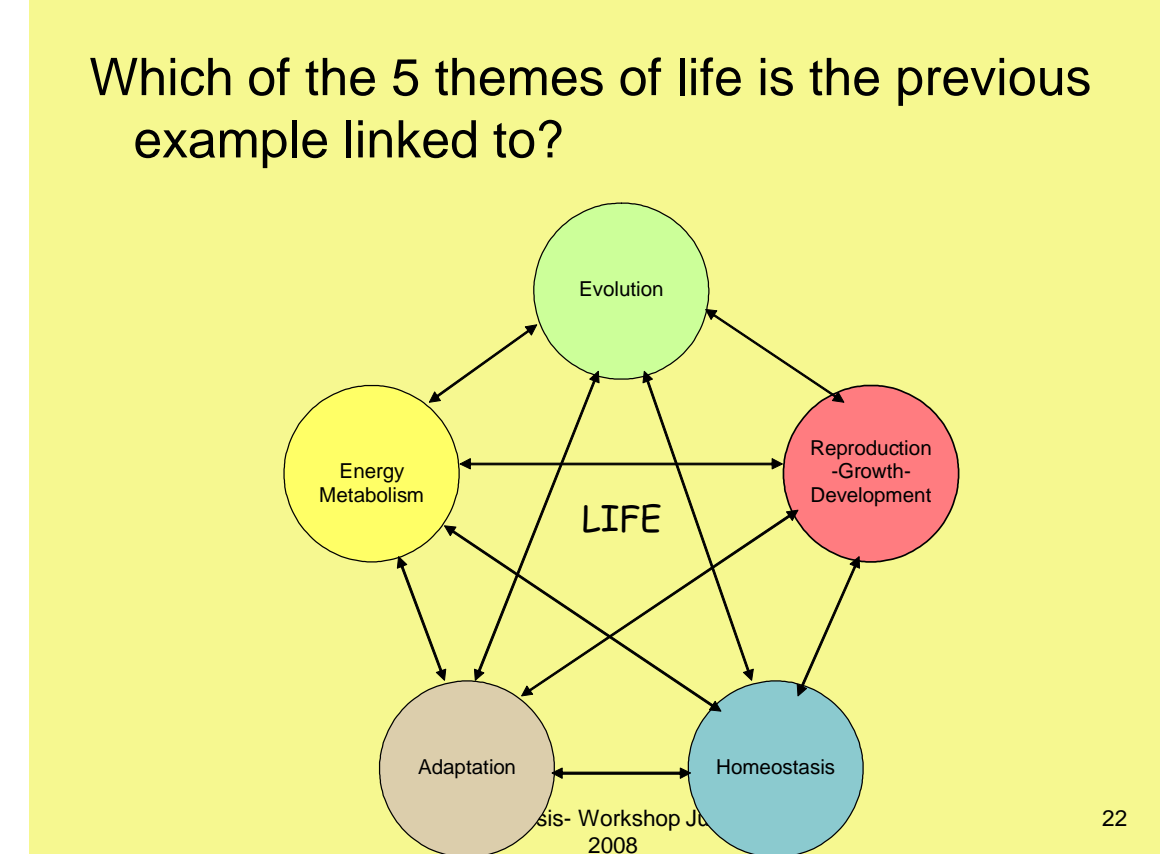
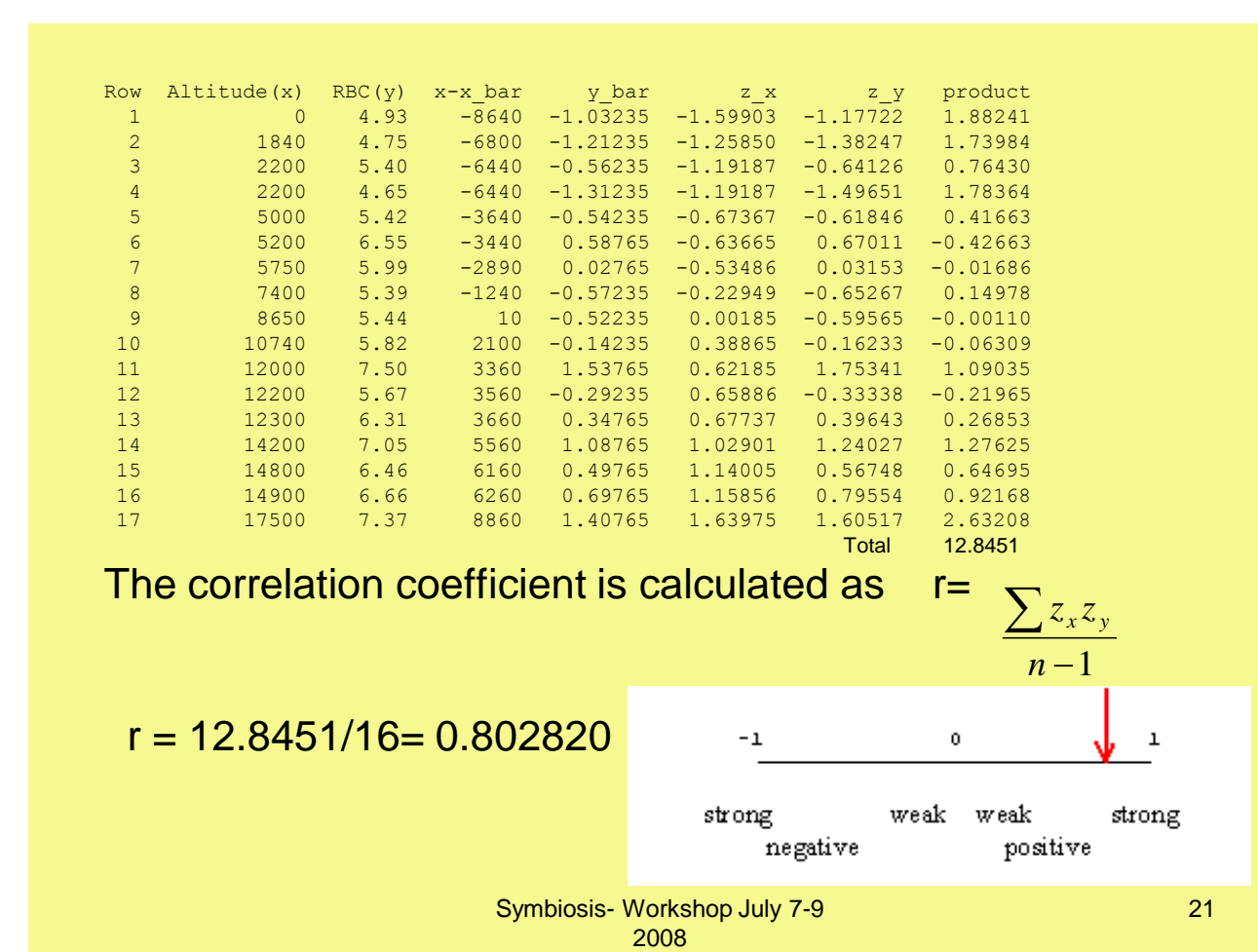
