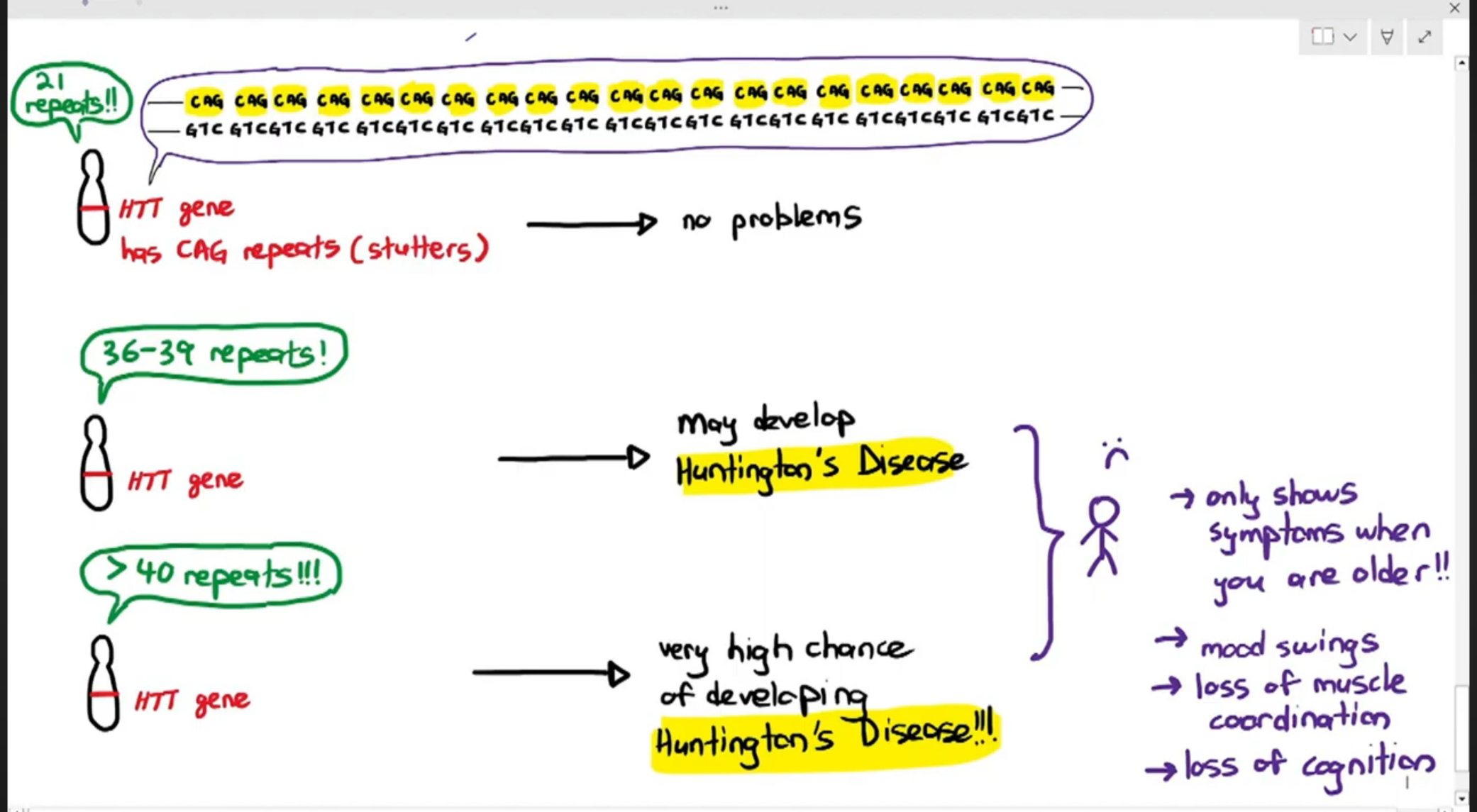
③ HTT gene



GENE → PROTEIN → PHENOTYPE

HTT gene → (Transcription and translation) → Huntingtin protein → affects brain development (we think.....)

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Dominant Allele (H)



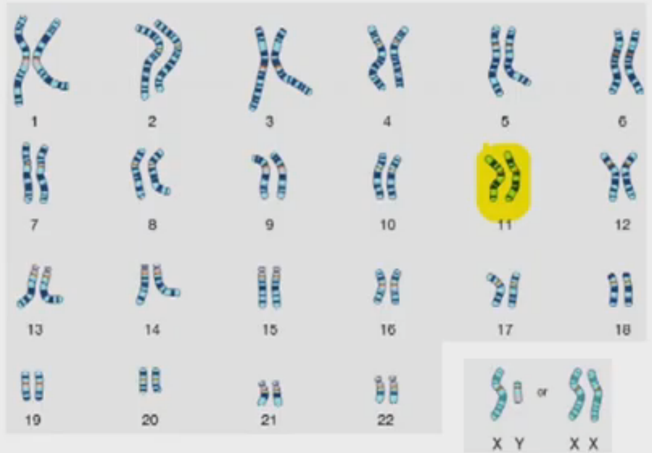
Recessive allele (h)

Genotype: HH Hh hh

Phenotype: most probably develop Huntington's disease!!!

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④ HBB gene



GENE

HBB gene

Transcription and translation

PROTEIN

β-globin (part of Haemoglobin)

PHENOTYPE

affects shape of RBC & O_2 transport



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GENE

HBB gene (Hb^A allele)

Transcription and translation

PROTEIN

B-globin (part of Haemoglobin)

PHENOTYPE

affects shape of RBC & O_2 transport



mutated HBB gene (Hb^S allele)

Transcription and translation

valine

B-globin (part of Haemoglobin)





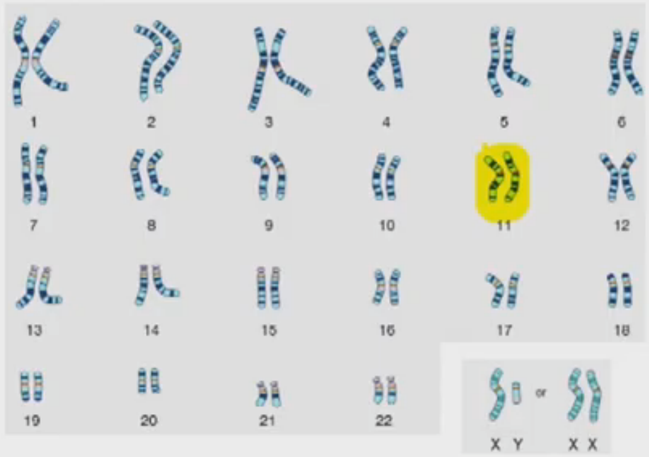
sickle cell anaemia!!

→ less O_2 transport

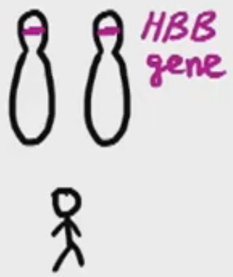
→ blockage in capillaries

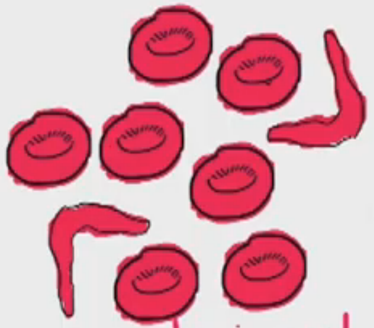
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④ HBB gene



