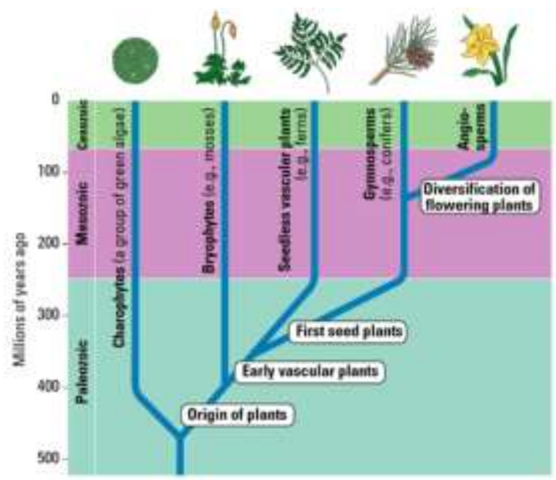
Bot 123 - Course Introduction and Fundamental Concepts

I. Welcome to Botany 123!
II. Course syllabus, introduction, and overview

III. OVERVIEW OF THE PLANT KINGDOM
See posted lecture slides. I will not structure major portions of assessments to cover this information, but you should understand the fundamental differences between the four plant lineages (evolutionary groups) below. Doing so is an important facet if botanical literacy and enjoying this course.

All modern plants are descendants of multicellular green algae (see diagram at right). There are four evolutionary lineages of plants. An evolutionary lineage is just nerd-speak for a group of organisms that are closely related (at least somewhat) to each other. All members of a given lineage are fundamentally different from the other lineages in important ways. We will observe many of these differences in the field this semester. The four groups (evolutionary lineages) in the plant kingdom are:



Mosses and relatives:
- First evolved ~475 mya; ~20,000spp.
- Small bodied, “soft” to the touch, usually in wet places
- Reproduce with spores, not seeds

Ferns and relatives:
- First evolved ~425 mya
- Larger than mosses
- Reproduce with spores, not seeds (spores often visible in clusters called sori on underside of leaves)

Gymnosperms (non-flowering seed plants)
- Most common type are conifers (cone-bearing trees) such as pines, redwoods, firs, etc.
- 3 other groups include: cycads, Ginkgo, gnetophytes
- First evolutionary group to make seeds; appear about 360 mya

Angiosperms (flowering plants)
- First evolved ~ 140 mya
- Make flowers that develop into fruits after pollination

IV. BINOMIAL NOMENCLATURE

Binomial nomenclature: a formal system of naming individual species with names comprised of two Latin words (sometimes borrowing roots from other languages such as Greek). (These names are often referred to as *Latin names* or *scientific names*.) Developed by Carl Linnaeus (1707-1778).

The root words of scientific names often describe the plants in some way, for example:
Toxidodendron diversilobum (poison oak). The leaves of poison oak cause skin irritation in most people (hence *Toxicodendron* or "toxic tree") and they are highly variable in color and shape (hence *diversilobum*)

The value of binomial nomenclature:

1) Efficient – species names before Linnaeus tended to be lengthy descriptions
2) Universal – Latin is not unique to any country or people, therefore "fair"
3) Stable – Latin is a "dead" language and is therefore not changing
4) Clarity – A single common name (nickname) can be used for different species and therefore be misleading (e.g., "ironwood" for *Lyonothamnus floribundus* and *Carpinus caroliniana*)
   - Multiple common names are often applied to a single species and are therefore misleading (e.g., many names for *Carpinus caroliniana*)
   - Common names are often misleading (e.g., poison "oak" vs. poison "ivy")

In a Latin name, the first word is the <u>genus name</u>, and the second is the <u>species epithet</u>:
<u>Example</u>:

Ceanothus	*megacarpus*
(genus name)	(species epithet)

Proper reporting of scientific names:

- First letter of the genus name is capitalized
- Species epithet is not capitalized
- Both are *italicized* (<u>underlined</u> if written by hand)

Correct:
- *Nicotiana glauca*

Incorrect (can you see why?):
- nicotiana glauca
- *nicotiana glauca*
- NICOTIANA GLAUCA
- *NICOTIANA GLAUCA*
- Nicotiana Glauca
- *ETC…*

Important names for the practicing botanist:
<u>species</u>, <u>genus</u>, and <u>family</u>

Similar (i.e., evolutionarily closely related) **species** are often organized into a single **genus**. Further, similar genera (and thus, the species each genus contains) may be organized into into a single **family**. (There are ~620 plant families).

You might remember the "complete" taxonomic hierarchy (levels) from previous biology courses (e.g., Domain, Kingdom, Phylum, Class, Order, Family, Genus, species).

When discussing or reporting the identity of plants, most botanists reference the Latin name (**genus** and **species**) and the **family**. For Bot123 (and most other applications), don't worry about the other taxonomic levels. Identifying the family to which a plant belongs is indispensable in botany – we'll do so whenever we identify plants!

V. Physical geography of California

As discussed in lecture, on the final exam you will be presented with a blank map showing only the political boundary ("outline") of California. On this blank map, you will be asked to draw the geographical features/landmarks listed below. Needless to say, your map won't be perfect. Nonetheless, you will need to demonstrate knowledge of the correct location and relative size of these features. (NOTE: This list *might* grow after our field trips – but not immensely so!!!).

