Ecology

Division B/C

Georgia Tech Event Workshop Series
2024-25

Science Olympiad at Georgia Tech®

Agenda

Event Overview

Topic Areas

Quantitative Tips

Note Sheet Tips

How to Prepare

Event Overview

Students will answer questions involving content knowledge and process skills in the area of ecology and adaptations in featured **North American biomes.**

Each team may bring only one 8.5” x 11” sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form from any source without annotations or labels affixed along with two stand-alone non-programmable, nongraphing calculators (Class II).

North American Biomes

- **Temperate deciduous forest**
- Coniferous forest
- Grasslands/Prairie
- Desert
- **Taiga**
- **Tundra**

Topic Areas

01 Part 1: Review of the General Principles of Ecology

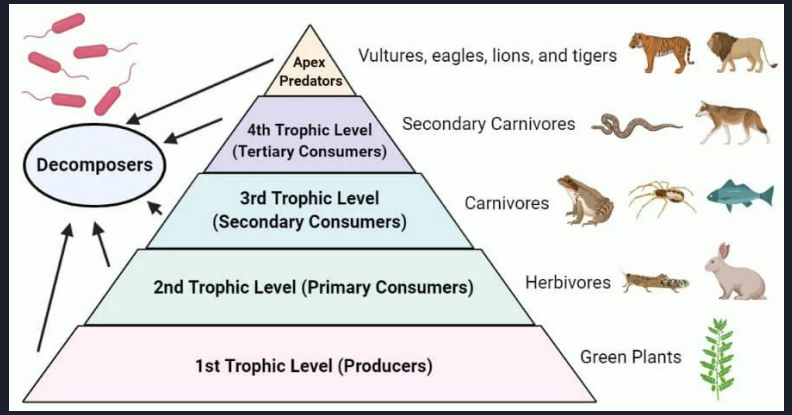
02 Part 2: Terrestrial Ecosystems

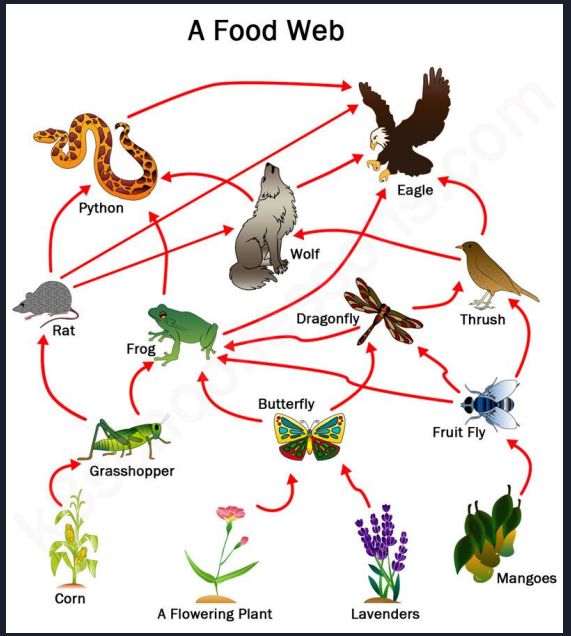
03 Part 3: Human Impact on Ecosystems

Part 1: Review of the General Principles of Ecology

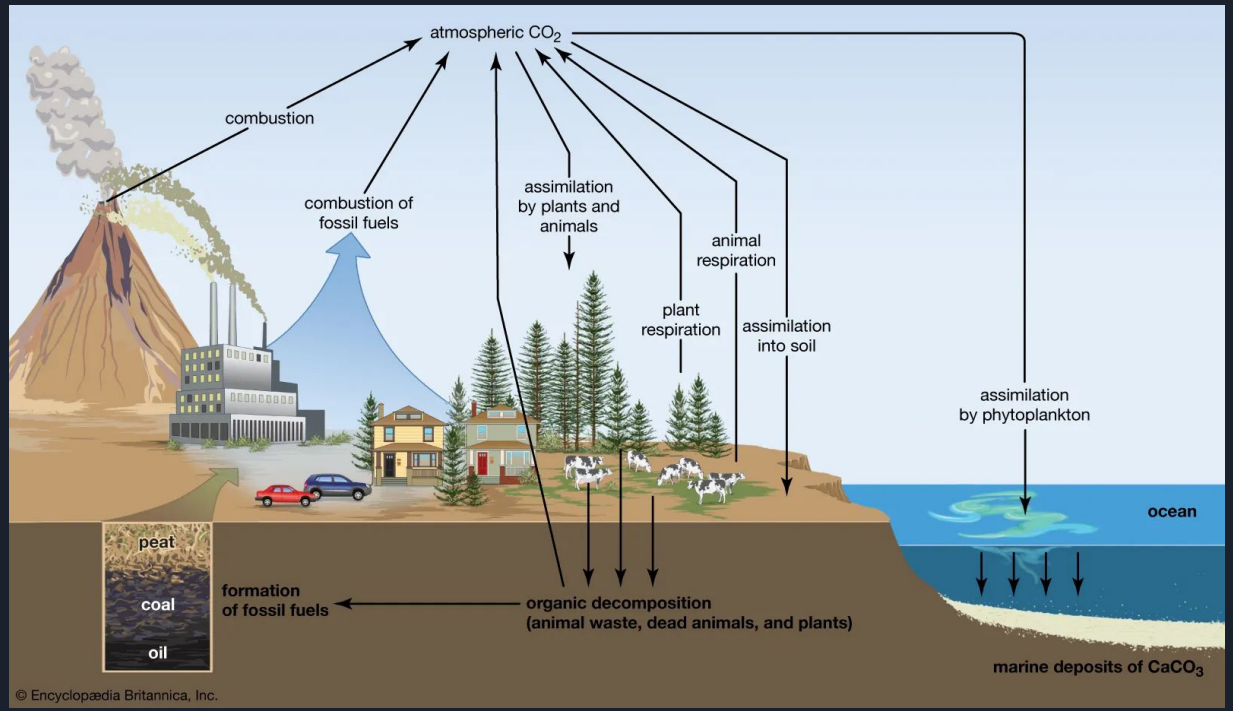
Food webs and trophic pyramids, nutrient cycling, community interactions, population dynamics (including density dependent/independent limiting factors, carrying capacity, doubling time, exponential/logistical growth and how to calculate population growth), extinction, selection, and migration. At the regional and state level, the general ecological principles should focus on local and regional ecology.