on the autosome





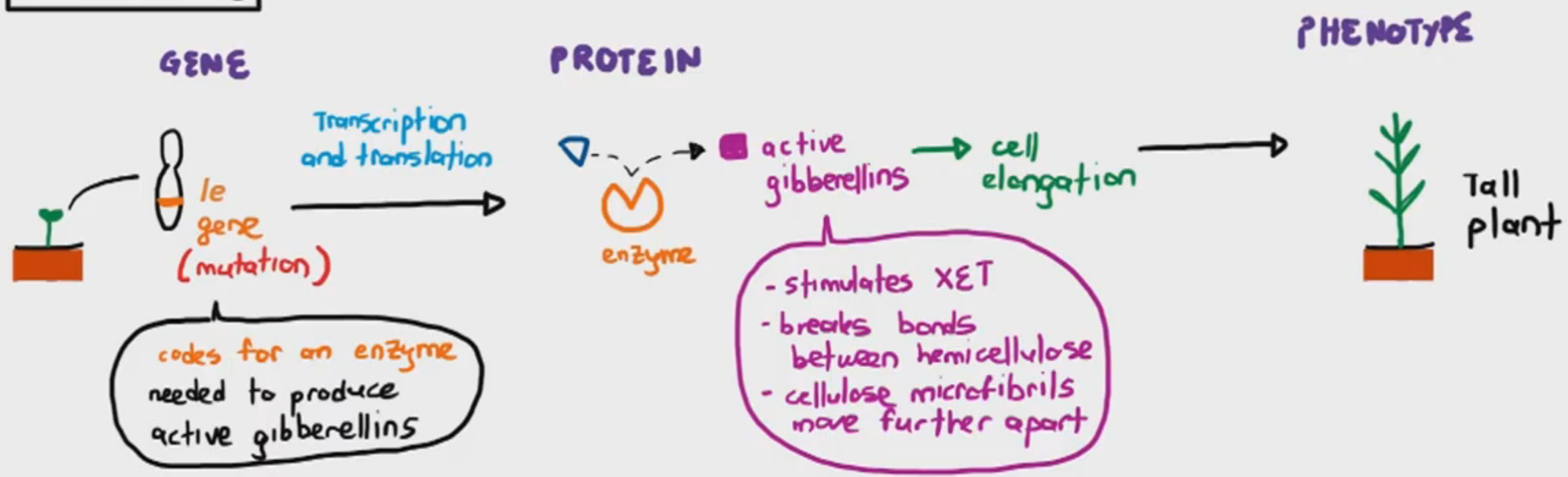
codominance!

Genotype: Hb^AHb^A Hb^SHb^S Hb^AHb^S

Phenotype: normal | sickle-cell anaemia | very mild sickle-cell anaemia

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⑤ Le Gene



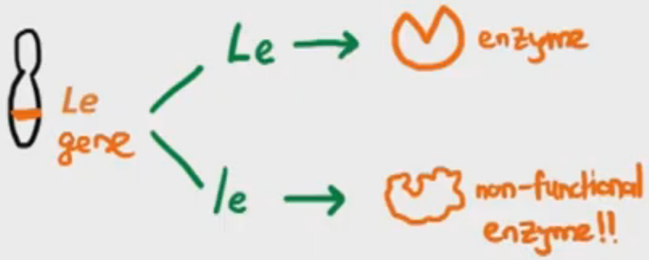
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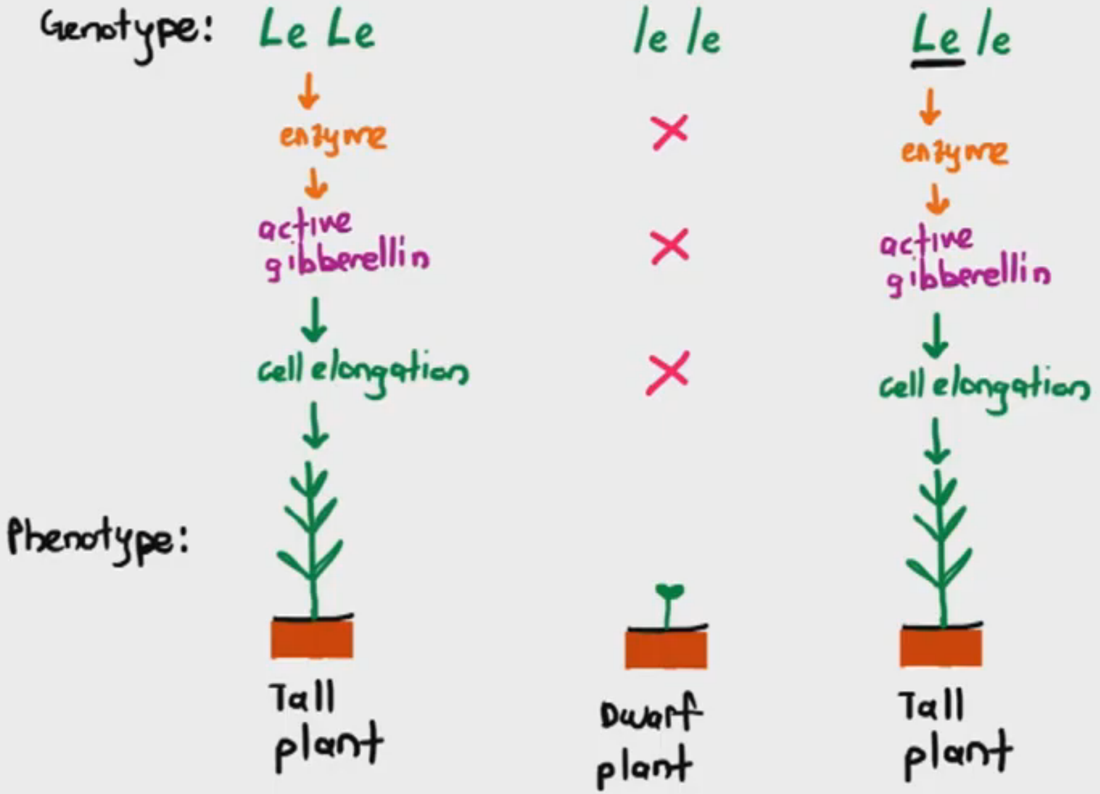
⑤ Le Gene



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⑤ Le Gene





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Control of gene expression

① What is gene expression?

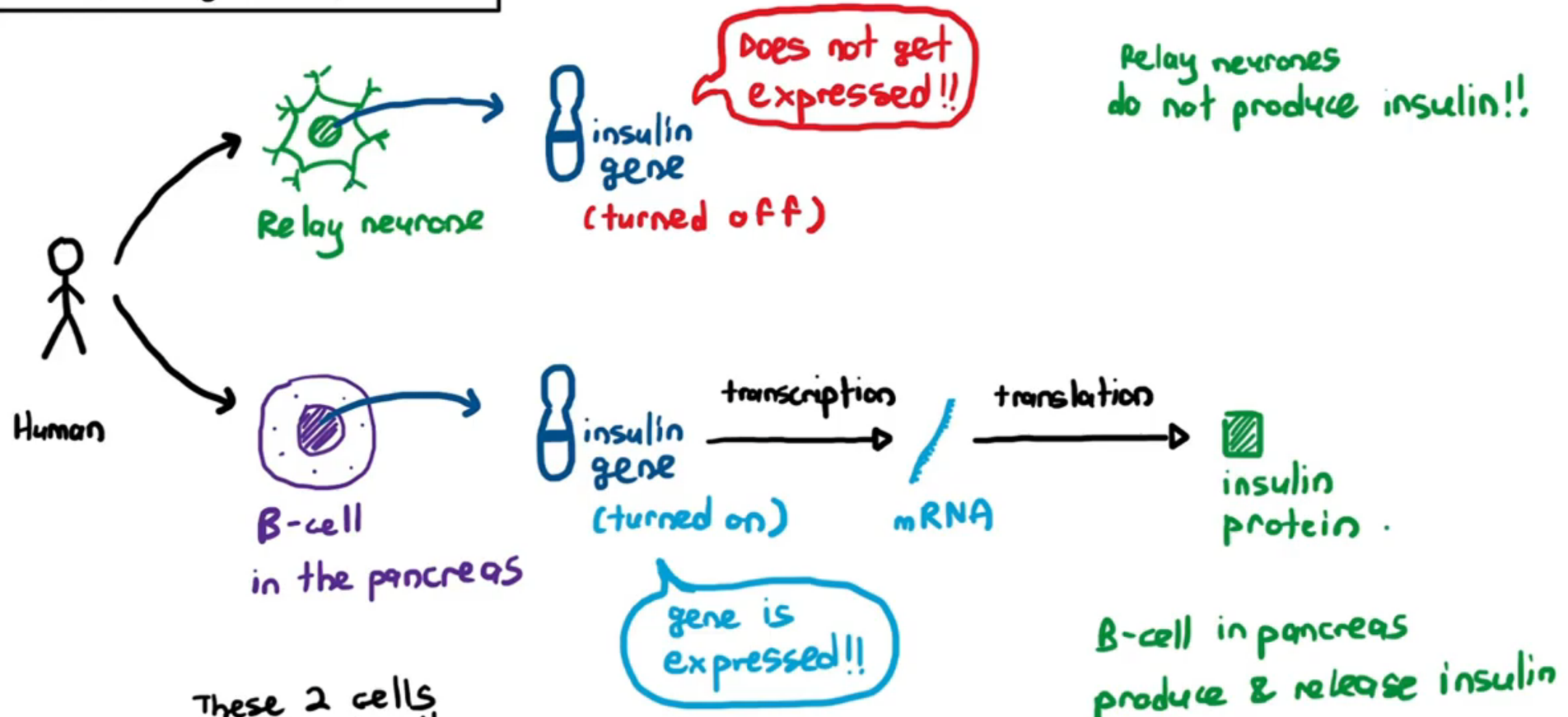




Gene is 'used' to code for a polypeptide production!!