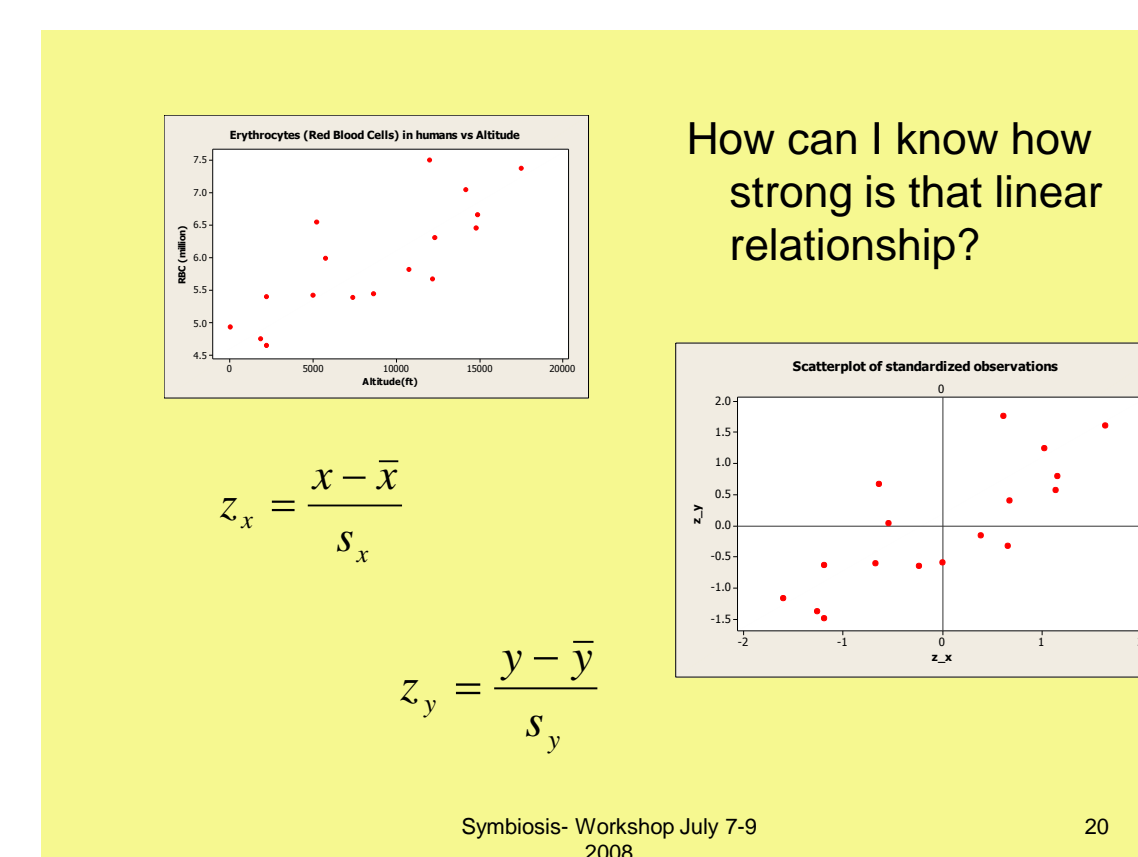
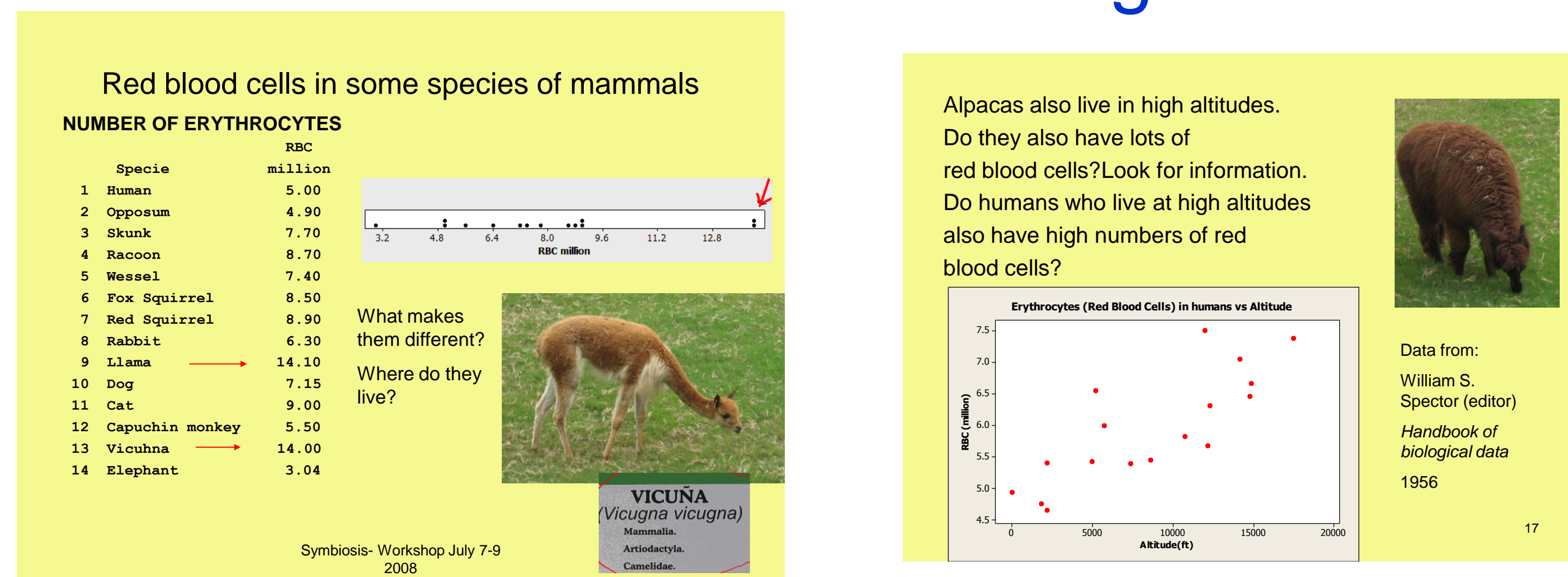