Food webs and trophic pyramids

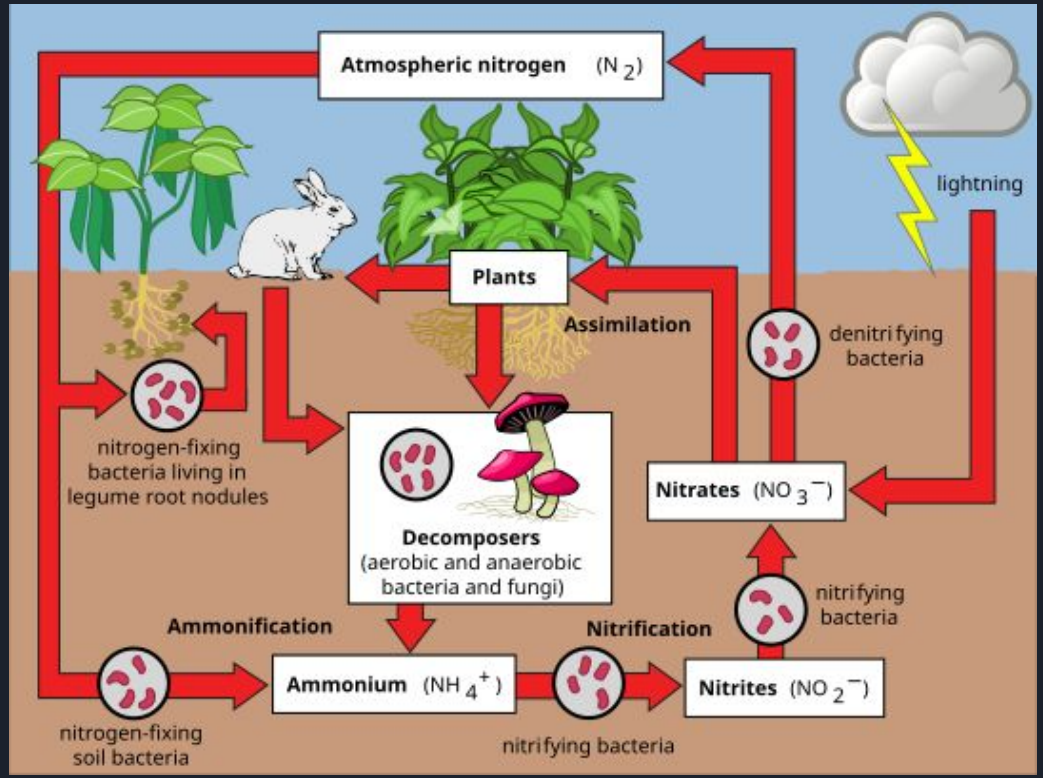




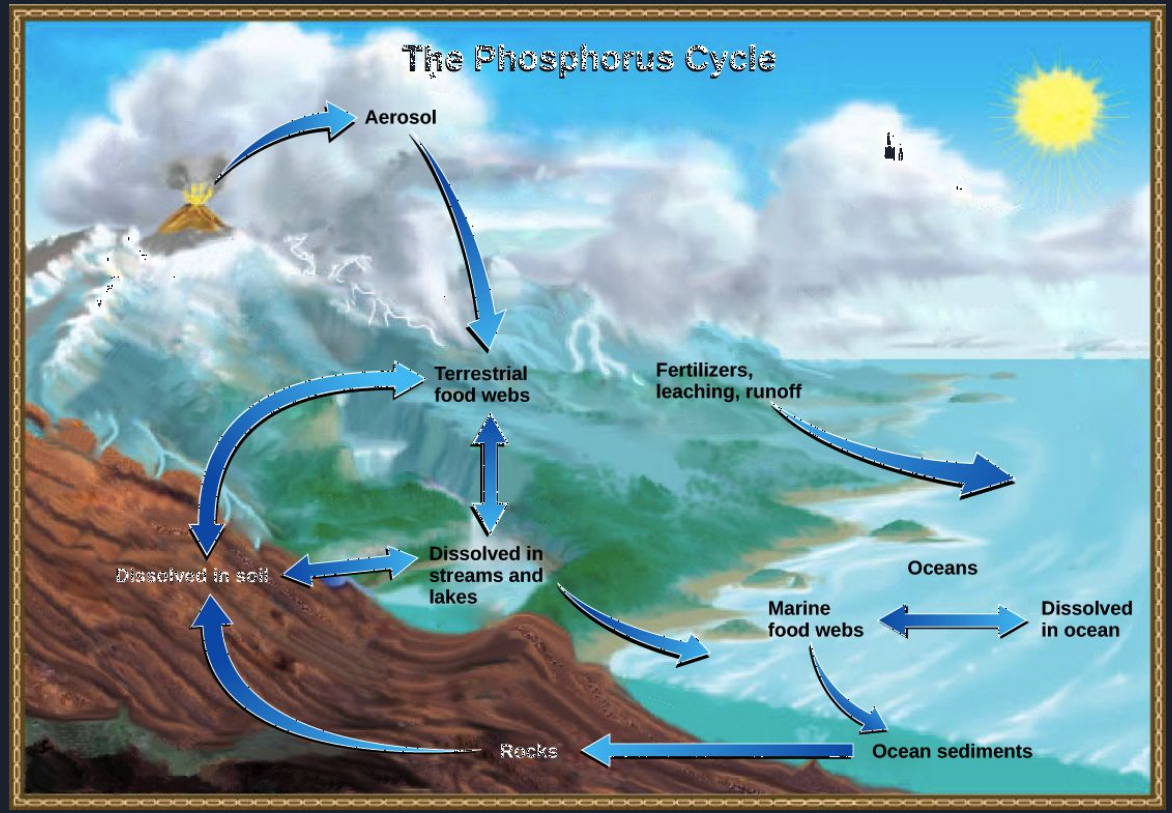
Nutrient Cycling - Carbon



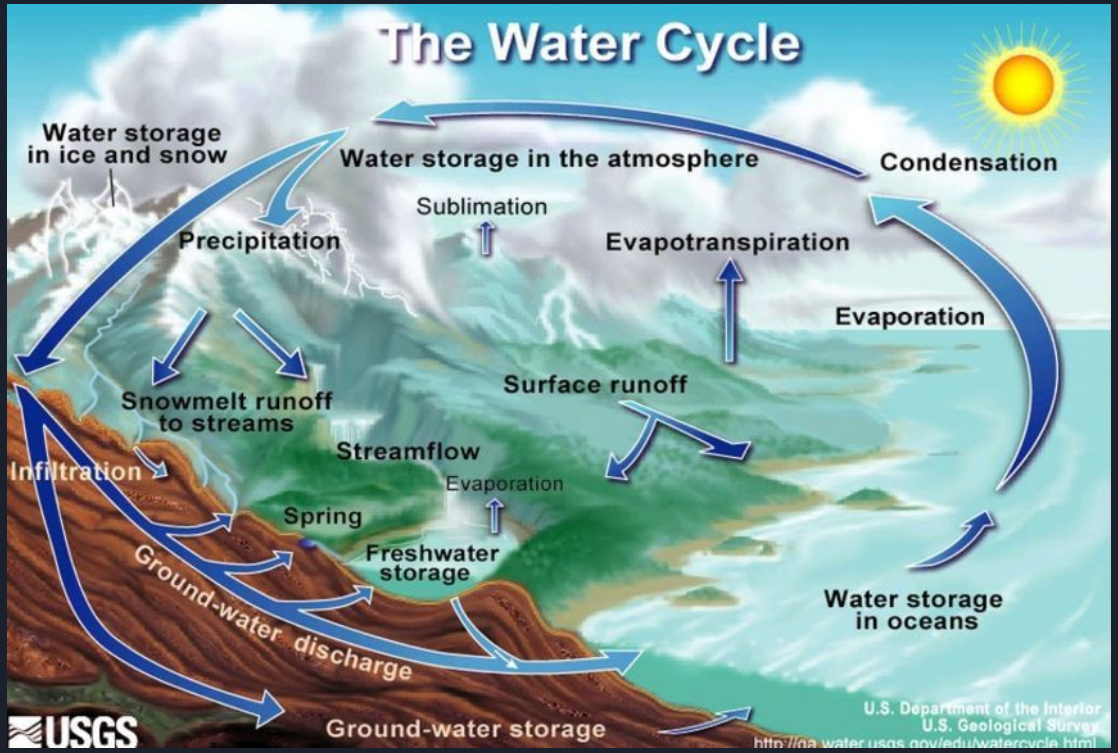
Nutrient Cycling - Nitrogen



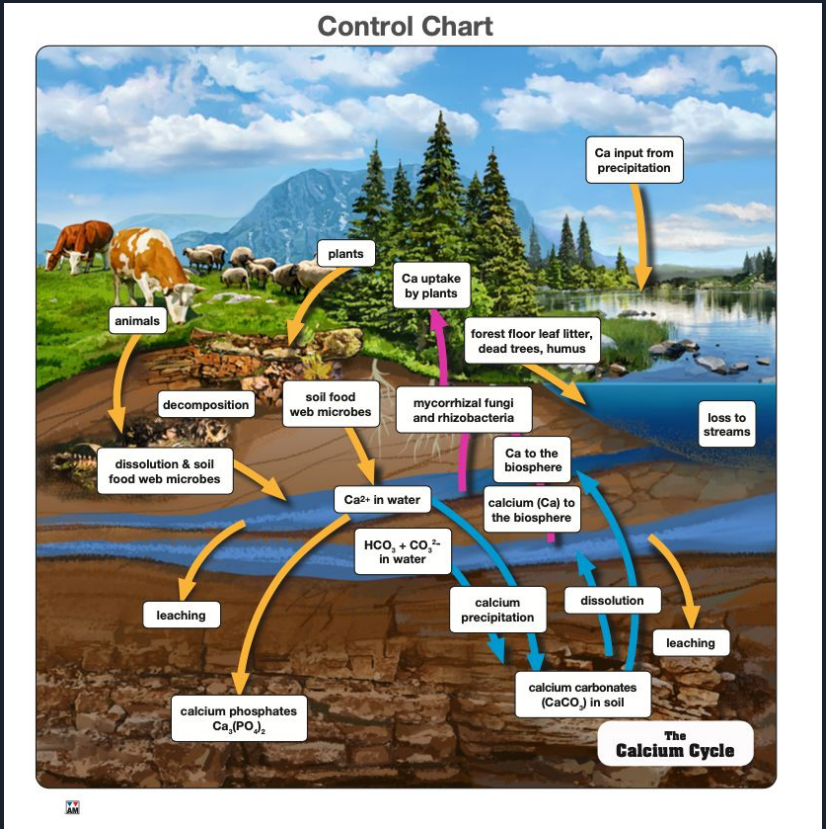
Nutrient Cycling - Phosphorus



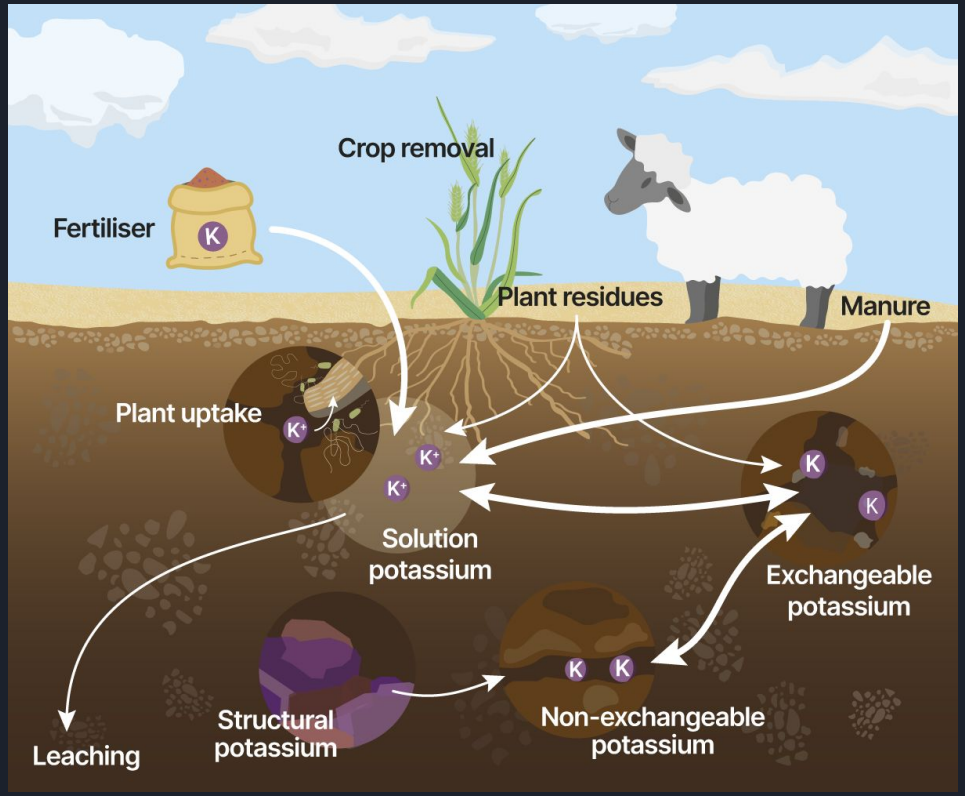