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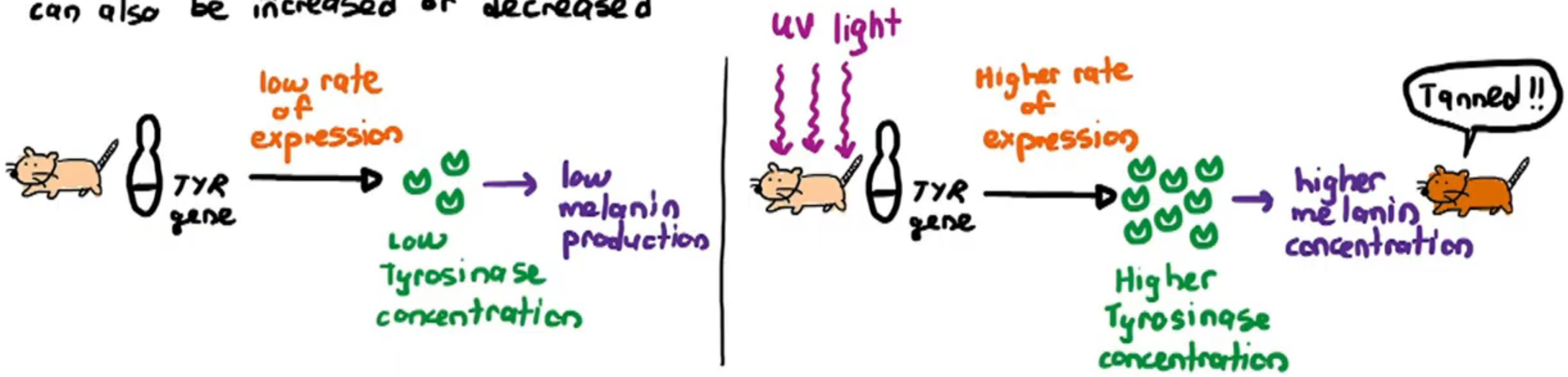
Control of gene expression



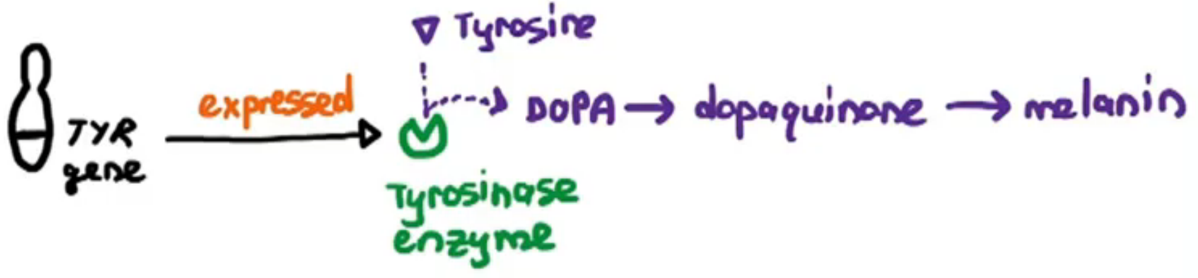
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Control of gene expression

