

Topics for Exam 2**I. Continuous Models of Population Growth: Differential Equations**

- (a) Malthusian or exponential growth (or decay) models
- (b) Logistic differential equation
 - i. Qualitative analysis
 - ii. Analytical solution
 - A. Local existence and uniqueness
 - B. Global existence and long-run behavior
- (c) General continuous population models
 - i. Linear first-order differential equations
 - ii. Non-linear first-order differential equations
- (d) Analysis of first order differential equations
 - i. Equilibrium points and stability
 - ii. Qualitative analysis
 - iii. The Principle of Linearized Stability
 - iv. Local existence and uniqueness theorem
- (e) Applications:
 - i. Conservation Principle
 - ii. One-Compartment models

II. Modeling the Number of Bacterial Mutations

- (a) Probabilistic Models
 - i. State Diagrams
 - ii. Random Processes
 - iii. The Poisson Process
- (b) Random Variables and Distributions
 - i. Probability Models in Genetics
 - A. Frequency Interpretation of Probability
 - B. Rules for Computing Probabilities
 - C. Conditional Probability
 - D. Independent Events

- ii. Random Variables
- iii. Expected Values
- iv. Probability Distributions
 - A. The Binomial Distribution
 - B. The Poisson Distribution
- (c) Mutation Rates and the Average Number of Mutations
- (d) Goodness of Fit Test: The Chi-Squared Distribution

Relevant Sections in the Text and Class Lecture Notes:

- Chapter 6.1 on *Mendelian Genetics* in the text
- Chapter 6.2 on the *Probability Distributions in Genetics* in the text
- Part II in the Class Lecture Notes on *Probabilistic Models*, starting on page 43