Water (Hydrologic) Cycle



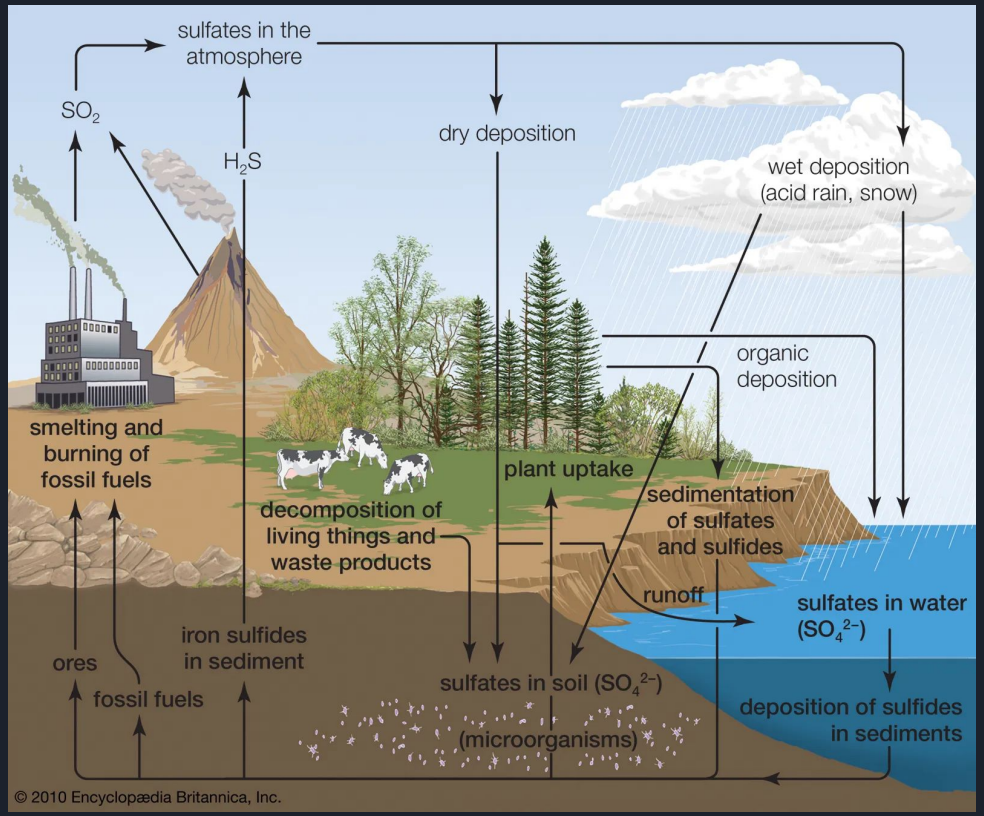
Nutrient Cycling - Calcium



Nutrient Cycling - Potassium



Nutrient Cycling - Sulfur



Community Interactions - Interspecific

Interaction	Species 1	Species 2	Example
Competition	-	-	Blue mussels (Species 1) competing with barnacles (Species 2) for space in the intertidal zone
Mutualism	+	+	Zooxanthellae (Species 1) providing coral (Species 2) with photosynthate and gaining nutrients from the coral
Antagonistic (Predation, Parasitism, Herbivory)	-	+	An antelope (Species 1) killed and consumed by a lion (Species 2)
Amensalism	-	0	Insects (Species 1) crushed by a walking elephant (Species 2)
Commensalism	+	0	Remora (Species 1) catching a ride on a large shark (Species 2)
Neutralism	0	0	Two species without niche overlap sharing a habitat

Competition

- Gause's Competitive Exclusion Principle
- Niche Partitioning
- Interference Competition
- Exploitative Competition
- Apparent Competition