At the end of the course, you should be able to recall the major, interesting, or unique plant communities that we saw in the areas we visited.

Features you should be able to draw on a blank map of CA:

Mountain Ranges:	Valleys:	Coastal features:
Coast ranges Transverse Ranges Peninsular Ranges Sierra Nevada Mtns. White & Inyo Mtns	Owens Valley Santa Ynez Valley San Joaquin Valley } CA Central Valley Sacramento Valley } Deserts: Mojave Desert	SF Bay Point Conception Monterey Bay Rivers & Lakes: Owens River Santa Ynez River Merced River Mono Lake

Political features: Yosemite National Park, Santa Barbara, Los Angeles

Features you should be able to draw on a blank map of the Santa Barbara Region:

Mountain Ranges:	Valleys:	Coastal features:
Santa Ynez Mtns San Rafael Mtns Sierra Madre Mtns Caliente Mtns Temblor Mtns	Santa Ynez Valley San Joaquin Valley Specific features: La Cumbre Peak Figueroa Mountain	Point Conception Guadalupe Dunes Rivers & Lakes: Santa Ynez River

That's a great start, we might add specific locations after our field trips – stay tuned.

VI. Evolution and natural selection

No understanding of biology/botany is complete without an understanding of evolution and natural selection. I will use the following vocabulary frequently in the field, and I expect you to know what I am talking about!

Adaptive trait (aka adaptation): An inherited characteristic that increases an organism's ability to survive and reproduce (the "meaning of life" !!!).

Selective pressure (selection pressure, evolutionary pressure): Any cause that reduces an organisms ability to survive and reproduce (e.g., predators, difficulty securing food/water, disease, drought, freezing, etc…).

- Adaptive traits, in essence, are inherited characteristics that allow organisms to overcome selective pressures.
- It is conceptually accurate, therefore, to think of adaptive traits as evolutionary "solutions" to selective pressures. Throughout the semester, we will think about the selective pressures and adaptations present in plants and plant communities– this mindset is foundational and a fun element of botany and biology!

Natural selection: A process in which individuals with certain inherited traits (i.e., adaptive traits) are more likely to survive and reproduce (in this class, the "meaning of life"!!!) than individuals without those traits.

- Organisms with adaptive traits survive reproduce at a higher rate, and thus the inherited adaptive traits that are passed on to their offspring become more common in the general population – thereby driving evolutionary change.
- Natural selection is the mechanism that drives evolution. Charles Darwin's greatest (but not his only!) contribution to science.

Three conditions must be present for Nat. Selection to occur in a population/species:

1) Genetic diversity
2) Struggle for existence due to selective pressures
3) Differential S&R due to fact that some individuals have superior adaptive traits for dealing with selective pressure(s).

Darwinian natural selection vs. Lamarckism

Lamarckism: traits acquired during an organism's life can be passed along to offspring (e.g., a giraffe's neck stretches and elongates in an effort to reach tall branches – and this longer neck is then passed along to offspring. We know this to be false, of course….)

Darwin: adaptive traits are inherited from parents. Organisms with adaptive traits have a higher rate of survival and reproduction.

Concluding key point about natural selection:

1) Adaptive traits are inherited, not acquired (latter = Lamarckism!)
2) A single individual does not evolve. Evolution via natural selection is an incremental process that occurs over many generations and often over long time periods (shocking exceptions of rapid evolution exist, such as bacterial resistance to antibiotics – but bacterial generation times are very short and the change still occurs over many generations.)

VII. Plant communities

Ecosystem: All the organisms in a given area, along with the nonliving (abiotic) factors with which they interact.

Plant community: an assemblage of plant species growing together in a particular area.

Ecotone: A transition area between 2 or more ecosystems or plant communities.

A word of caution about the notion of "plant community" (you do not need to know for exams):

Plant communities are proposed as general, tidy, and convenient categorizations of plant assemblages. These categorizations are simultaneously useful and dangerous.

They are useful to the botanist, because they allow him/her to identify groups of plants and then discuss features common to the group. For example, Chaparral plant communities share features that make them very different than oak woodlands. Plant communities, as defined by humans, reflect our own species' propensity for categorization – which is an important component of logic and reasons.

Such categorizations are intellectually dangerous because nature often does not conform to the tidy categories that humans create. For example, imagine two groups of plants that exist some distamce apart from each other, but are assigned to a particular community (e.g., chaparral). Although the same community type, these two clusters of plants may vary in many important ways: the total number of different species present, actual height, density or other physical feature of the plants themselves, the ratio of different plant species in the community (e.g., if two species are present, do they exist in a 50:50 ratio or a 90:10 ratio – and does it matter to the botanist?), and the presence/abundance of plant species that are categorized in some other community type (For example, what if a chaparral community has 10% coverage by coast live oak trees (*Quercus agrifolia*) - is it still chaparral – or is it something slightly different…?!!). What about ecotones – which community(-ies) should they be classified under?!

