Biology 210

# MONOHYBRID AND DIHYBRID CROSSES

I. Objectives: When you have finished this recitation, you should be able to:

A. Define the terms: **dominant**, **recessive**, **homozygous**, **heterozygous**, **observed value**, **expected value**, **null hypothesis**, and **alternative hypothesis** as they pertain to Mendelian genetics and the Chi-square test;
B. Use the **if … and … then** format to write **null** and **alternative hypotheses**;
C. Determine the **expected Mendelian ratios** for **monohybrid** and **dihybrid crosses**;
D. Apply appropriately the **rules of probability**;
E. Use a $X^2$ test to evaluate the hypothesis that observed results of a **monohybrid** cross are in accordance with the expectations of the appropriate Mendelian Law(s);
F. Use a $X^2$ test to evaluate the hypothesis that observed results of a **dihybrid** cross are in accordance with the expectations of the appropriate Mendelian Law(s).

II. **Text Assignment:** pages 262 - 271, Biology, 8th edition, Campbell and Reece; Handout on $X^2$ analysis (included in this recitation).

III. **Introduction:** During this recitation, we will analyze statistically some of the **phenotypic ratios** in the $F_2$ generation of peas that Mendel reported in his seminal paper of 1865, Experiments in Plant Hybridization. Each **pea** is a **seed**; usually more than one pea is found in a **pod**, which is a **fruit**. Each pod develops from the ovulary of one flower, and each seed results from the random union of the **male gametophyte** (pollen grain with two sperm cells) and **female gametophyte** (with one egg cell) during **fertilization**. We will examine results of both **monohybrid** (seed shape: round or angular) and **dihybrid** (seed shape: round or angular; and albumen (seed) color: yellow or green) crosses. I will quote liberally from Mendel's paper in what follows so that you will get a flavor of his writing.

IV. **Monohybrid cross:** One of the characters that was "selected for experiment relate[s]: 1. To the difference in the form of the ripe seeds. These are either **round** or roundish, the depressions, if any, occur on the surface, being always only shallow; or they are irregularly **angular** and deeply wrinkled." For this first experiment, Mendel "united by [artificial] cross-fertilization" true-breeding parents of each seed form and effected "60 fertilizations on 15 plants." In all of the offspring (e.g., $F_1$ generation) of this cross "the hybrid-character resembles that of one of the parental forms so closely that the other either escapes observation completely or cannot be detected with certainty." In this case all of the seeds produced were round or roundish. Accordingly, for the character "form of the ripe seeds," Mendel called the round seed trait **dominant** and the angular seed trait **recessive**. The "hybrid-character" (it probably should be called the hybrid-trait) in the $F_1$ generation resembled only the true-breeding round seed parent.

In the first generation from the hybrids (the $F_2$ generation) Mendel reports "there reappear [ ], together with the dominant character [ ], also the recessive one [ ] with [its] peculiarit[y] fully developed, and this occurs in the definitely expressed average proportion of 3:1 … Transitional forms were not observed in any experiment." Mendel further reports that for "Expt. 1: Form of seed. From 253 hybrids 7324 seeds were obtained in the second trial year. Among them were 5474 round or roundish ones and 1850 angular wrinkled ones. Therefrom the ratio 2.96:1 is deduced." **Are these results consistent with his 3:1 ratio at the 5% error level in a Chi-square test?**