Symbiosis I is the first of a sequence of three Biology, Mathematics and Statistics integrative courses. Students who pass Symbiosis I get credit for Biology I and Introductory Statistics. Since the times of Galton and Fisher, Biology in general, and genetics in particular, have a long history of integration with statistics and probability. Teaching both subjects together in the classroom provides an intuitive approach to both Biology and Statistics. Biological topics provide a motivation for the learning of statistical tools and the results of the application of the latter raise more biological questions. Diagrams and simple probability models help to introduce biological concepts in a schematic and clear way. Statistical methods appear in a natural manner to enhance the biological material. Some excerpts from the teaching material of Module 2 (Cell and Statistics) and Module 4 (Mendelian Genetics and Probability) are displayed below as examples of the integration of Biology and Statistics in the classroom.

Learning from data



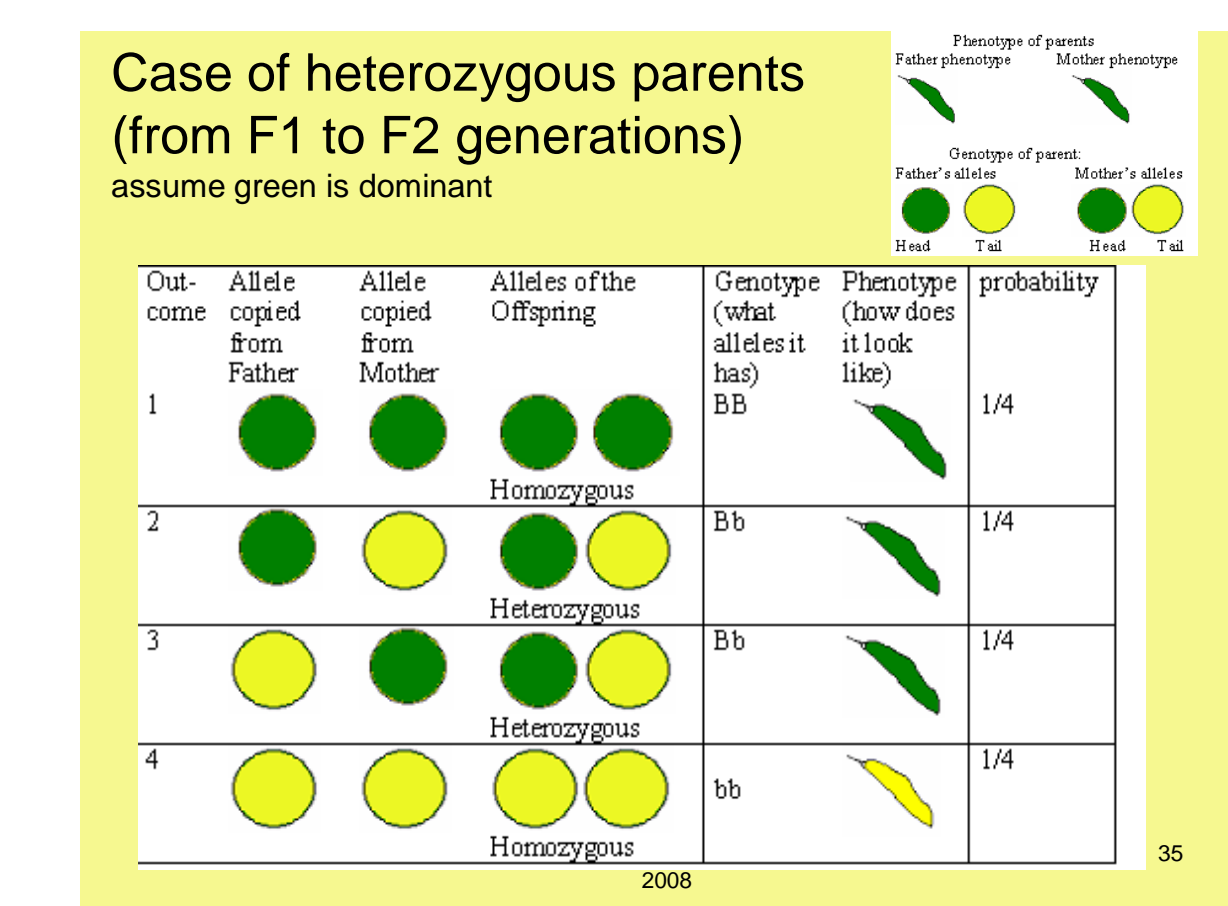
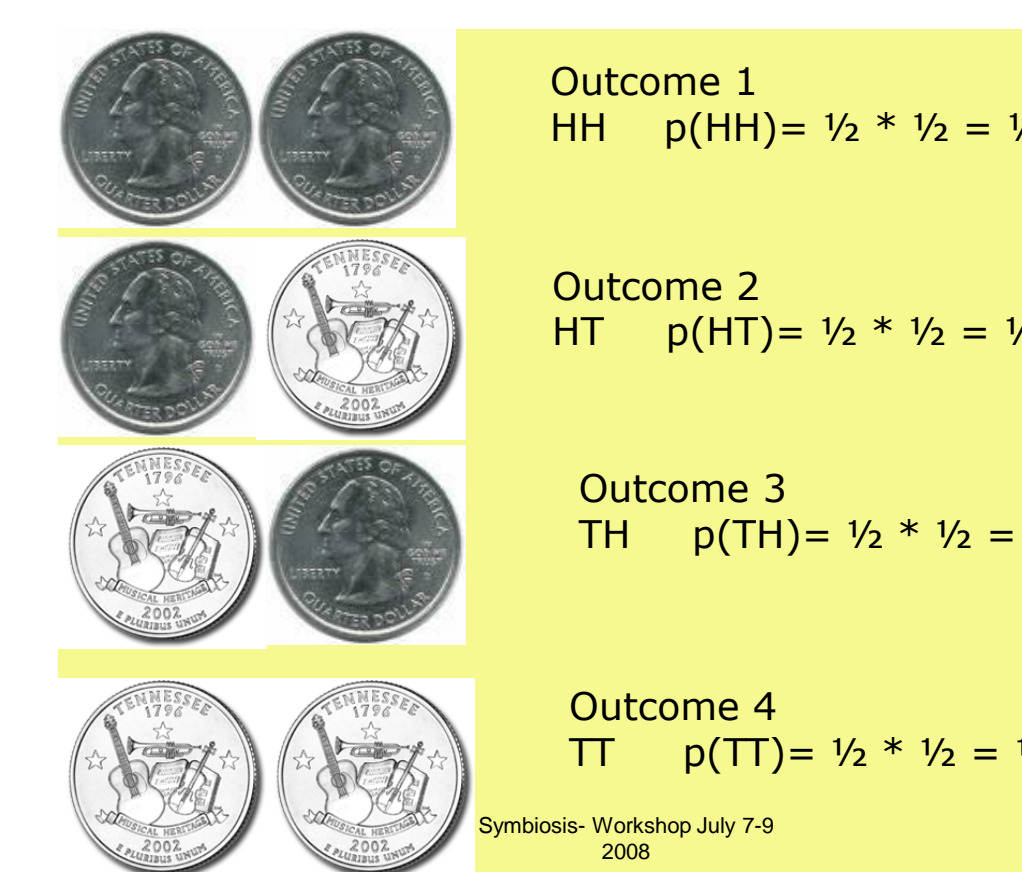
Genotypes and Phenotypes using a coin model

Understanding Genotype and Phenotype using a coin model



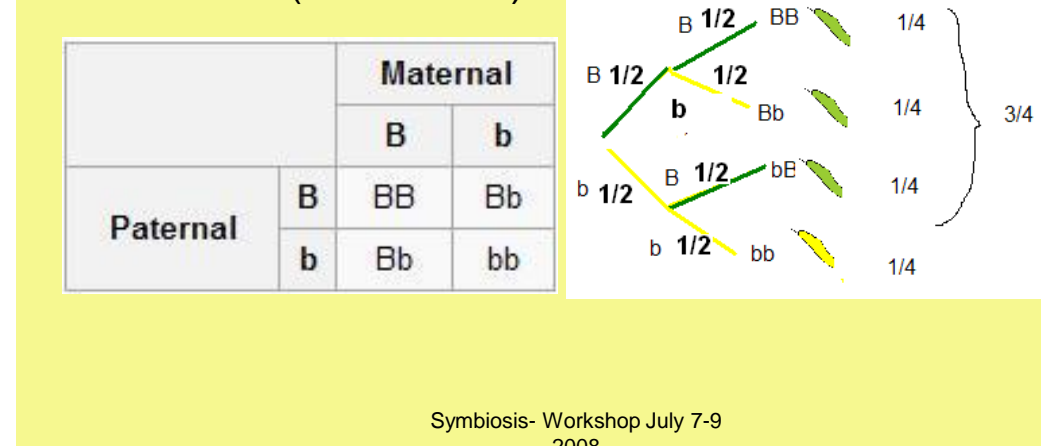
Sides of Coin one
Sides of Coin two

If you flip each coin once, what are the possible outcomes? And what is the probability of each outcome?

