# Chan's ENVS200 Review

## Chapter 3 - Physical Conditions and the Availability of Resources

ENVIRONMENTAL CONDITIONS

- Conditions are physiochemical features of the environment
- Resources are consumed by the organisms within it (for the sake of growth/reproduction)
- Conditions produce responses in organisms - three general types of response curves
  - Unfavourable -> Favourable -> Unfavourable
    - ex. Temperature - extreme cold is lethal, while there is a middle ground that is favourable for living, and then extreme heat is also lethal
  - Favourable -> Less favourable -> Unfavourable
    - ex. Concentration of arsenic - at zero to extremely low concentrations, we can perform quite well, but after the concentration becomes significant, our ability to survive greatly decreases
  - Lethal -> Favourable -> Unfavourable -> Lethal
    - ex. Concentration of salt - most organisms need at least some salt - no salt will certainly mean death. Then, there is a favourable region until we get too much salt, at which point we start to die
- Temperature is approximately linear with growth rate AND development rate except at the extremes
- Rates of growth (how fast do we grow) and development rate (how long are we in the growing phase for) determine the final size of an organism
  - Higher growth rate -> bigger organism
  - Higher development rate -> lower development time -> small organism
- Absolute temperature an organism experiences and the duration of that experience is important in determining the effects on it
  - You could probably survive -30 degrees for 10 seconds without clothes but not 10 hours
- Photoperiod, the amount of daylight, is used by a lot of plants and animals to determine how to approach changing seasons
- Tolerance (less change in response) to environmental stimulus is acclimatization
- Ectotherms rely on external sources of heat to determine the pace of their metabolism
  - Metabolic rate dependent on environment, but requires less energy to sustain itself
- Endotherms regulate body temperature by producing heat from within itself
  - Keeps itself near peak metabolic rate, but requires more energy
- Distinction between the two is not absolute - for example, some reptiles can generate heat for limited periods of time

RESOURCES FOR PHOTOSYNTHETIC ORGANISMS

- Organisms that can move can search for food
- Organisms that can't have to grow towards food, or catch resources that come their way
- Plants and algae have preferred amounts of solar radiation
  - Sun-loving species vs. shade-loving species
  - Sun-lovers usually have multiple layers of leaves and grow at acute angles to better absorb direct light
  - Shade-lovers usually have one layer of horizontal leaves
- Many trees produce different leaves in areas with high sunlight than the leaves in low sunlight areas
- When plants dry up, they wilt - if they wilt too much, they'll die
- Having water also lets the water evaporate, cooling the plant (like how humans sweat)
  - Not having enough water and not being able to cool can overheat and kill a plant
- Strategies for avoiding dry weather
  - Avoiders - short lifespans, limited to when water is readily available, dormant the rest of the year
  - Tolerator - long-lived leaves that photosynthesize slower, but are more water-efficient
- Photosynthesis approaches
  - C3 pathway - first product of photosynthesis is a 3-carbon sugar
    - Very productive, but requires a lot of water
    - Used by any plants that have ready access to water
    - When other resources are adequate, increasing $CO_2$ makes C3 plants grow much more
  - C4 pathway - first product of photosynthesis is a 4-carbon sugar
    - Much more efficient use of $CO_2$ and water
    - Better in drier environments with lots of sunlight
    - When other resources are adequate, increasing $CO_2$ doesn't affect anything
  - CAM - crassulacean acid metabolism
    - Fix carbon dioxide as malic acid so it can use it later
    - Used in cactuses and in other plants where water is extremely rare
- Root systems
  - Shallow roots when there's a lot of water available
  - Deep roots when less water available
  - Wide when soil isn't very nutritious
  - Thin when soil is nutritious
  - Root architecture also determines how well a plant can find nutrients in the soil
- Autotrophs manufacture food from inorganic resources like sunlight and water
- Heterotrophs consume autotrophs or other heterotrophs

HETEROTROPHS AND THEIR RESOURCES

- General categories

    - Decomposers - eat dead things
    - Parasites - mooch off alive things' bodies
    - Predators - seeks out other things, kills them, and eats them
    - Grazers - seeks out other things, eats parts of them without killing them
- Different parts of plants have different nutritional qualities (bark vs. leaves, etc.)
- This diversity reflects in the many ways animals have of eating different plants' parts
    - Beaks of birds to eat seeds
    - Tongues of butterflies to drink nectar
    - Molars of mammals to chew leaves
- Plants have a lot of structural carbon, their C:N ratio is usually higher than 40:1
    - Main waste of herbivores is carbon-heavy
- Ratios rarely exceed 8:1 in non-plant tissues (animals, fungi, etc.)
    - Main waste of carnivores is nitrogen-heavy
    - Even though taste of animal tissues can be extremely different, the composition is generally very similar
    - Digestive systems of carnivores are also largely similar
- Defense mechanisms are generally "cheap" to make
    - ex. Plants usually have an abundance of cellulose, so it can use it to form husks and shells around its seeds at very low cost, because the defence mechanism requires very little protein (which is an important and rare resource)
    - Additional chemicals specifically used to deter predators is quite common as well
- Quantitative chemicals
    - Effective at high concentrations
    - Requires a lot of energy to produce all the time
    - Produced regardless of whether the plant is being eaten
- Qualitative chemicals
    - Poisonous even in small quantities
    - Requires relatively smaller amounts of energy to produce when needed
    - Produced relatively rapidly - when a plant is being eaten, as a response to being damaged
- Generally, the shorter the lifespan of a plant, the more likely its defence mechanism is qualitative
- Animals also may use chemical defences, but may have other means such as camouflage
- Others, like the monarch butterfly, are brightly coloured, but toxic, so predators are disincentivized from eating them after eating one and "learning" the result

EFFECTS OF INTRASPECIFIC COMPETITION FOR RESOURCES

- Intraspecific competition is competition between individuals of the same species
- Competition where individuals interact indirectly is called exploitation
    - ex. Grasses don't actively try to kill other grasses, they just eat up nutrition from the soil so others can't eat it

- Interference competition is when things fight over resources and do things to actively undermine others
  - ex. Vultures fight over dead animals
  - ex. Telling your enemy the wrong answer for an assignment
- Competition is usually density-dependent
  - The more of a species there is, there more fighting over resources
- Some species have mechanisms to deal with overcrowding, like producing less offspring (to better manage the lesser amount of resources available)

CONDITIONS, RESOURCES, AND THE ECOLOGICAL NICHE

- Niche - a summary of an organism's tolerances and requirements
  - Describes how an organism lives in its habitat
  - A multidimensional niche is a niche that has more than one dimension
    - ex. An organism needs specific temperature and water requirements - if those are met, it can live anywhere. This would be a 2-dimensional niche.
  - All niches can be referred to as n-dimensional hyper volumes
- Habitat - the area in which an organism lives