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المحاضرة الثامنة: الكروموسومات

- Genetics - Part 2 - Chromosomes

Linkage

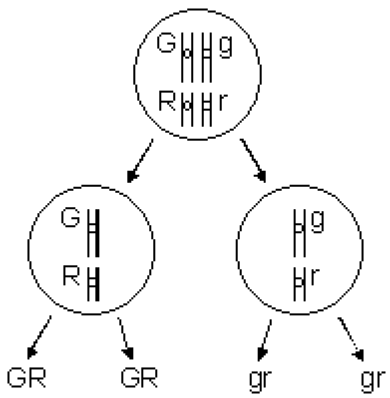
Genes on the same chromosome are linked.

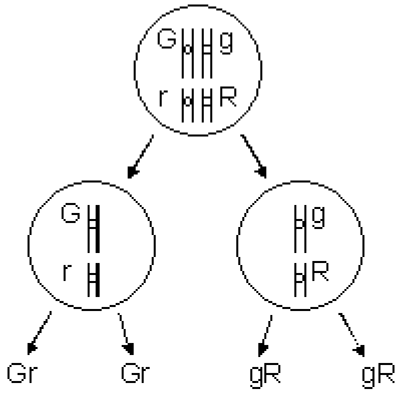
Example: Unlinked Genes

G = gray body
g = black (ebony) body

R = red eyes
r = purple eyes

The diagrams below show that the locus for body color (G or g) is on a different chromosome than the locus for eye color (R or r). These two loci will assort independently to produce either GR and gr gametes or Gr and gR gametes.





cross: GgRr X ggrr

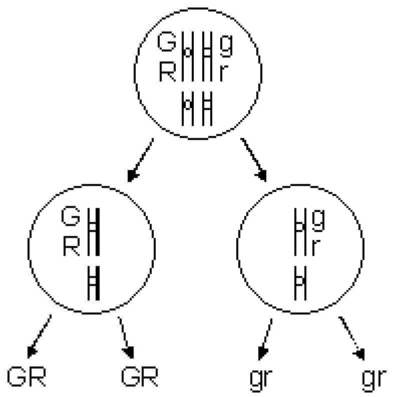
gametes: GR, Gr, gR, gr X gr

	GR	Gr	gR	gr
gr	GgRr	Ggrr	ggRr	ggrr
	gray red	gray purple	black red	black purple

Ratio expected: 1:1:1:1

Example: Linked Genes

Suppose G and R are linked as shown below. If the body color and eye color loci are on the same chromosome, they will not assort independently unless crossing-over occurs frequently.



In this case, GgRr can produce only two kinds of gametes: GR and gr.

GgRr X ggrr

gametes: GR, gr X gr

	GR	gr
gr	GgRr	ggrr
	gray red	black purple

If G and R are linked, then whenever you have a G, you have an R. Any gray, purple offspring (G-rr) would result from crossing over because a Gr gamete is needed.

Suppose out of 100 offspring, you got 46 gray, red, 46 black purple, 4 gray purple and 4 black red. Eight percent of the offspring resulted from crossing over. These offspring are ***recombinant***.

Crossing Over

Crossing over is more likely to occur between genes that are far apart. The farther apart genes are, the greater the probability that crossing over will occur between them.

In the example above, we had 8% crossing over.

The percent of recombination (crossing over) can beused as a measure of how far apart genes are.   1% crossing over = 1 map unit.

Example

G = gray body
g = black (ebony) body

R = red eyes
r = purple eyes

Suppose that G and R are linked (on the same chromosome) in a particular individual and g and r are also linked

P_1 GgRr X ggrr

If there is no crossing-over, possible gametes for the first parent are GR and gr.

If there is crossing-over, possible gametes are gR and Gr.

the following results were obtained:

	GR	gr	gR	Gr
gr	40 GgRr	40 ggrr	10 ggRr	10 Ggrr
	gray red	black purple	black red	gray purple

How far apart are the G and R loci?

Sex Chromosomes

Humans have 23 pairs of chromosomes (46 total) chromosomes. Two of these are called ***sex chromosomes***, the other 44 are called ***autosomes***.

There are two kinds of sex chromosomes, called the X chromosome and the Y chromosome. The X chromosome is larger and contains many genes. The Y chromosome is much smaller and contains very few genes.