can also be increased or decreased



Revision



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Control of gene expression

Important Definitions

1. Structural genes
2. Regulatory genes
3. Promoters
4. Inducible enzymes
5. Repressible enzymes

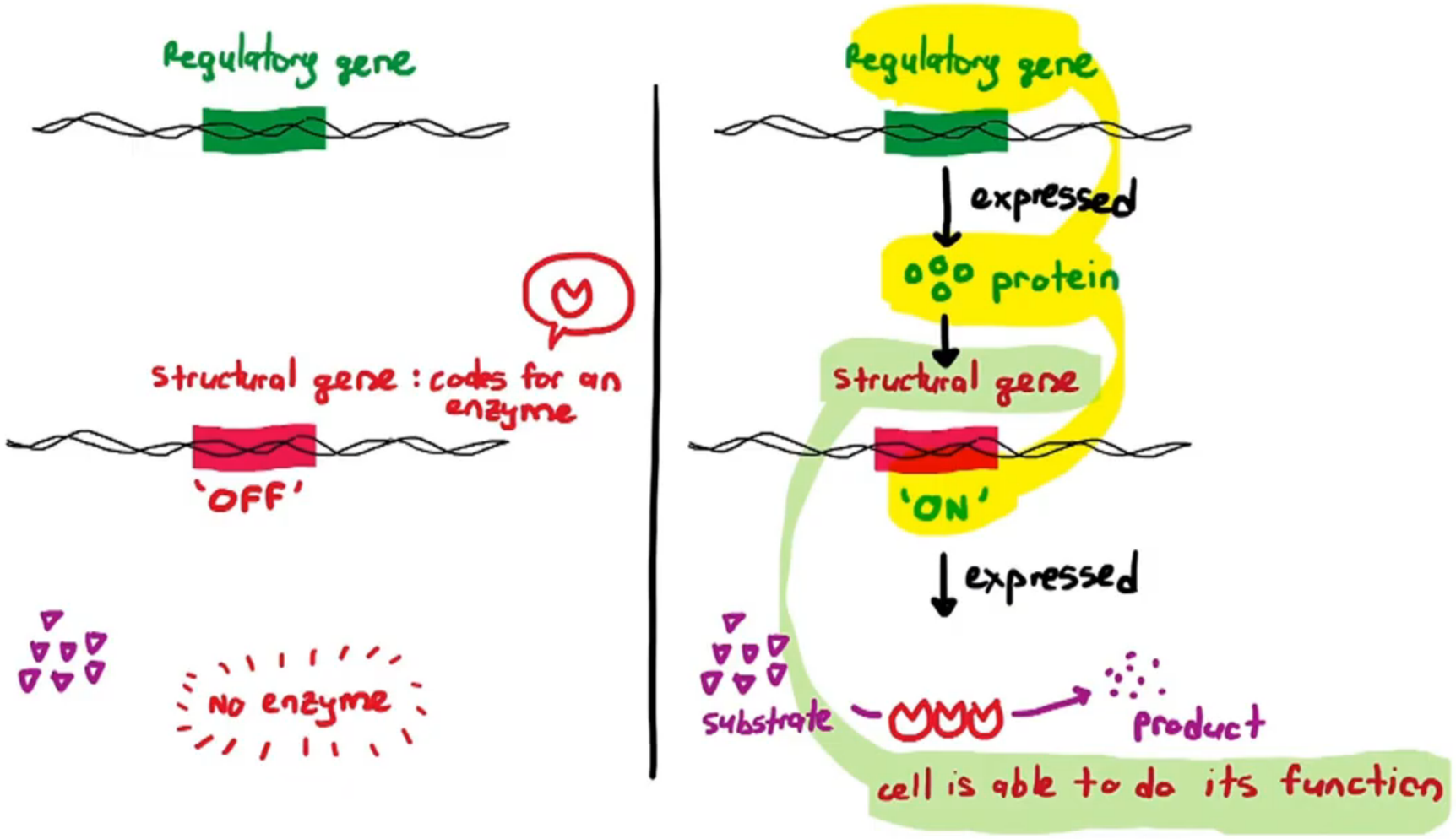


Regulatory gene: codes for a protein that affects the expression of other genes

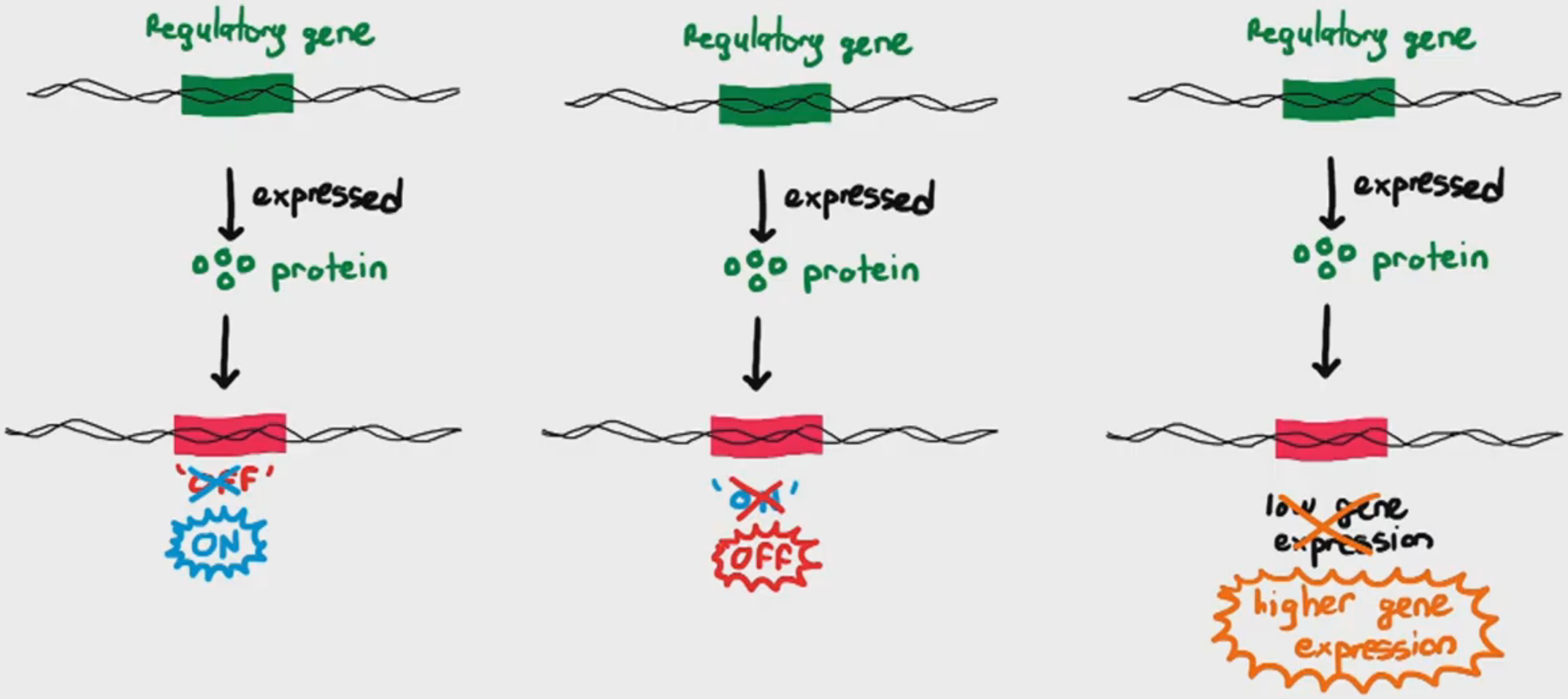


Structural gene: codes for a protein that has a function within the cell

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Control of gene expression

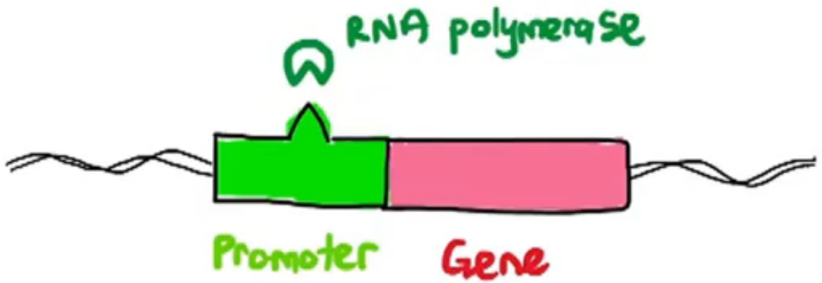
Important Definitions

1. ~~Structural genes~~
2. ~~Regulatory genes~~
3. Promoters
4. Inducible enzymes
5. Repressible enzymes

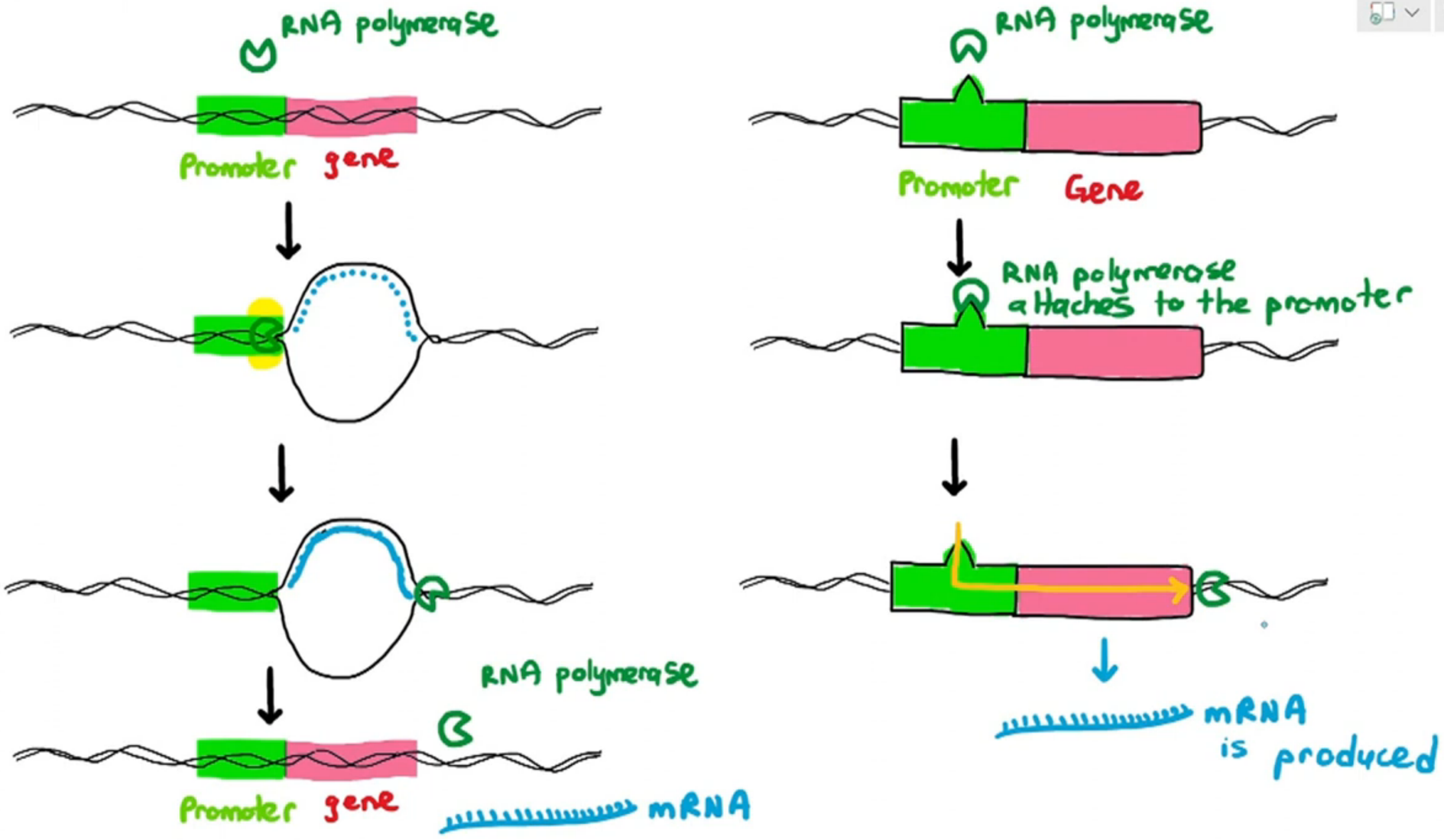
Promoters

* a length of DNA that is the binding site of RNA polymerase so that transcription of genes can occur!!