Limiting Factors

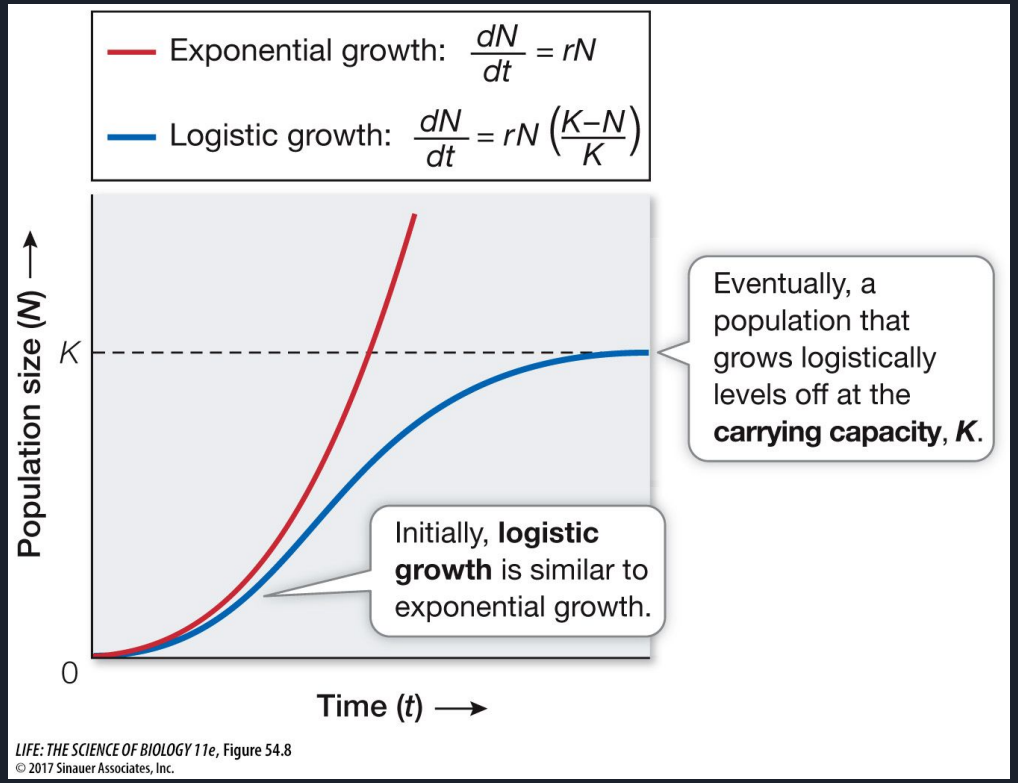
Density Dependent

- Disease/parasitism
- Competition
- Predation
- Resource Availability

Density Independent

- Climate and weather events/seasonal cycles (monsoons)
- Catastrophic events (fires, hurricanes, etc.)
- Habitat alteration and destruction
- Pollution

Population Growth



LIFE: THE SCIENCE OF BIOLOGY 11e, Figure 54.8

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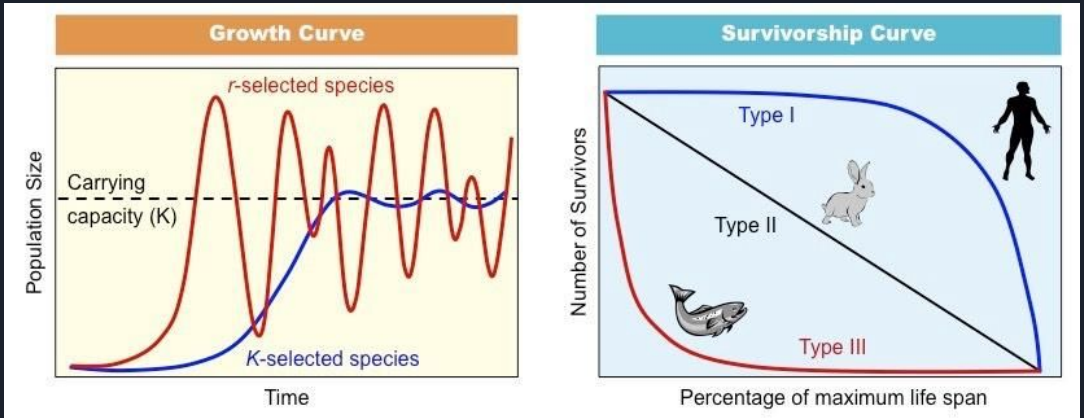
r/K Selection Theory

Verhulst equation of population dynamics



Population Doubling

- Rule of 70: Doubling Time = 70/rate of growth
- T(double) = ln(2)/k

Predation

Trophic Cascade

Interspecific competition: Lotka-Volterra Model

Species 1: $$\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 - \alpha N_2}{K_1} \right)$$

Species 2: $$\frac{dN_2}{dt} = r_2 N_2 \left(\frac{K_2 - N_2 - \beta N_1}{K_2} \right)$$

Competition coefficients:

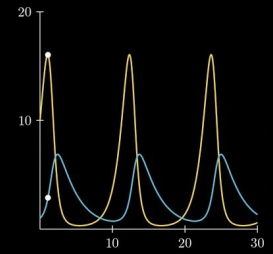
α : the effect an individual of species 2 has on the population growth of species 1

β : the effect an individual of species 1 has on the population growth of species 2

Lotka-Volterra

$$\frac{dx}{dt} = \alpha x - \beta xy$$

$$\frac{dy}{dt} = \delta xy - \gamma y$$



Predator-Prey

Selection

- Natural selection
- Variation
- Differential Reproductive Success
- Adaptation
  - Mimicry
- Speciation
  - Prezygotic barriers
  - Postzygotic barriers
  - Allopatric speciation
  - Sympatric Speciation
- Adaptive Radiation
- Character displacement
- Mutation
- Evolution