With this disclaimer issued, we will whole-heartedly embrace the concept of "plant community" as a valid means of categorizing vegetation types. We do so while bearing in mind the common sense conclusion that nature often deviates from the simple categories assigned by humans, but this does not make the categories invalid or useless. While it is true that no two plant patches on Earth are identical, the features present may be similar enough to warrant placement in a mutual category.

There are **approximately 6,000 – 7,000 native and naturalized species of plants in California, and perhaps ~1500 in the SB region** (the numbers vary depending upon the source and the manner of counting/identifying individual species [i.e., "lumping" vs. "splitting"], here I pull from TJM2 for CA, and Smith 1998 for the SB region). This is an extremely high number of species, and owes in part to the diversity of physical environments in California and Santa Barbara.

As with the number of species, the number of different plant communities in California and SB identified by botanists varies, but Holland and Kiel (1995; California Vegetation) identify 16 different major communities, as listed below. Within each type, Holland and Kiel identify a number of different subcategories (the numbers in parentheses, below). *You do not need to memorize this list!*

Per botanical convention, the subcategories identified by Holland and Kiel are based upon the **dominant (i.e., most abundant) plant species** (or genera/groups of species) present in each community type. For example, one of the two subcategories of the *coastal coniferous forest communities* are the redwood forests (*Sequoia sempervirens*), and one of the *oak woodland community* subcategories is coast live oak woodland (*Quercus agrifolia*).

Dominant species: species that comprises most of the biomass in an ecosystem or plant community, and is therefore used to define that system/community.

<u>Major CA plant communities (and subcategories – in parentheses), as identified by Holland and Kiel 1995</u>
Coastal sand dune and beach communities (3)*
Coastal scrub communities (4)*
Marine aquatic communities (3)*
Chaparral communities (11)*
Grassland communities (4)*
Closed-cone coniferous forest communities (~8)
Coastal coniferous forest communities (2)*
Mixed evergreen forest communities (3)*
Oak woodland communities (6)*
Montane coniferous forest communities (11)*
Alpine communities (3)*(for us in Bot123 - subalpine)
Desert woodland communities (7)*
Desert scrub communities (9)*
Riparian communities (5)*
Freshwater wetland communities (5)*
Anthropogenic communities (5)*

Needless to say, in Bot 123 we cannot explore the full range of plant communities above. **You do not need to memorize this list!** It is simply meant to give you an appreciation of the diversity of plant communities in California. We will, however, explore a fair number of these communities (categories are noted with an asterisk), and we'll explore them in respectable detail!! You will learn the dominant species in many communities, and for 1-3 of them you and your lab partners will press and preserve 8-12 species.

<u>Plant communities are shaped by two general types of "forces", or factors</u>:

Biotic factor: A living component of an ecosystem that influences other living organisms.

<u>Four key biotic factors that shape plant communities and ecosystems</u>:
1) **production** (process of acquiring energy through carbon fixation, conducted by autotrophs ['producers'], usually via photosynthesis)
2) **consumption** (i.e., herbivory) (process of acquiring energy by consuming other organisms – conducted by heterotrophs, 'consumers')
3) **competition** (fight amongst organisms for limiting resources. Examples of limiting resources: space, water, light, nutrients, food, mates)
4) **disease** - abnormal condition affecting the body of an organism (often causing lower survival and reproduction)

Abiotic factor: A nonliving component of an ecosystem/plant community that influences living organisms

<u>Six key abiotic factors that shape plant communities and ecosystems</u>:
1) **Temperature/heat** – (life can exist within a range of temperatures, and near

the extremes of this range many organisms cannot function.
The basis for this temp. range: At low temps molecular processes slow to critically low rates and cells rupture when they freeze; at high temperatures proteins denature and/or organisms can dehydrate. High temps also cause water to evaporate out of soils.

2) **Humidity** - water vapor in air
3) **Precipitation** – atmospheric water that falls due to gravity (rain, snow, hail, etc.)
4) **Light** – (can be limiting because **production** via photosynthesis requires light
5) **Edaphic:** of, produced, or influenced by soil. **Soil** - Upper layer of earth that contains minerals (sand, silt, clay) and organic matter and into which plant roots penetrate. (note: this is a simplistic definition…soil science is complex).
6) **Physical disturbance** (wind, fire, storm events, etc. that kill/inhibit organisms)

*Items 1-3, (and some of items 6) are contained in **climate**.
Climate: Average patterns in temperature, humidity, precipitation, wind and other variables over long periods of time. (contrast with **weather** = short term conditions/events)

*Items 1-2 (and soil moisture) are greatly influenced by the **aspect** of a slope, and plant communities are greatly influenced by slope aspect!
Aspect: The direction that an object (e.g., a hill/mountain slope) faces (here, North vs South).

*Items 1-4, and 6 are influenced, in varying degrees, by the **elevation** of a location. Elevation has many interesting impacts upon climate, weather, and physical disturbance- we'll explore these as we move along through the semester.

Elevation: The height of an object *attached to the Earth* above some fixed reference point, usually sea level.
--vs.--
Altitude: The height of an airborne object above some fixed reference point, usually sea level or the nearest Earth surface underneath the object.