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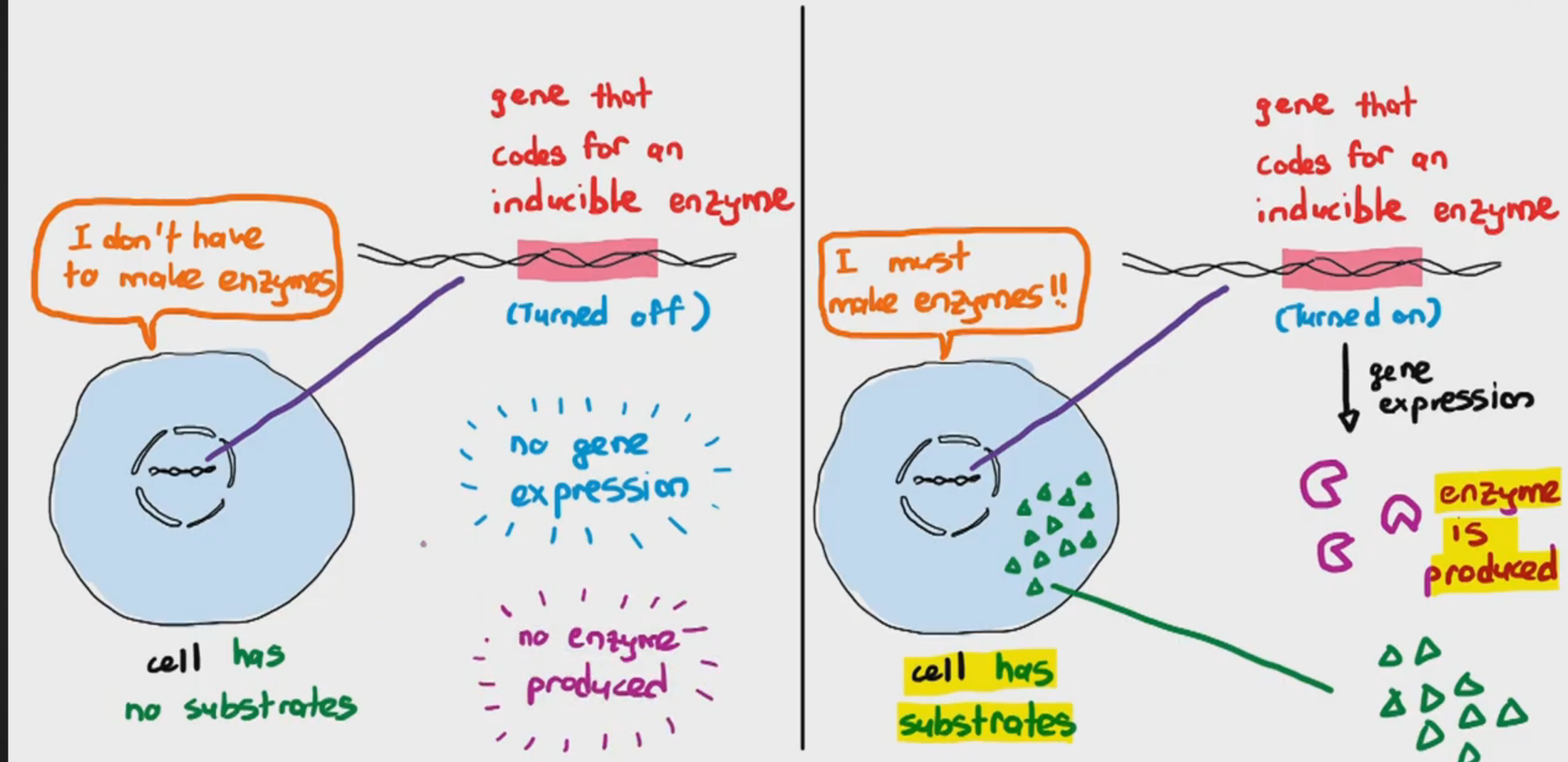
Control of gene expression

Important Definitions

1. structural genes
2. Regulatory genes
3. Promoters
4. Inducible enzymes : an enzyme that is synthesized when the substrate is present!!!
5. Repressible enzymes



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Control of gene expression

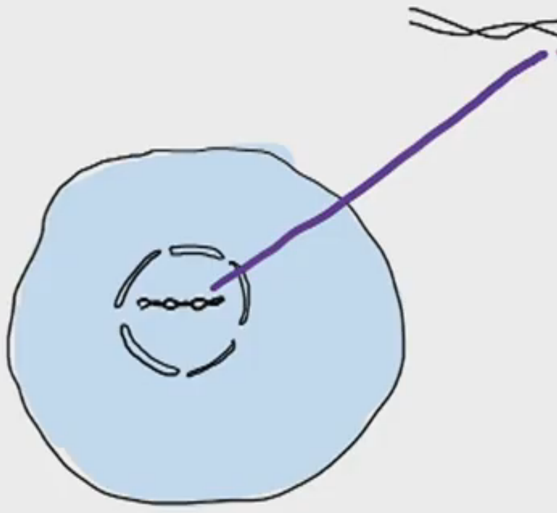
Important Definitions

1. Structural genes
2. Regulatory genes
3. Promoters
4. Inducible enzymes
5. Repressible enzymes : an enzyme that is normally produced, But its synthesis can be blocked by an effector/molecule !!

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gene that codes for a repressible enzyme

(usually turned on)



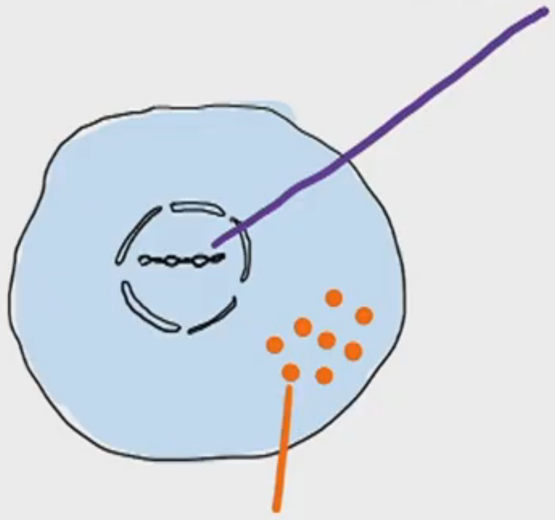
gene expression

enzyme is synthesized

molecule

gene that codes for a repressible enzyme

(turned off)