Regional Ecology

- Southeast Region
- Understand specific keystone species, common species, endangered species
- Flora and fauna
- Regional climate trends
- Agricultural impacts
- Know case studies

Part 2: Terrestrial Ecosystems

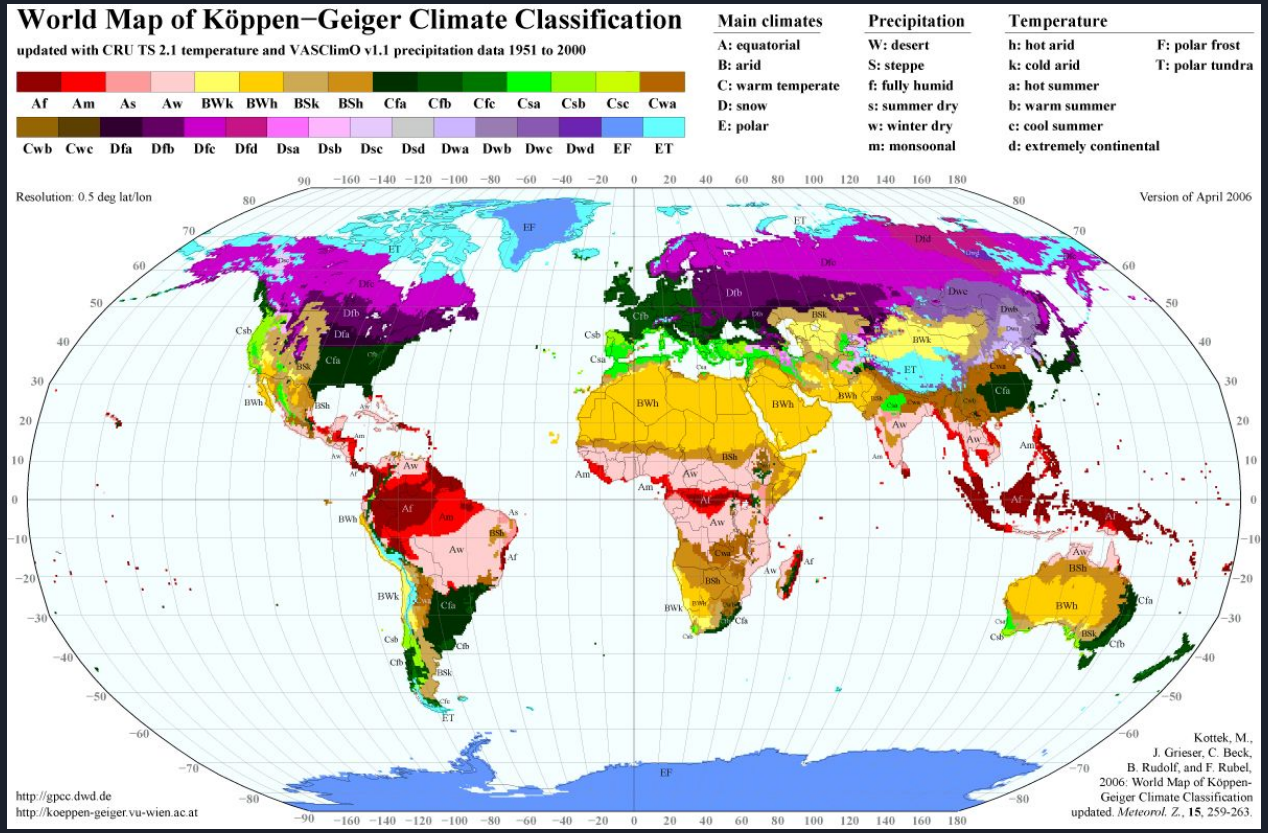
Ecology of the Tundra, Taiga and Deciduous Forests

Understand basic concepts of biodiversity (e.g., importance, different types)

Div. C State and Nationals only: Be able to apply knowledge of biodiversity (plot maps, simulations of selection effects on populations)

Div. C Nationals only: Understand terminology and be able to calculate biodiversity of sample data (species richness, Simpson index, Shannon-Wiener index)

Koppen Climate Classification System



Soil Classification Systems

USDA Soil Taxonomy

Unified Soil Classification

Soil texture triangle

Biome-specific soil profiles

Impact on agriculture

Part 3: Part 3: Human Impact on Ecosystems

Topics such as climate change, invasive species, acid deposition (including acid rain), erosion, and chemical contamination (pollution)

The pros and cons of using alternative energy and its effect on the environment

Understand the goals of conservation biology and how they can be obtained

Reclamation of disturbed areas versus reintroduction of species

Division C State and Nationals only: Be able to answer questions as they pertain to case studies

