BGEN 55 - Advanced Genetics II

Week 5 at a Glance

Evolutionary Force I: Mutation & Balance

🗺️ Week 5 Learning Path

Part 1: Introduction → Part 2: Mutation Properties →
Part 3: Recurrent Mutation → Part 4: Mutation-Selection Balance →
Part 5: Synthesis

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Mutation Basics

Ultimate source of genetic variation

Key Property: Weak but constant force

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Recurrent Mutation

One-way mutation model

Formula: $p_t = p_0(1 - \mu)^t$

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Mutation-Selection Balance

Opposing forces reach equilibrium

Formula: $\hat{q} = \sqrt{(\mu/s)}$

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Real-World Applications

Genetic disorders, conservation, medicine

Concept: Genetic load

📐 Essential Formulas

Recurrent Mutation

$$p_1 = p_0(1 - \mu)$$

$$\Delta p = -\mu p_0$$

$$p_t = p_0(1 - \mu)^t$$

Mutation-Selection Balance

Recessive: $\hat{q} = \sqrt{(\mu/s)}$

Dominant: $\hat{q} = \mu/s$

Additive: $\hat{q} = \mu/(hs)$

🎯 Core Concepts Mastered

Mutation Rate (μ)

Probability of mutation per generation

Typical: 10^{-5} to 10^{-8}

Selection Coefficient (s)

Reduction in fitness due to allele

Range: 0 to 1

Genetic Load

Reduction in population fitness

Formula: L = 2μ (recessive)

Equilibrium

Balance point of opposing forces

Condition: Input = Output

Concept Recurrent Mutation Mutation-Selection Balance **Forces Involved** Mutation only Mutation + Selection **Equilibrium** p = 0 (all alleles mutate) $\hat{q} = \sqrt{(\mu/s)}$ (stable balance) **Time Scale** Very slow (thousands of generations) Reached relatively quickly **Real-World Relevance** Limited (other forces usually present) High (explains genetic disorder persistence) **Key Formula** $p_t = p_0(1 - \mu)^t$ $\hat{q} = \sqrt{(\mu/s)}$

🔍 Quick Problem-Solving Guide

Step 1: Identify the Scenario

- **Only mutation?** → Use recurrent mutation formulas
- **Mutation + selection?** → Use balance formulas
- **Check inheritance pattern:** recessive, dominant, or additive

Step 2: Choose the Right Formula

- **Recurrent mutation:** $p_t = p_0(1 - \mu)^t$
- **Recessive balance:** $\hat{q} = \sqrt{(\mu/s)}$
- **Dominant balance:** $\hat{q} = \mu/s$

Step 3: Calculate Carefully

- Watch units and exponents
- Use approximations for small μ: $(1 - \mu)^t \approx e^{-\mu t}$
- Check if answer makes biological sense

Step 4: Interpret Results

- Compare with real-world data
- Consider other evolutionary forces
- Think about practical implications

💡 Common Pitfalls & Tips

❌ Common Mistakes

- Using wrong inheritance formula
- Forgetting square root for recessives
- Mixing up μ and s values

✅ Success Strategies

- Always write down known values first
- Double-check units and exponents
- Use reality checks for answers

- Ignoring population size assumptions
- Consider multiple evolutionary forces

🎓 Learning Objectives Check

You should now be able to:

✓ Model recurrent mutation effects

✓ Explain mutation-selection balance

✓ Calculate equilibrium frequencies

✓ Apply concepts to real scenarios

🚀 Looking Ahead

Next Week: Evolutionary Force II: Genetic Drift

We'll explore how random sampling in finite populations affects allele frequencies, completing our toolkit of evolutionary forces!