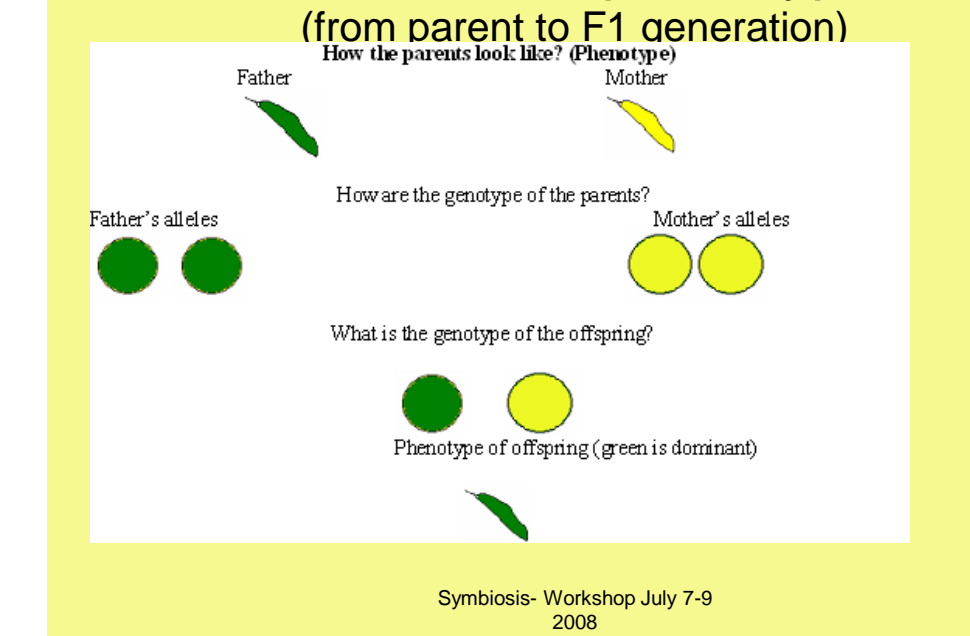


Integrating biological and statistical language

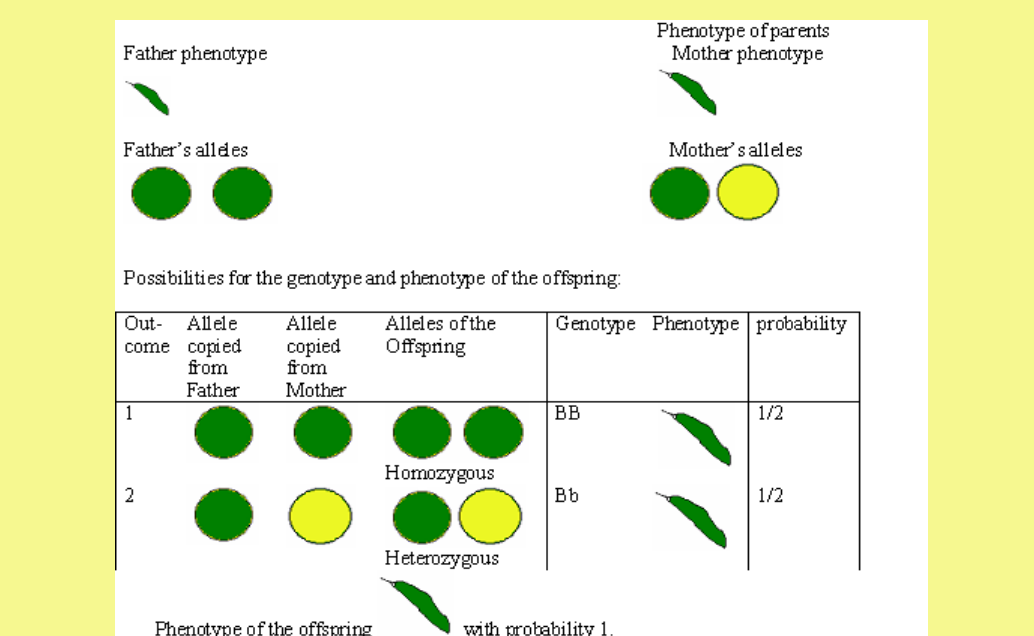
- Punnett squares
- Probability trees



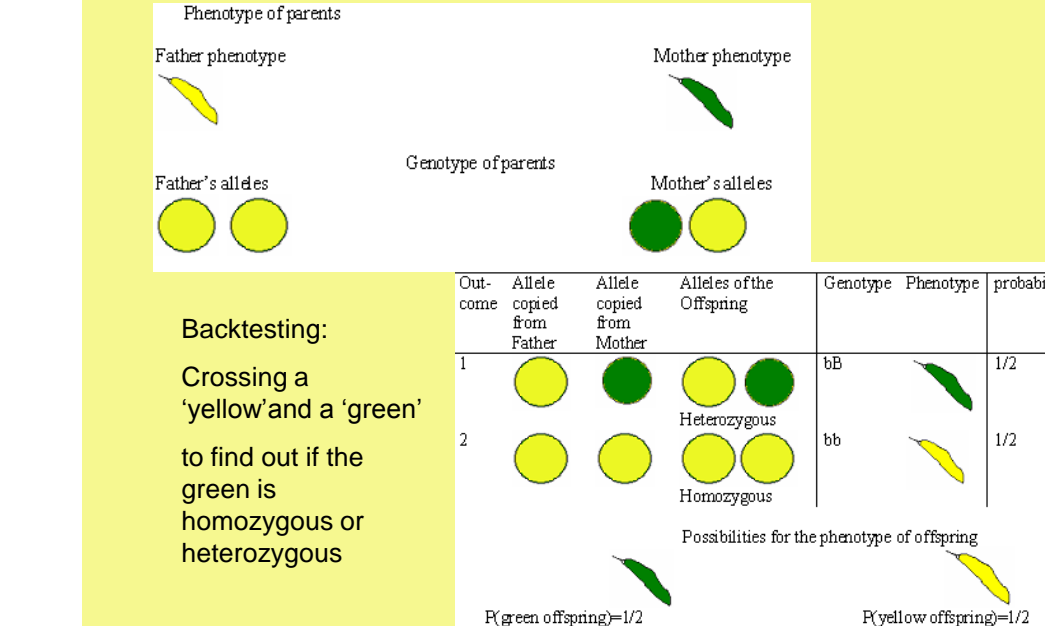
Case of 2 homozygous parents - of different phenotype



