

Chapter 15 - The chromosomal Basis of inheritance

Read pages 274-279 (you are not responsible for mapping), 282-284)

On pages 285-287 is information about aneuploidy, a topic we discussed in connection with meiosis. Use this as reference.

Work problems: 1(the first two parts), 3 (first part), 4.

We've covered some of the material from this chapter already.

From this lecture you should know:

What is linkage and how can you determine if genes are linked or unlinked?

What are autosomes and what are sex chromosomes?

How is sex determined in the XY system?

What are sex linked traits and how are they inherited?

What do the following terms mean? Complete dominance, Co-dominance, Incomplete dominance, Multiple alleles, Polygenic inheritance, Environmental effects

Be able to look at a pedigree and infer genotypes based on phenotypes and inheritance patterns.

LINKAGE

Figure from page 278 (unnumbered)

If genes **are not** on the same chromosome:

a cross between a double heterozygote (YyRr) and a double recessive homozygote (yyrr) should yield equal proportions of parental types and recombinant types

This is a type of **test cross**

Fig. 15.2 Genes that are on different chromosomes are **unlinked**

Genes that are on the same chromosome are **linked**

Linkage was first studied extensively in the fruit fly *Drosophila melanogaster*

- wild type = the "normal" type or type usually found in natural populations
- *Drosophila* geneticists have even more complex notation for genes than pea geneticists
- The locus is designated by a letter. The wild type form has a + superscript.

Fig. 15.5 Are genes for body color and wing shape linked?

- What are the predicted phenotypic ratios in a test cross if genes are unlinked?
- (Recall that If genes **are not** on the same chromosome (unlinked):
- a cross between a double heterozygote (YyRr) and a double recessive homozygote (yyrr) should yield equal proportions of parental types and recombinant types)
- Prediction is equal proportions of parental types and recombinant types
- Deviation from the predicted ratio suggests that genes are linked (they are on the same chromosome).
- Why are there any recombinants? How do you get b^+ and vg together in the same gamete?

Fig. 13.11 Crossing over

Fig. 15.6 Crossing over results in a ratio of parental and recombinants that is not 50:50. Note that the frequency of recombination can be calculated from the ratio of the number of recombinants to total number of offspring.

Fig. 15.7 The farther apart two genes are on a chromosome, the higher the probability that a crossover will occur between them and the higher the frequency of recombination

Fig. 15.8 Linkage map of chromosome II

The frequency of crossing over can be used to create a map showing the relative locations of loci on a chromosome

Gene locations on the tomato genetic map. Causse, M. et al. J. Exp. Bot. 2004 55:1671-1685

SEX CHROMOSOMES

In humans and many other types of organisms, the sex of an individual is determined by the “X-Y” system

Fig. 13.3

- Sex chromosomes are directly involved in determining the sex of the individual
- Autosomes are not directly involved in determining the sex of the individual
- Humans have 22 pairs of **autosomes** and one pair of **sex chromosomes**
- Sex chromosomes are: **X** and **Y**
- X and Y are not homologous (they do not have identical genes) but they do pair at meiosis

Fig. 15.9 Sex determination in humans (and many other organisms)

- Diploid parents: 44 autosomes+ 2 sex chromosomes
- Haploid gametes: 22 autosomes + 1 sex chromosome
- 1:1 ratio of males to females in offspring

Fig. from page 282

Many genes on the X

Few genes on the Y

Genes located on the X or Y chromosome are sex-linked

Fig 15.10 Inheritance of a sex-linked recessive, e.g., color blindness**Fig. 15.10 (a)**

- Mom is homozygous wild type
- Dad is **hemizygous** recessive
- (the Y does not carry an allele for the character so the genotype is referred to as hemizygous)

- All daughters are **carriers** (they are heterozygotes but have a normal phenotype)
- All sons are wild type and hemizygous for the dominant allele

Fig. 15.10 (b)

- Mom is a carrier (heterozygote with a normal phenotype)
- Dad has a normal phenotype and is hemizygous dominant
- 1/2 of daughters are homozygous wild type
- 1/2 of daughters are carriers (heterozygotes with normal phenotype)
- 1/2 of sons are wild type
- 1/2 of sons are colorblind
- **If mom is a carrier 1/2 of her sons will have the disease**

Fig 15.10 (c)

- Mom is a carrier (heterozygote with a normal phenotype)
- Dad is color blind
- 1/2 of daughters are homozygous recessive and are color blind
- 1/2 of daughters are carriers (heterozygotes with normal phenotype)
- 1/2 of sons are wild type
- 1/2 of sons are colorblind

Back to chapter 14...

INHERITANCE PATTERNS CAN BE MORE COMPLEX THAN TWO ALLELES PER GENE AND COMPLETE DOMINANCE (PAGES 260-264):

Complete dominance

Co-dominance

Incomplete dominance

Multiple alleles

Polygenetic inheritance

Environmental effects

Co-dominance=both alleles expressed in the heterozygote

Fig. 5.21

--Normal and sickle hemoglobin are each alleles of the hemoglobin gene

--Both alleles are expressed in the heterozygote (Ss)

Incomplete dominance=heterozygote's phenotype is intermediate

Fig. 14.10

Multiple alleles--many may exist in a population but each individual has only two per locus

Hemoglobin is an example

--Normal and sickle hemoglobin are each alleles of the hemoglobin gene

--Other alleles of the hemoglobin gene exist and associated with other diseases

Polygenic inheritance-traits are controlled by more than one gene

Fig 14.12 Polygenic control of skin color

A, B, C are different genes that each contribute one unit of skin pigmentation

Predicted offspring phenotypes and frequencies (bars)

Continuous distribution (blue line) results from **environmental effects**

HOW TO MAKE INFERENCES BASED ON A PEDIGREE