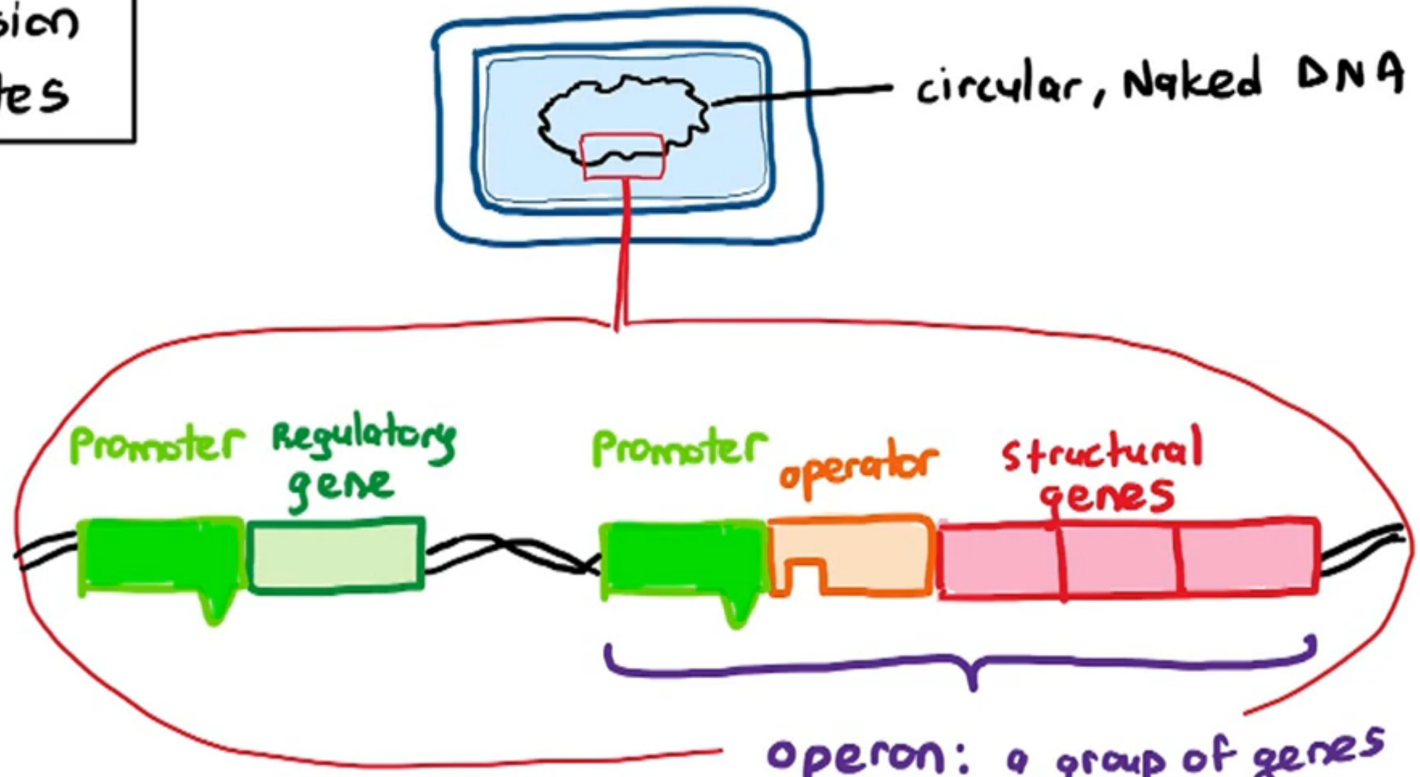


NO gene expression

an effector/ molecule = enzyme synthesis stops !!!

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Control of gene expression in prokaryotes