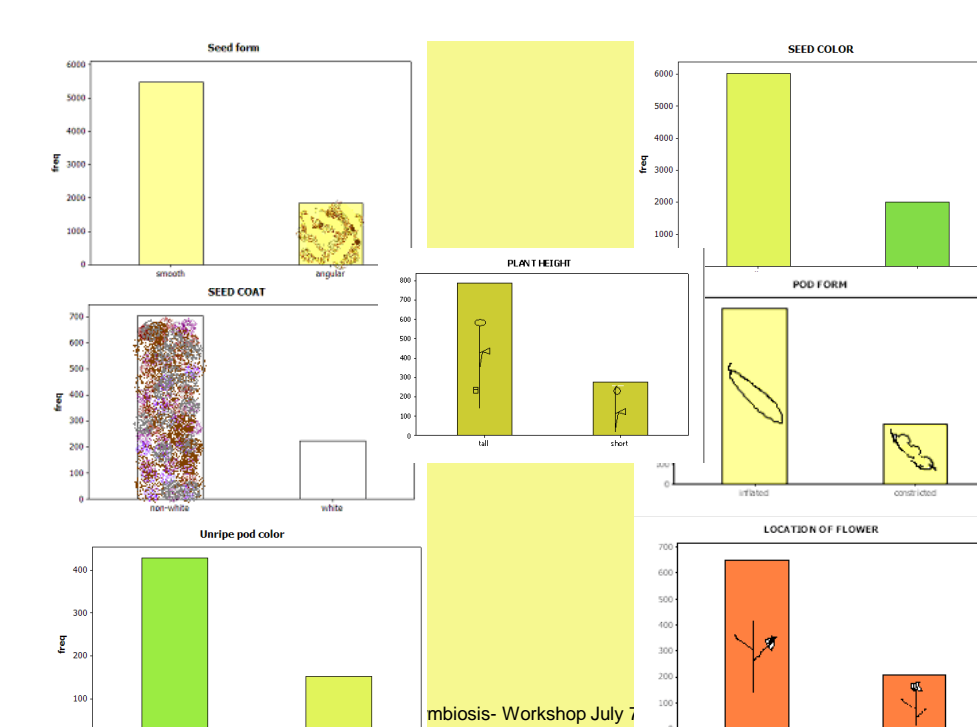
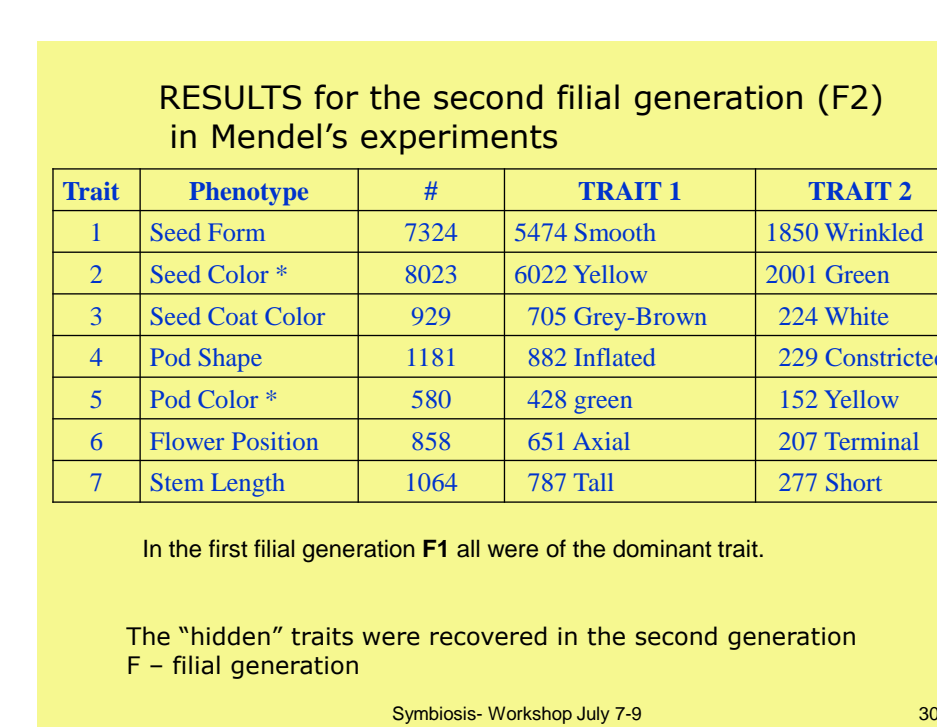
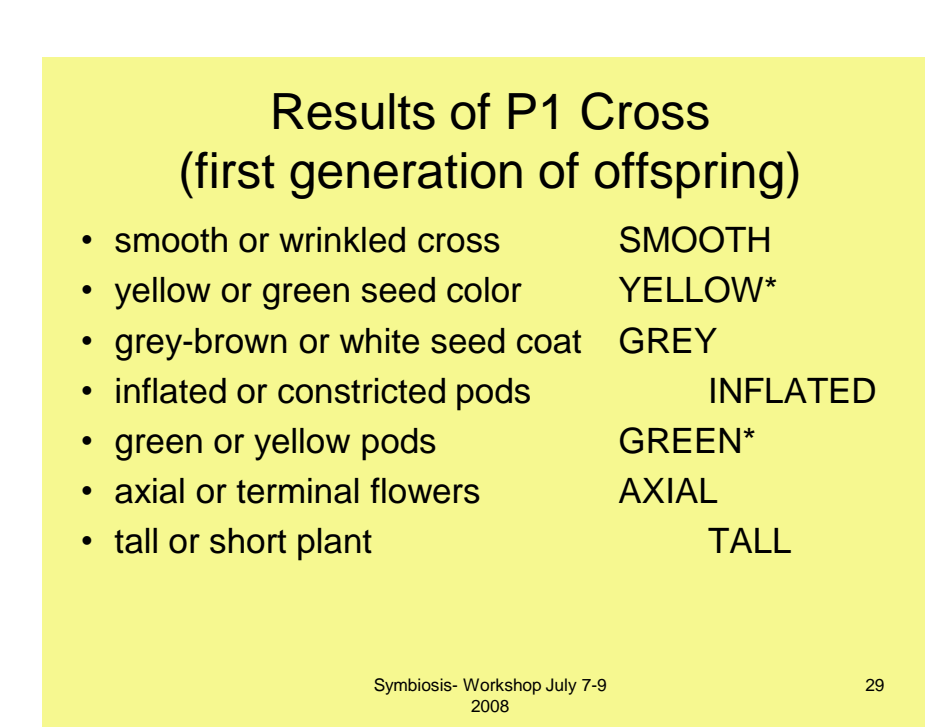
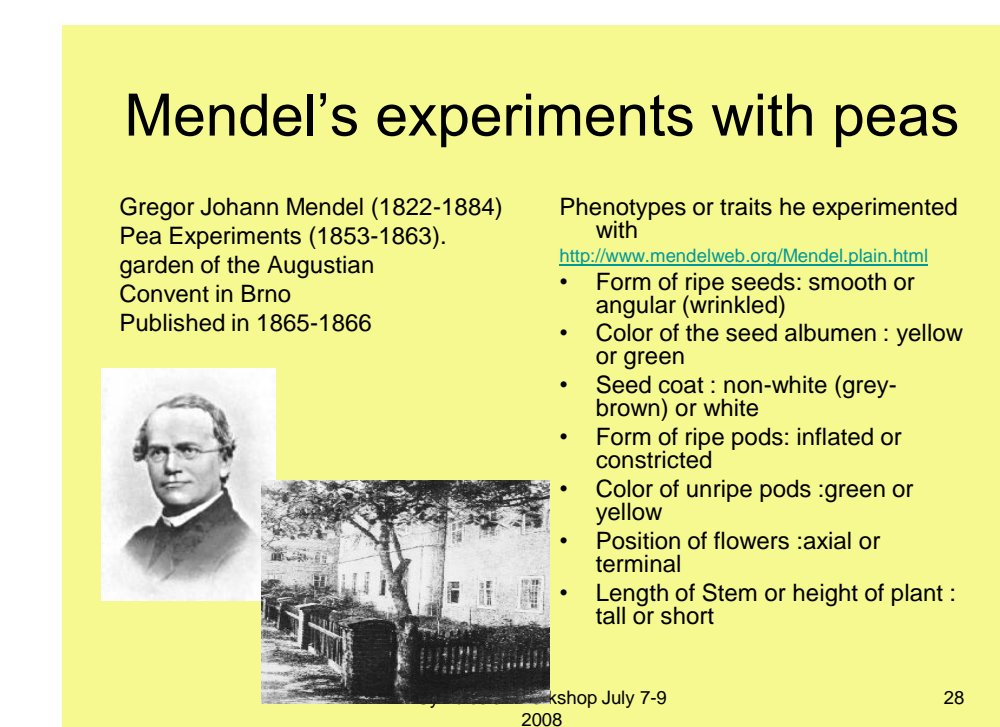
Other cases: Case of one heterozygous parent and one homozygous parent (with dominant allele)