Division C only: adding indigenous knowledge or traditional ecological knowledge (TEK) to our “toolkit”

Threats to the Tundra

- Climate Change
- Air Pollution
- Industrial Activity
- Invasive and Migrating Species

Threats to the Taiga

- Deforestation
- Commercial Activity
- Acid Rain

Threats to the Deciduous Forest

- Forest fragmentation
- Overpopulation
- Invasive species
- Pollution
- Fire Suppression
- Acid rain and other changes in atmospheric chemistry
- Human-induced climate change

Agricultural Impacts

Issues relating to crops that are frequently grown in your region/state

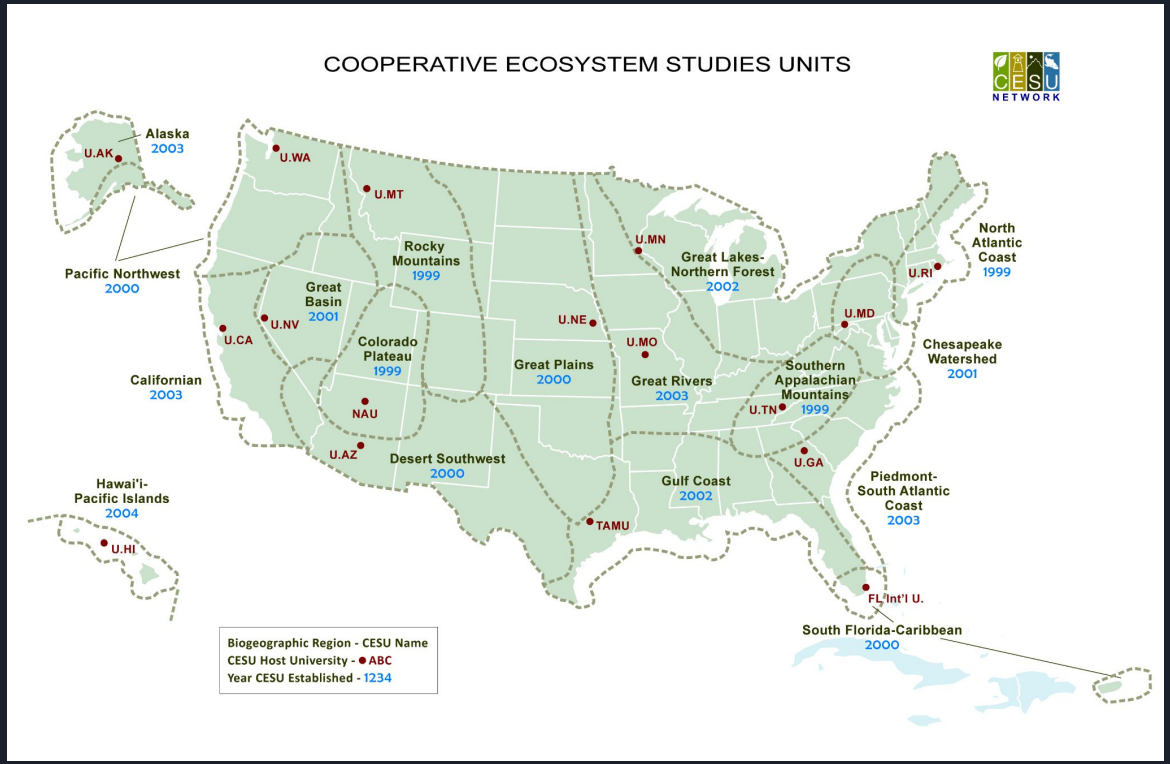
CAFOs and animal waste

Climate change impacts on crop viability and seasonality

GMO crops

Fertilizer and runoff

Traditional Ecological Knowledge



Quantitative Tips

- Write all formulas down in your note sheet
- Make sure you know what each variable stands for
- Write an example of how to use the numbers in a solved problem
- If you encounter a graph/plot you've never seen before – decipher it by looking at the axes, read the context

Shannon Index

Species	Frequency	p_i	$ln\,(p_i)$	$p_i * ln\,(p_i)$
A	40	0.38	-0.97	-0.37
B	20	0.19	-1.66	-0.32
C	15	0.14	-1.95	-0.28
D	8	0.08	-2.57	-0.20
E	22	0.21	-1.56	-0.33
			H	**1.49**

Note Sheet Tips

- Organize the note sheet by the 3 parts and topic areas
- Landscape orientation
- Use 3 columns
- Small size font, sans serif
- Minimize margins
- Include common diagrams/graphs/charts
- Print in color
- Front and back – fill all the empty space
- Can hand write into the empty space

How to Prepare

Gaining Knowledge and Preparing Note Sheet

- Textbooks
- YouTube/Khan Academy
- AP Biology class

Practice Tests and Test Releases

- Test trading with other schools
- Invitational test releases
- Past archives
- AP Biology ecology practice questions

THANKS!

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Feel free to reach out if you have any questions!