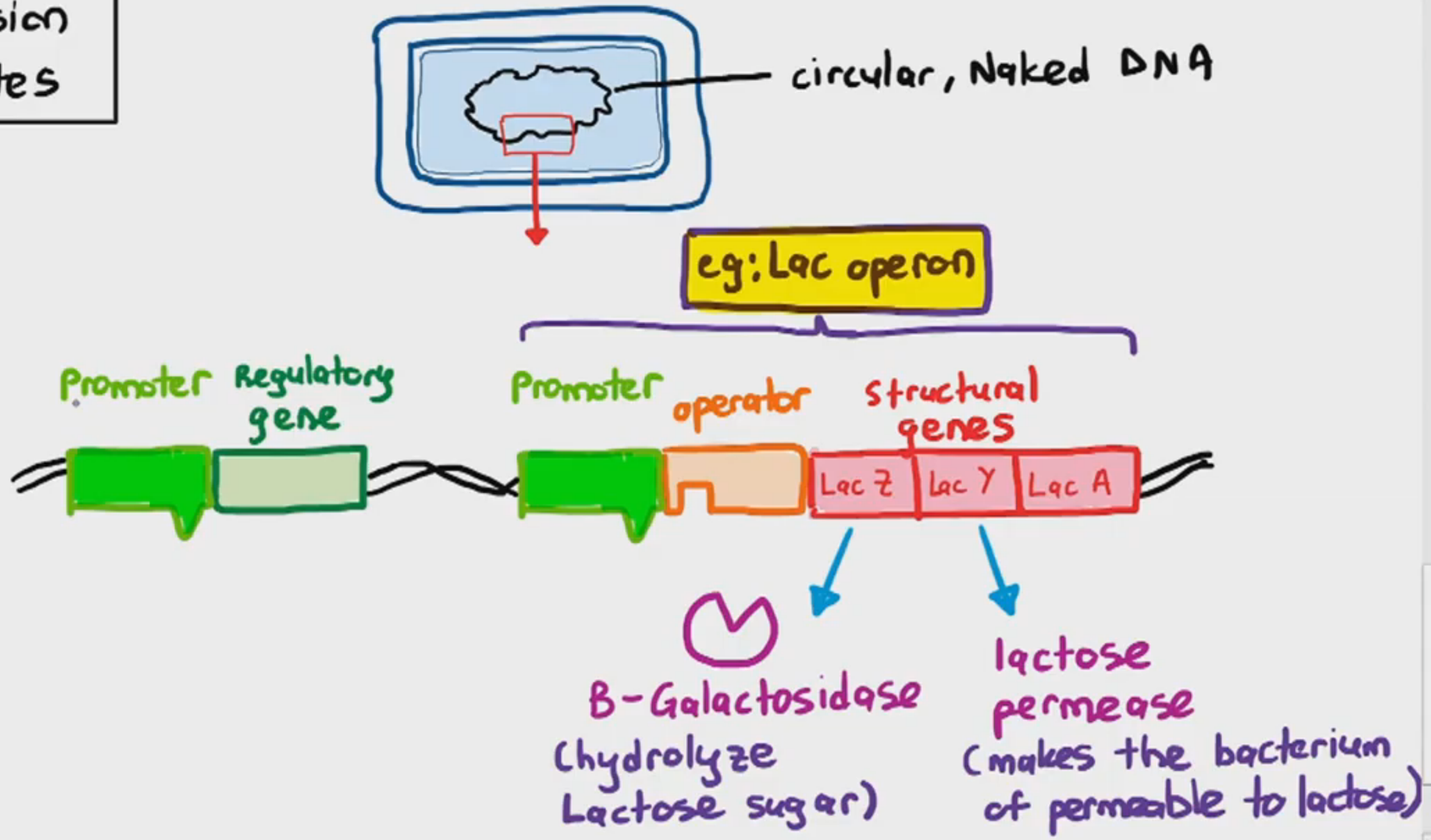


operon: a group of genes controlled by one promoter

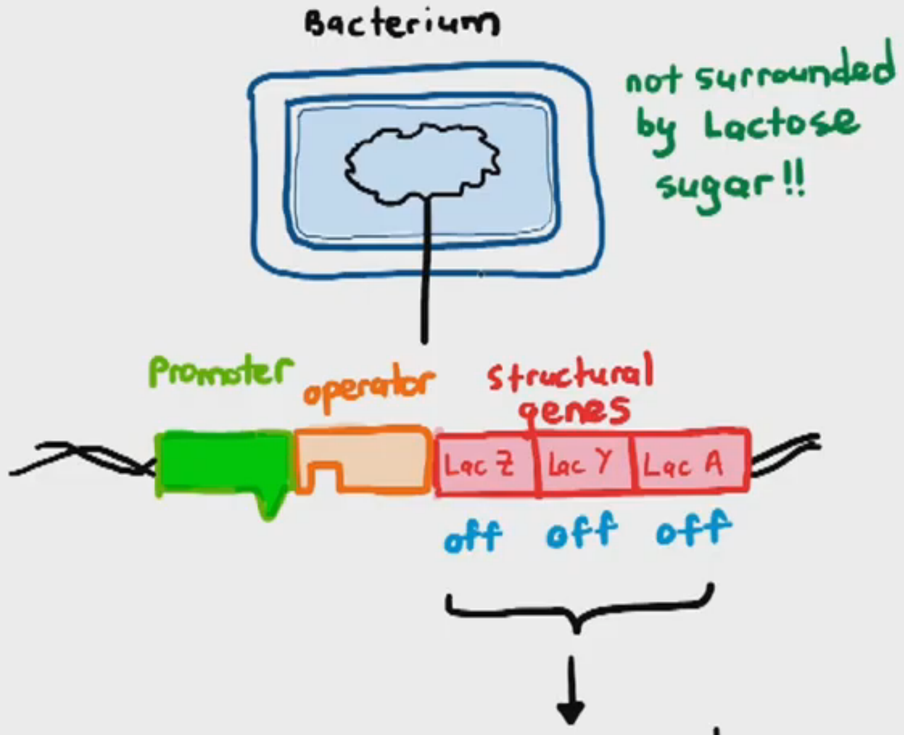
eg: Lac operon

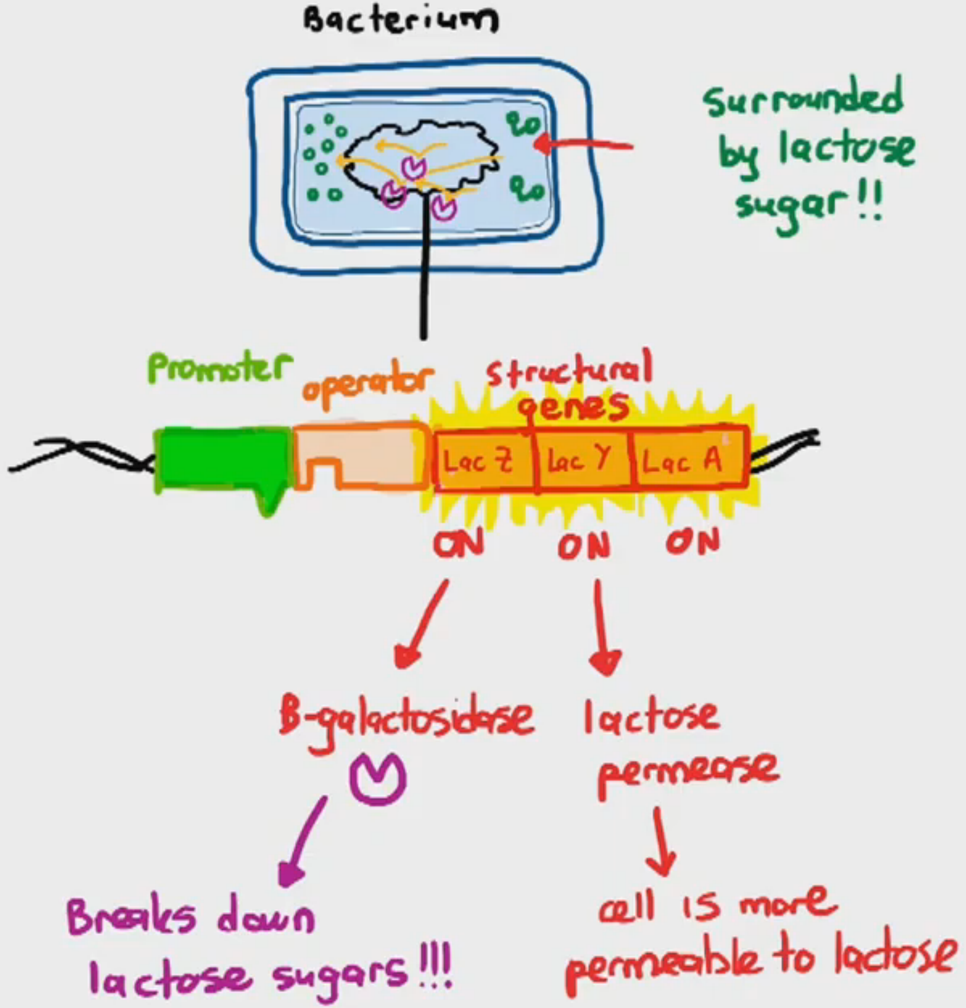
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Control of gene expression in prokaryotes

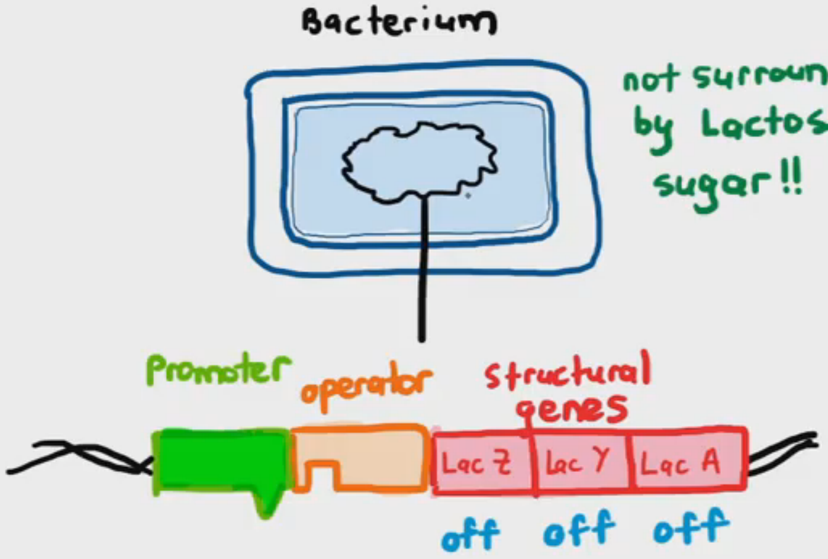


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NOT surrounded by lactose sugars

⇩

Lac Z, Lac Y & Lac A are NOT expressed!!!

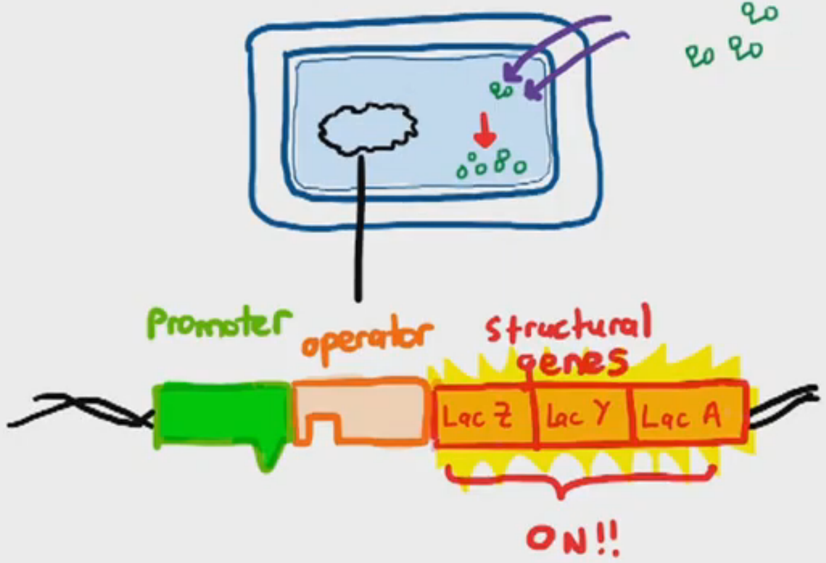
⇩

saves ATP & amino acids from being wasted!!

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Lactose sugars

Bacterium



surrounded by lactose sugars

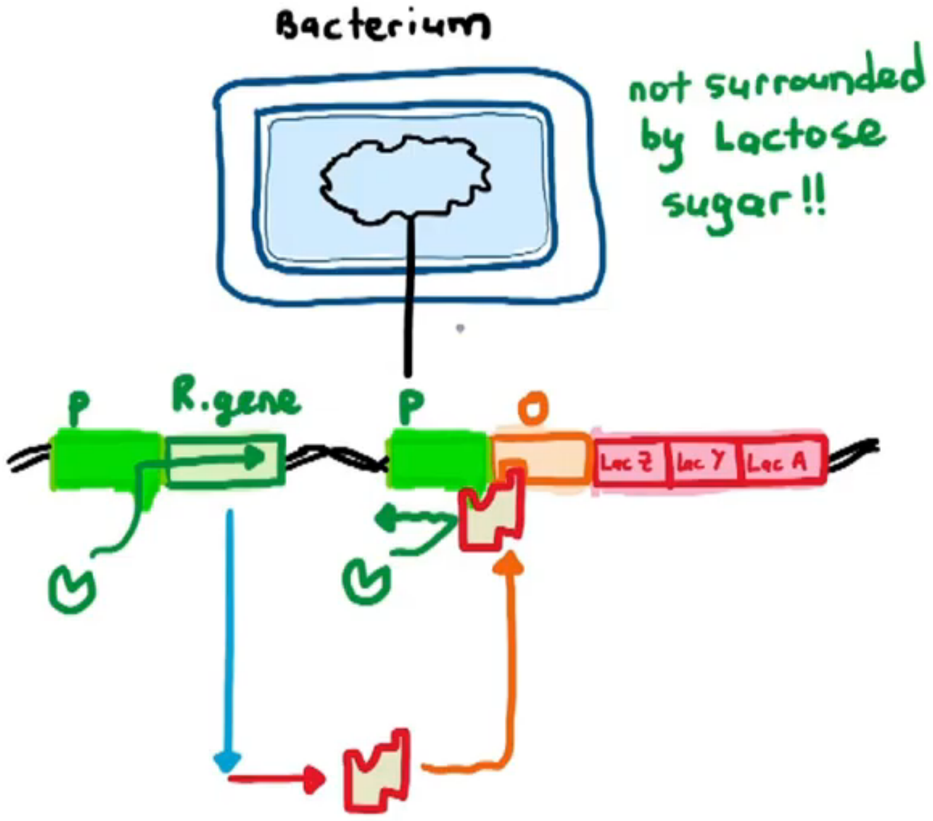
↓

Lac Z, Lac Y & Lac A are expressed!!