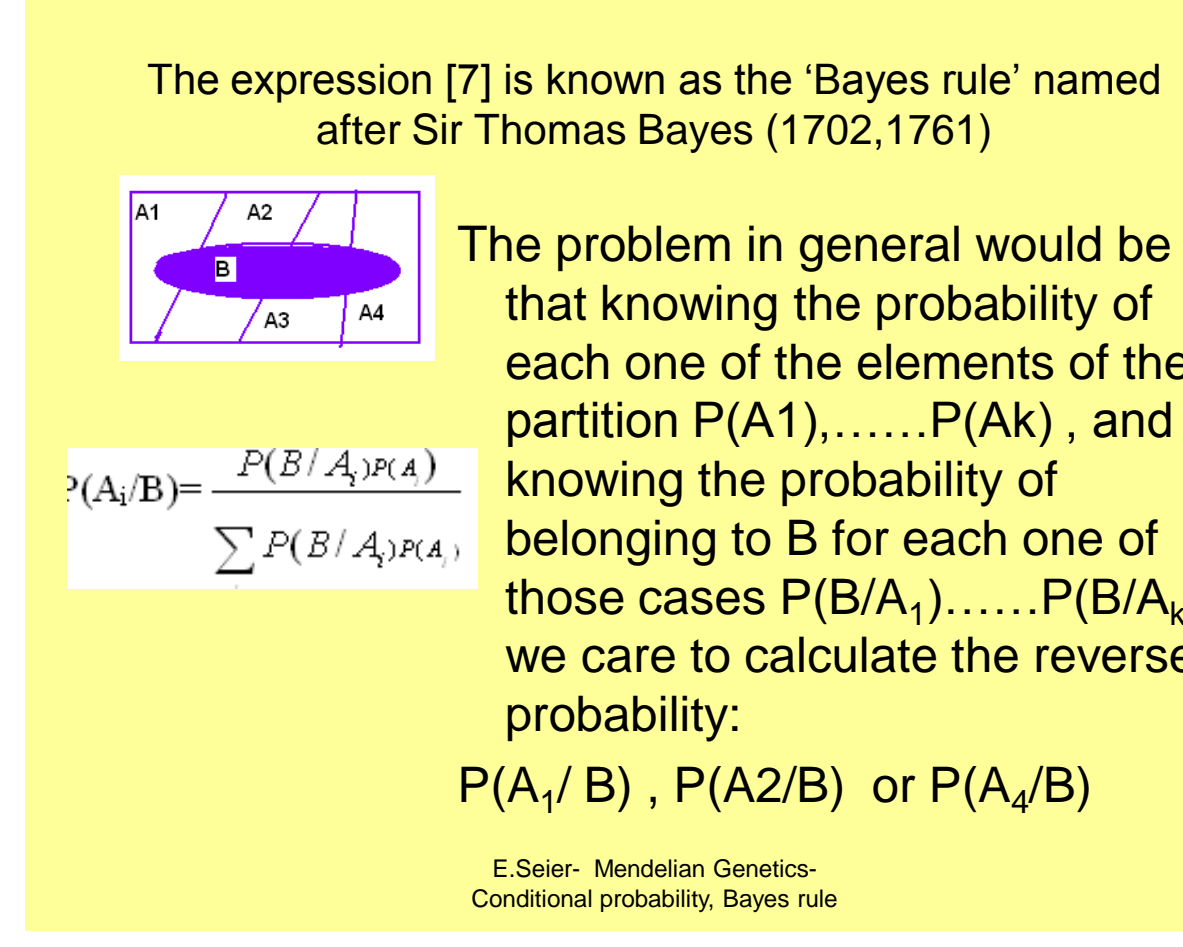
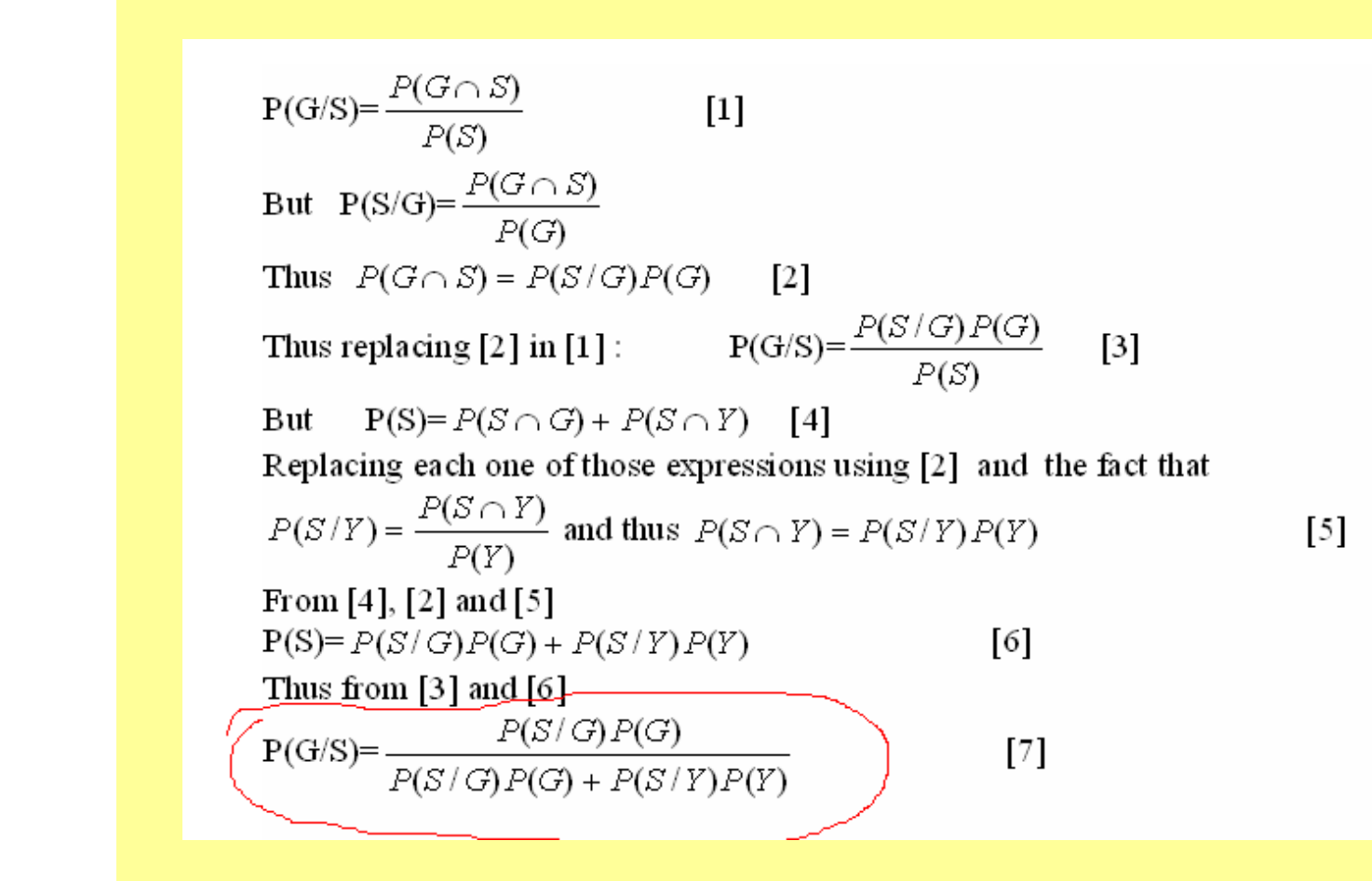
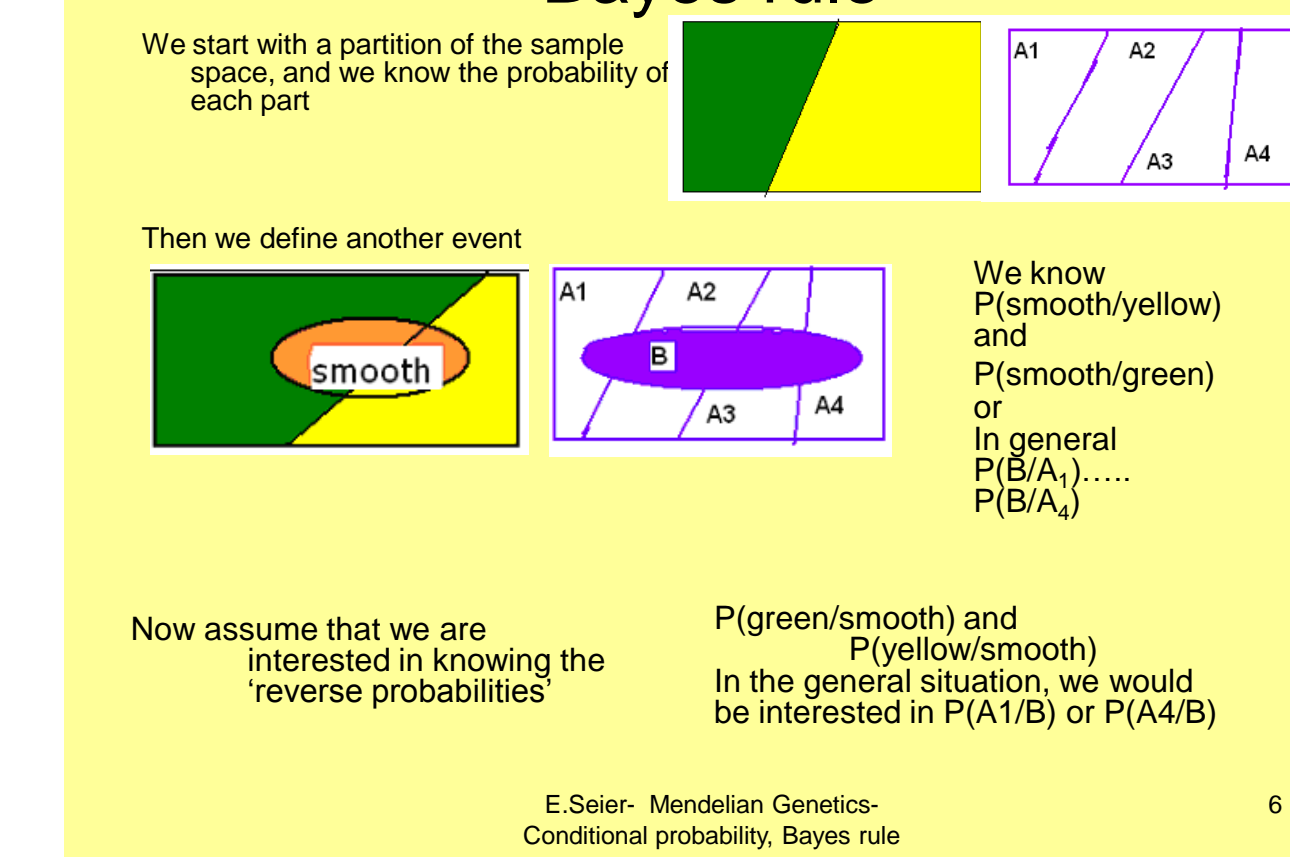
Case of one heterozygous parent and one homozygous parent (with non-dominant allele)



