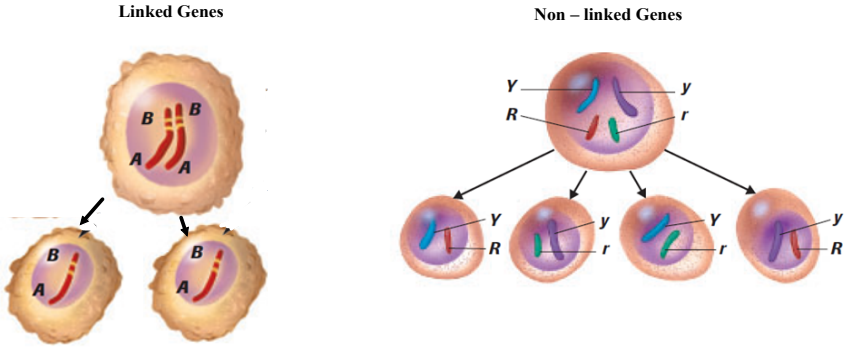
Topic 7 – Gene Linkage and Crossing Over

- **Linked Genes** – genes located on the same chromosome
  - Linked genes do not assort independently



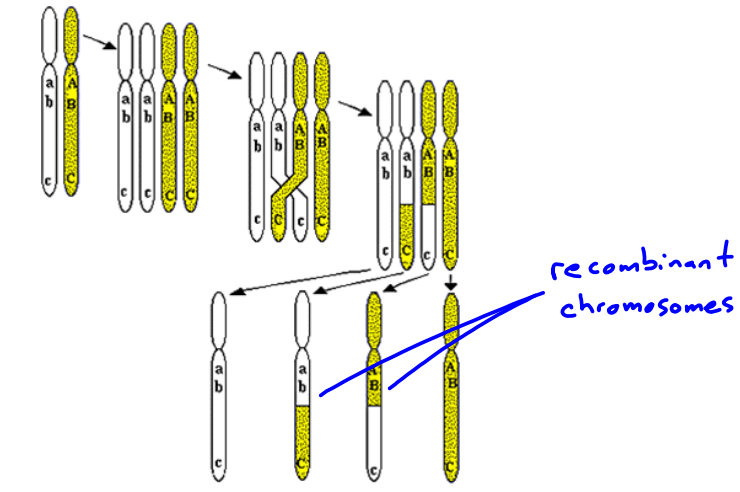
Crossing over –
- homologous chromosomes pair up during prophase I, they may exchange pieces of chromosome

- Linked genes do not always stay together in gamete formation

- Crossing over results in new combinations of genes

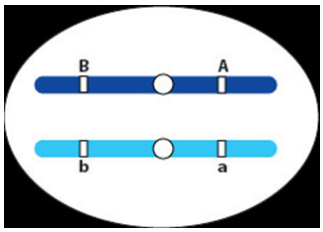
- Crossing over occurs during meiosis and cause linked genes to separate.

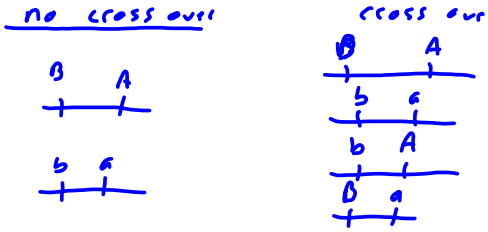
- Genes that are farther apart on a chromosome are more likely to be separated by crossing over



Crossing-over and recombination during meiosis

Example: What gametes can the cell below produce when it goes through meiosis





Cross over frequency or percentage

$$\% \text{ cross over} = \frac{\text{number of recombinations}}{\text{total number of offspring}} \times 100$$

- The frequency of recombinant gametes tells about the physical distance between two linked genes on a chromosome.
  - Low frequency → linked close together
  - High frequency → linked far apart

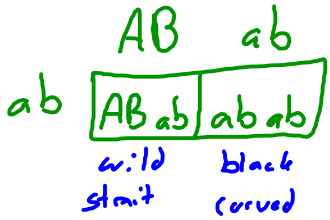
- The closer linked genes are to each other, the less likely they will separate in crossing over.

- eg. Cross over frequency = 5%
  - This means that the 2 genes are 5 map units apart. (close)

- eg. Cross over frequency = 30%
  - This means that the 2 genes are 30 map units apart. (far)

Calculating Cross over Frequencies

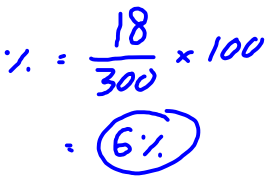
eg. Drosophilia (fruit fly)



- Body color and wing shape are linked
  - A (wild type color) B (straight wings)
  - a (black color) b (curved wings)

AB ab (male) x ab ab (female)

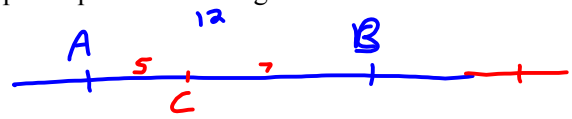
F_1 offspring produced were:
- 136 wild type coloring / straight wings (AB ab)
- 146 black coloring / curved wings (ab ab)
- 9 wild type coloring / curved wings (Ab ab)
- 9 black coloring / straight wings (aB ab)



Problem #1 : 3 genes A, B, C

- Cross over frequencies: AB = 12% BC = 7% AC = 5%

- Determine the proper sequence of these genes.