Lactose permease makes the bacterium more permeable to lactose

B-galactosidase hydrolyzes Lactose!!

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NOT surrounded by lactose sugars

⇩

Regulatory gene is expressed

A repressor is produced

⇩

Repressor binds to the operator

Blocks the promoter on the Lac operon

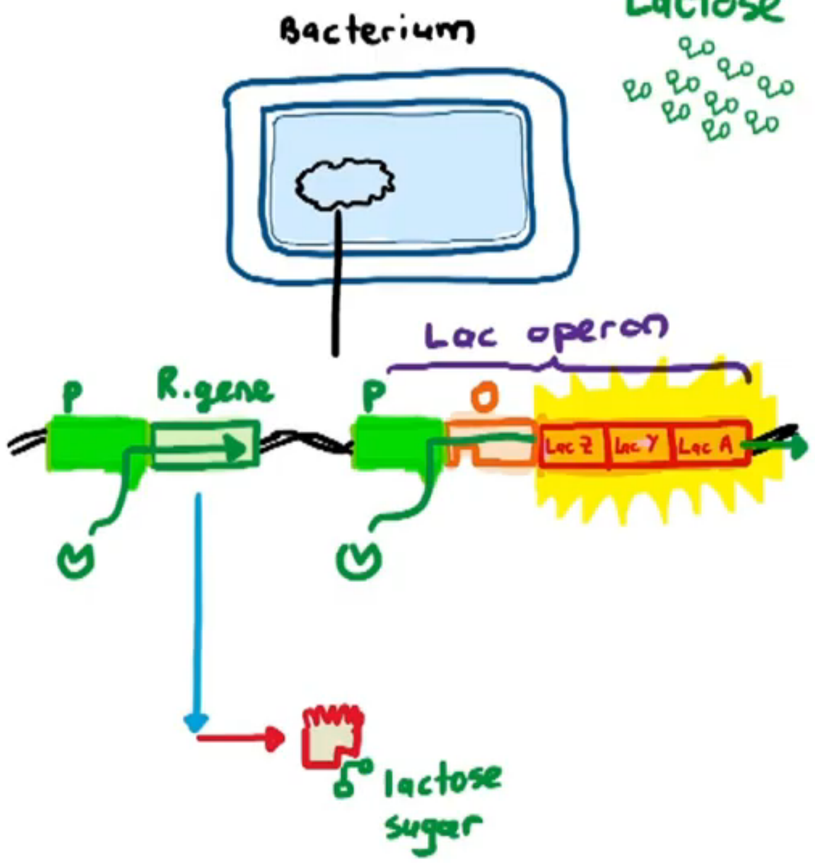
⇩

Lac Z, Lac Y & Lac A are NOT expressed!!!

⇩

saves ATP & amino acids from being wasted!!

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surrounded by lactose sugars

⇩

Regulatory gene is expressed
A repressor is produced

⇩

Lactose sugar binds to repressor & distorts its shape

⇩

The promoter on the Lac operon is no longer blocked

⇩

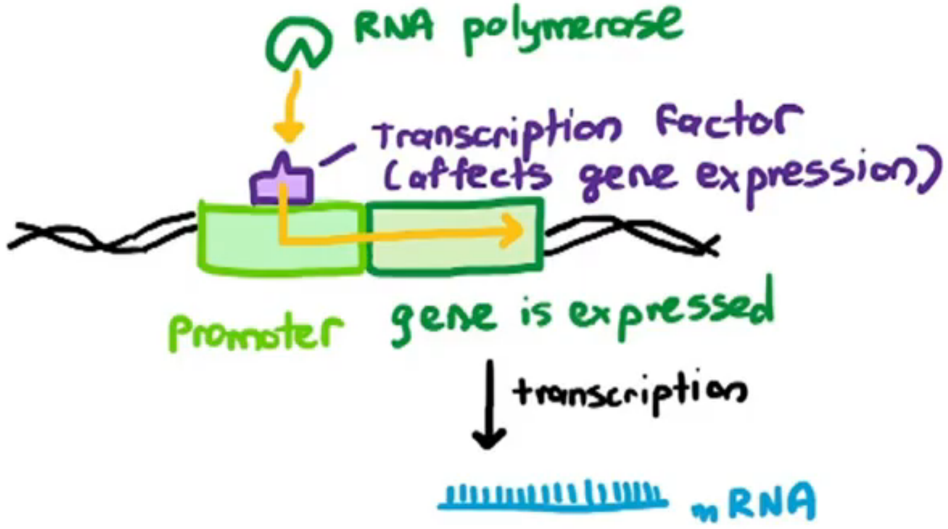
Lac Z, Lac Y & Lac A are expressed!!

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Control of gene expression in eukaryotes

Highly complicated ....





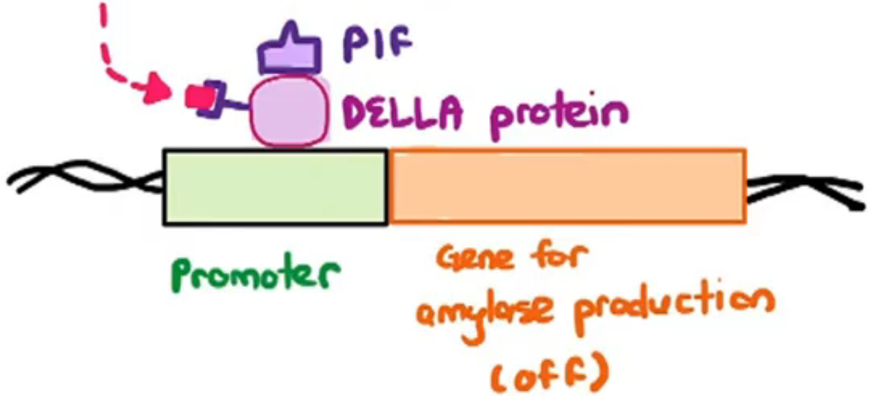
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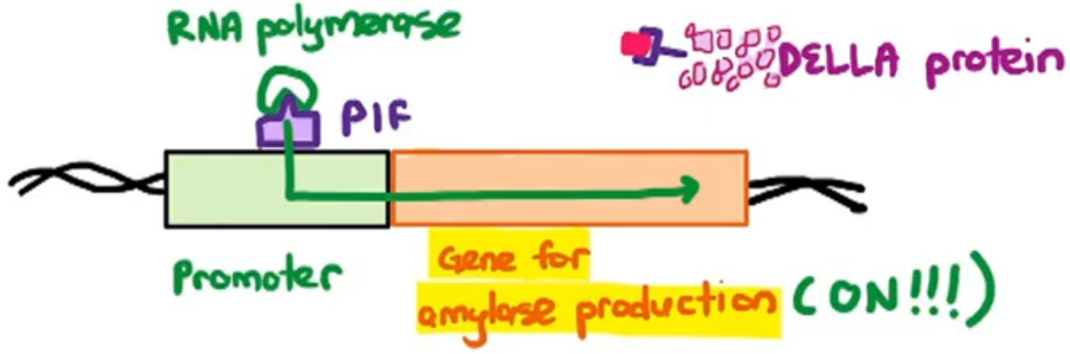
H_2O enters the seed and activates the embryo

⇨ embryo releases gibberellins that diffuse to the aleurone layer

⇨ Aleurone layer synthesizes amylase!!

i) Gibberellins bind to a receptor → ii) Destroys DELLA proteins → PIF binds to promoter!! → Gene expression happens!!





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