Does Mendel's data constitute evidence against the coin model?



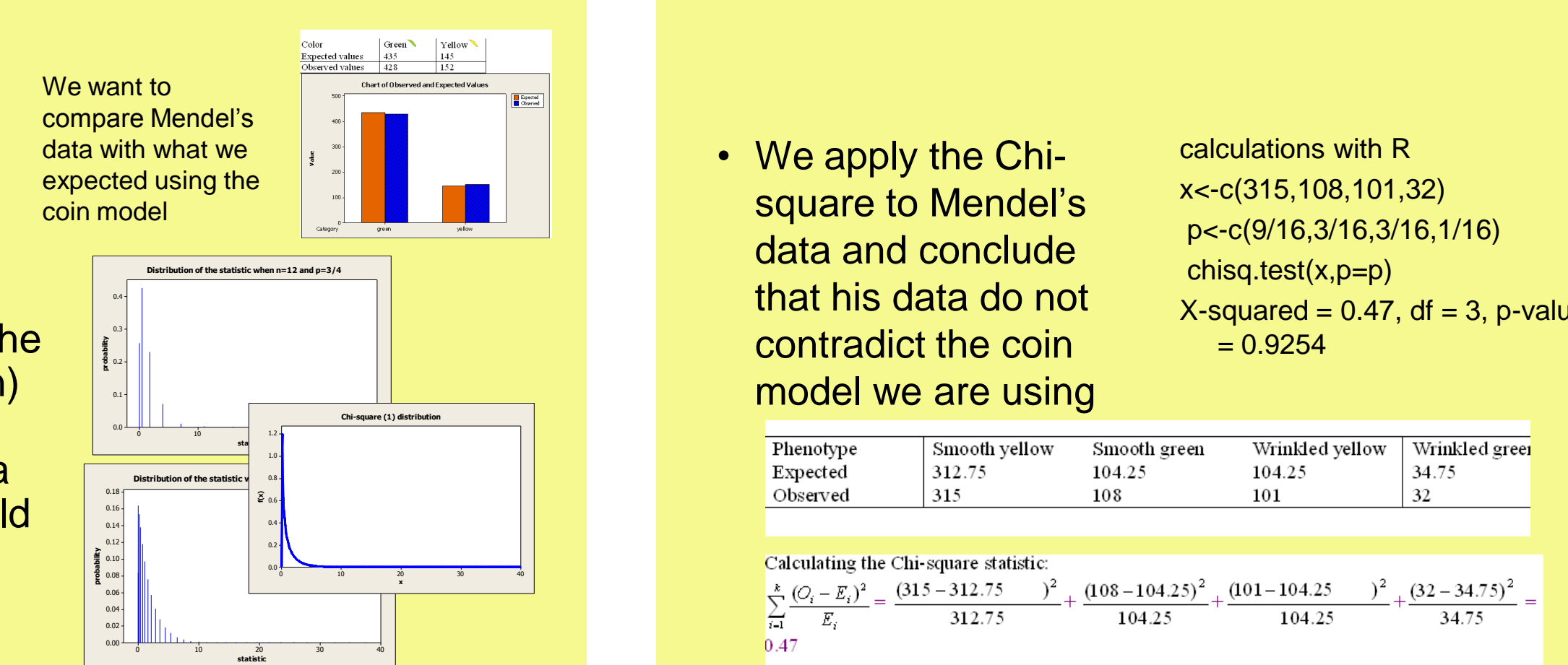
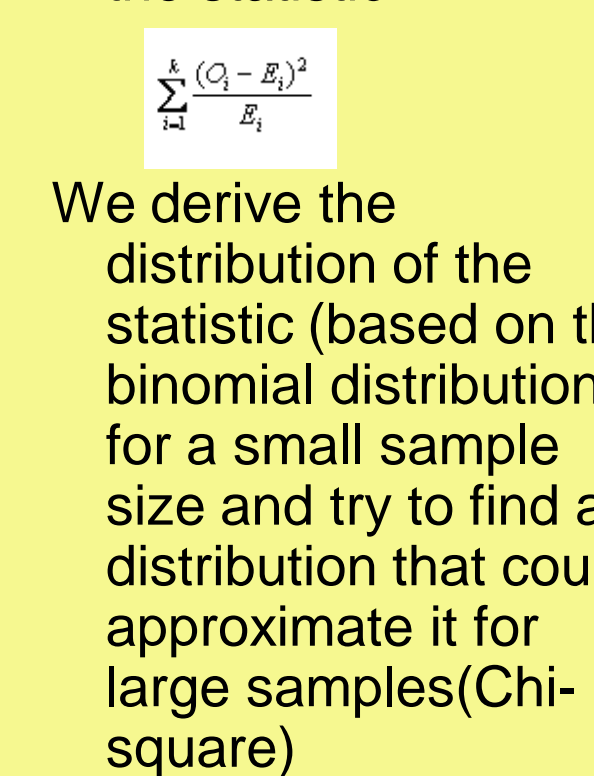
Bayes rule