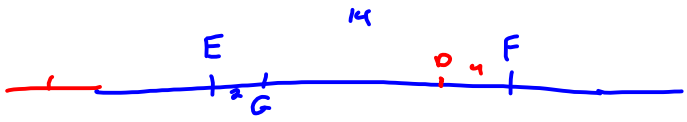


Problem 2:

Cross over frequencies:

Genes	D	E	F	G
D	-	10%	~~4%~~	8%
E	10%	-	~~14%~~	~~2%~~
F	~~4%~~	~~14%~~	-	12%
G	8%	~~2%~~	12%	-

Determine the proper sequence of these 4 genes along the chromosome.

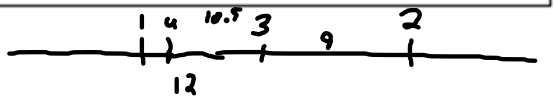


Topic 7
Review Sheet

Use the following information to answer the next two questions.

Cross-over Frequencies of Some Genes on Human Chromosome 6

Genes	Approximate Cross-over Frequencies
Diabetes mellitus (1) and ovarian cancer (2)	21%
Diabetes mellitus (1) and Rhesus blood group (3)	12%
Ragweed sensitivity (4) and Rhesus blood group (3)	10.5%
Rhesus blood group (3) and ovarian cancer (2)	9%
Ragweed sensitivity (4) and ovarian cancer (2)	19.5%



Numerical Response

5. On human chromosome 6, the order of the genes numbered above is 1 (2), 4 (3), 3 (4), and 2 (1).

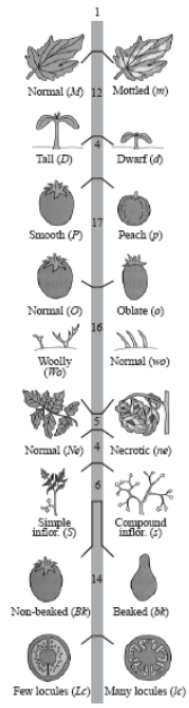
(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

31. What is the approximate cross-over frequency between the diabetes mellitus gene and the ragweed sensitivity gene?

A. 1.5%
B. 10.5%
C. 15.0%
D. 22.5%

Use the following information to answer the next two questions.

Gene Loci for a Tomato Plant



—from *Griffiths et al., 1993*

During meiosis, which of the following pairs of genes has the greatest chance of being separated by crossing over?

A. *(m)* and *(d)*
B. *(ne)* and *(p)*
C. *(m)* and *(lc)*
D. *(p)* and *(o)*

Use the following additional information to answer the next question.

Cross-over frequencies for some genes on a tomato plant:

Genes	Cross-Over Frequency
normal leaf (*M*) and tall plant (*D*)	12%
normal leaf (*M*) and normal tomato (*O*)	33%
normal leaf (*M*) and simple inflorescence (*S*)	64%
tall plant (*D*) and normal tomato (*O*)	21%
tall plant (*D*) and simple inflorescence (*S*)	52%

The cross-over frequency between genes *O* and *S* is

A. 6%
B. 29%
C. 31%
D. 97%

Use the following information to answer the next question.

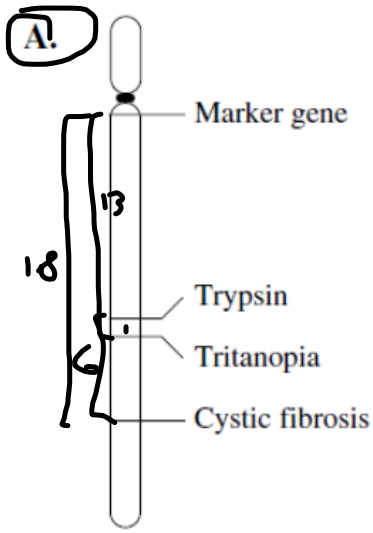
The use of marker genes and the analysis of crossover frequencies of genes have enabled geneticists to map the location of many genes on human chromosomes. Blue colour vision and blue colourblindness (tritanopia) are controlled by a gene on chromosome 7. The gene for the production of trypsin (a digestive enzyme) and the gene responsible for cystic fibrosis are also found on chromosome 7. Some crossover frequencies of these genes are shown below.

Pair of Genes	Crossover Frequency
Marker gene — cystic fibrosis	18%
Marker gene — tritanopia	13%
Cystic fibrosis — trypsin	6%
Trypsin — tritanopia	1%

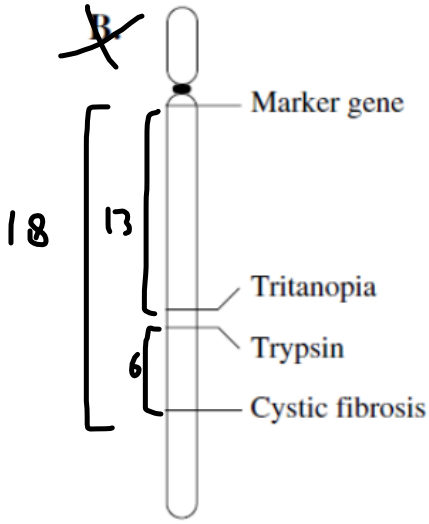
—from *Rimoin et al., 1996*

Which of the following gene maps shows the correct sequence of these genes on chromosome 7?

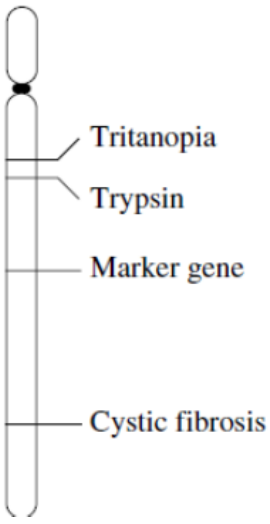
A.



B.



C.



D.