Normally, human females have two X chromosomes (XX) and males have one X and one Y chromosome (XY).

Occasionally, an accident happens in which a person is born with too many or too few sex chromosomes. In these cases, the person will be male if they inherit a Y chromosome and female if they do not.

Examples of four different possibilities that produce males are shown below. The last three are abnormal.

XY
XXY
XXXY
XYY

Examples of four different possibilities that produce females are shown below. Normal females are XX.

X
XX
XXX
XXXX

The cross below shows that normal females produce eggs that have one X chromosome. Half of the sperm produced by normal males have an X chromosome and the other half have a Y chromosome.

XX x XY

↓

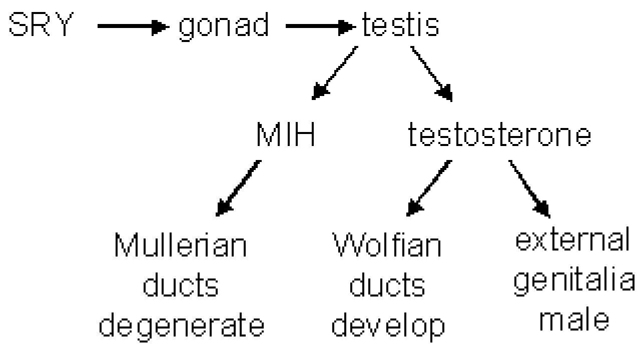
	X	Y
X	XX	XY

This analysis shows that half of the offspring are expected to be male, half are expected to be female.

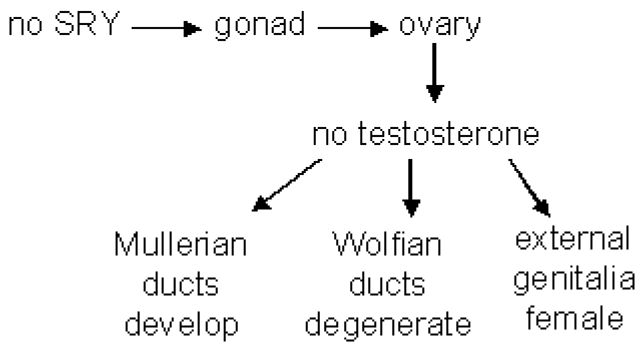
Chromosomal Determination of Sex

Males

The Y chromosome contains a gene called SRY (for sex-determining region of Y).



Females



Testicular Feminization

The body cells of people with testicular feminization are insensitive to testosterone and therefore develop the female phenotype even though they have a Y chromosome.

It has an X-linked recessive mode of inheritance.

Guevodoces

Guevodoces refers to a condition in which the male phenotype develops after puberty.

It is due to delayed testosterone production.

X-Linkage

Morgan (Columbia U):

P_1 red-eyed X white-eyed

↓

F_1 all red-eyed

F_2 3:1 (red:white) but all white were male

explanation:

These genes are found on the X chromosome but not on the Y chromosome. An X^rY male will therefore have red eyes. Details of this cross are below.

P_1 X^RX^R X X^rY

female male

gametes: X^R (female) and X^r, Y (male)

	X^r	Y
X^R	X^rX^R	X^RY
	female red	male red

The offspring produced from the above cross are crossed with each other (below):

F_1 X^RX^r X X^RY

↓

gametes: X^R and X^r (from female); X^R and Y (from male)

F_2:

	X^R	Y
X^R	X^RX^R	X^RY
X^r	X^rX^R	X^rY

Notice that there are three possible genotypes for females and two possible genotypes for males.

Females		Males	
Genotypes	Phenotypes	Genotypes	Phenotypes
X^RX^R	red	X^RY	red
X^RX^r	red	X^rY	white
X^rX^r	white		

X-Linked Inheritance

Males inherit their X chromosome from their mother. Their Y chromosome comes from their father. A male, therefore, cannot pass an X-linked trait to his sons. Males inherit all of their X-linked traits from their mother.

If a male inherits an X-linked recessive trait, it will be expressed because males do not have a homologous X chromosome.

Females can be carriers of X-linked traits without expressing them because they might carry the dominant allele on the other X chromosome. For example, the following genotype will have a dominant phenotype: X^AX^a.

References المصادر

Russo Vanputte, Regan : Seeley's Anatomy & Physiology 10th Edition (Hardcover) Hardcover – January 1, 2014