Goodness of fit test.

- Questions:
- Can we use the coin model to explain the transmission of genetic information from parents to offspring?
 - Do Mendel's data contradict the coin model?
 - How are we going to find this out?

We intuitively develop the statistic

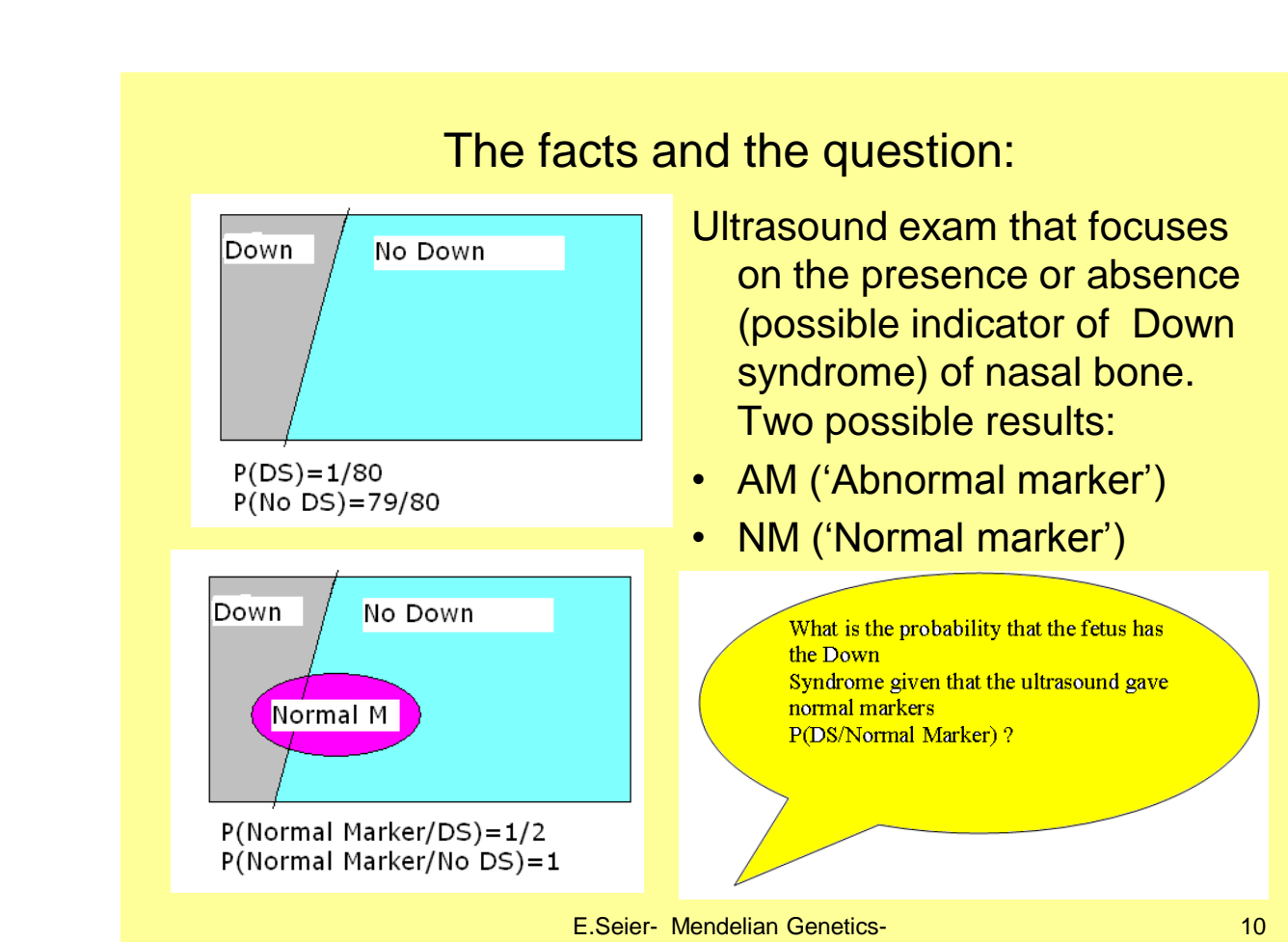


An example of Bayes rule in the genetics context

Reference: Fan J. & Levine, R. (2007) To Amnio or Not to Amnio: That is the question for Bayes - Chance, Vol 20 # 3.

Down syndrome is associated to Trisomy 21 (a triplicate at chromosome 21) a result of an error in cell division. People with Trisomy 21 have 47 chromosomes instead of 46. For the general population the prevalence in the USA is 0.2 per 10,000 live births. However the risk of having a child with Down syndrome increases with age (1/1177 at age 20, 298 at age 35, and increases much faster after that). There is a definite test for Down syndrome in the fetus called amniocentesis but it is a very invasive exam so patients usually prefer to have other tests before deciding to have an amniocentesis. Women who belong to high risk groups, mainly because of age go through a preliminary blood test called 'the triple marker test' (that has a high rate of false positives). For women with certain results in the preliminary blood test, the probability that the fetus has Down syndrome is 1/80. The paper focuses in this group of women. Here we report the probabilities calculated in the paper and have added some plots to add to the understanding of the problem.

E. Seier - Mendelian Genetics- Conditional probability, Bayes rule



Application of the Bayes rule

We can see how for a woman belonging to this high risk group the probability that the fetus has Down syndrome at the beginning of the story, 1/80, change to 1/159 after the information given by the ultrasound test. That, in a simplified way reflects the idea of the Bayesian approach in Statistics: we start with certain probabilities and we modify them at the light of the information given by the data.

E. Seier - Mendelian Genetics- Conditional probability, Bayes rule