Study Guide - Midterm #1

ECOSYSTEMS

Carbon cycling and the global C budget

What are the recent patterns in atmospheric CO_2 concentrations? How does these relate to long-term records of atmospheric CO_2, temperature and other greenhouse gases? What is causing the changes? What is the evidence? What is the Suess effect, and how does this help pinpoint the sources of elevated CO_2 in the atmosphere? What is the greenhouse effect, and how is it related to elevated CO_2 levels? What are some ways that the enhanced greenhouse effect could influence the environment in addition to higher average temperatures? How might global warming relate to species' environmental tolerances? What is the role of methane and nitrous oxide in the enhanced greenhouse effect? Make sure you understand the global carbon budget figure from the IPCC.

What are autotrophs, heterotrophs, producers, and consumers? What types of organisms are in these different categories? What is the difference between plant production and plant biomass? Which is the larger of the two values? Can they ever be equal? Know the definitions for and relationships among the following: gross primary production, net primary production, net ecosystem production, autotrophic respiration, heterotrophic respiration, and secondary production. What are the major pools and fluxes in the carbon cycle? Can you draw a diagram of the carbon cycle, including all those pools and fluxes? Which of these pools and fluxes are most relevant for long-term storage (sequestration) of carbon in ecosystems?

Controls on production: How do climate (temperature and water), nutrient availability, time, and species composition influence primary productivity? What is actual evapotranspiration (AET)? What effect does AET have on NPP? In what ways is this similar to controls on photosynthesis at the individual plant level? What feedbacks at the ecosystem level operate between these different controls on production? How might they change through succession? What nutrients typically limit production in terrestrial ecosystems? Freshwater ecosystems? Marine ecosystems? What is eutrophication? How do ecosystem biomass and plant productivity change through succession? What brings about these changes? What are the differences between top-down and bottom-up controls on production? What is a trophic cascade?

Decomposition

How is decomposition important in the global carbon cycle? How does decomposition influence NEP? What is the difference between conditioning and primary decomposition? In which of these does respiration of dead biomass occur? What organisms are primarily responsible for these different steps? What are the different potential fates of organic carbon that enters the detrital pool? What is the general pattern of litter decomposition (i.e., how does % of initial biomass change with time)? How do temperature and moisture affect decomposition rates? What two chemical components of plant litter exert the strongest control on decomposition rates? In what way? How is decomposition related to the nitrogen and phosphorus cycles? How might this feed back to affect levels of ecosystem productivity? How does the amount of decomposition change through succession? How does the balance between primary production and decomposition affect carbon storage in ecosystems?

Plant growth and photosynthesis

How might elevated CO2 affect leaf-level photosynthesis in plants? Is it likely that all species will respond similarly to elevated CO2? What factors might influence whether the response of leaf-level photosynthesis to elevated CO2 is similar to or different from responses of whole plant growth or whole ecosystem primary productivity?

What happens in the light-dependent reactions of photosynthesis? What happens in the light-independent reactions of photosynthesis? In which of these is CO2 actually fixed into sugars? What is rubisco and why is it important? Be able to draw a labeled graph of the responses of photosynthesis to CO2, nutrients, and light (including all axes and important points). What do we mean by biochemical limitation of photosynthesis in response to CO2 and light, and how does this relate to both tissue nitrogen concentrations and allocation strategies within the leaf? How do differences in light response curves for sun and shade plants relate to these different allocation strategies within the leaves?

What are the potential fates of fixed sugars in the plant? How might differences in allocation strategies lead to different responses of plant growth to increased photosynthesis? What do we mean by "optimal foraging" in plants and how might this lead to different growth strategies in different environments?

What are the primary differences among C3, C4, and CAM photosynthesis? What are the advantages and disadvantages of each? Under what conditions would you expect plants to use these different photosynthetic mechanisms? How do you account for the difference in distribution between C3 and C4 grasses?

CLIMATE, BIOMES AND PHYSIOLOGICAL ECOLOGY

Introduction

Terrestrial biomes (Chapter 2)

What is the difference between climate and microclimate? What are the three main factors that determine climate? What are the factors that determine microclimate?

What are potential and actual evapotranspiration? How do they relate to precipitation and temperature in determining water availability? How do they differ in warmer vs. cooler and wetter vs. drier climates or microclimates?

What are the nine (or ten) major biome types? How do biomes vary with climate across North America when going from north to south? from east to west? What organisms define biomes? Be able to interpret climate diagrams and relate the information they show to adaptations of organisms in particular biomes, as well as limitations to primary productivity there.

Organism adaptations and tolerance

Know the terms we discussed (see powerpoint file). What is the meaning of "adaptation"? What is the "law of tolerance"? What are its various components? How does this relate to acclimatization in organisms? How does acclimatization relate to adaptation to stress? Over what relative time scales do each of these operate? What are some examples of each?

What are phenotypes, genotypes and ecotypes? If you had plants of the same species living in different environments, describe an experiment that would help you distinguish among these. How might the results depend upon the phenotypic plasticity of that species?

How do negative and positive feedbacks relate to the concept of homeostasis? How does homeostasis relate to thermal balance and water balance in both animals and plants? What are some examples of important biological negative feedbacks from the chapters we have read and from lectures?

Temperature relations (Chapter 5) – We'll see how far we get in this material.

What are ectotherms, endotherms, and heterotherms? What are homeotherms and poikilotherms? How do these terms relate to each other? What organisms are examples of each?

What is the basic equation for heat balance? What are the six primary components? Which ones are one-way fluxes and which are two-way fluxes? What are the primary variables that determine the magnitudes of each of those components of heat flux?

Chapter 5 lists lots of different adaptations for both ectotherms, endotherms, and heterotherms for maintaining heat balance. While there are a wide variety of adaptations, in one way or another each manipulates one (or more) of the six fundamental heat flows. Categorize those adaptations according to which pathway they act upon. Which adaptations influence more than one pathway? Which adaptations are specific to one group of organisms or another (e.g., plants vs. ectos vs. endos vs. heteros)?

How might global climate change influence animal temperature balance? Are mean or extreme temperatures more likely to influence species ranges?