Evolution

requirements of natural selection	variation, inheritance, variable survival/reproductive success	
homology	similar origin	bat/bird wings
analogy	similar structure	butterfly wings
apomorphy	derived, shared traits	
plesiomorphy	ancestral, shared traits	
autapomorphy	derived, unique	
synapomorphy	derived, shared in ancestry	
homoplasy	derived, found independently in tree	
stabilizing selection	intermediately favored, average (purifying)	
directional	extreme phenotype	
disruptive	2+ favored (diversifying)	
genetic drift	change in allele frequency due to chance	Founder-Bottleneck-
gene flow	movement of alleles between pops	migration, seed dispersal
hardy-weinberg	$p^2+2pq+q^2=1$	if mutation, non-random mate, small pop size, gene flow, natural selection

Macroevolution

pre-fertilization barrier	prevent fert	spatial, behavior, mechanical, temporal, gamete incompatibility
post	hybrid dies	hybrid sterility/inviable
speciation	form new species	
punctuated speciation	short bursts	
graduated	slow changes	

phylogeny

limitations of linnaean classifications	species may not be closely related, unrelated species placed together due to convergent evolution, related species separated, subject to reclassification if DNA indicates
monophyletic	full clade
paraphyletic	ancestral and some descendants
polyphyletic	not include most common ancestor
ingroup	species part of study

Plant History

470mya	origin from green algae
425mya	traits for life on land
385mya	first forests
challenges for land plants	limited water, structural support, reproductive techniques (wind/pollinators)
benefits	more sunlight, carbon dioxide, soil nutrients

Seedless Vascular (pteridophyta)

sporophyte	fertilization (diploid) visibly dominant	all seedless vascular (eg. ferns)
gametophyte	meiosis (haploid)	moss, liverwort
thallus	plant w/o leaf, stem, roots	
asexual repro	produce spores in sori, spores germinate	
sexual repro	prothallus produce eggs (archegonia) and sperm (antheridia), sperm fertilizes egg	

Seeded plants

characteristics	roots, stems, leaves, vasc tissue, sporophyte dom, reproduce by seeds	
benefits of seeds	embryo protection, food reserve for embryo, dormancy, dispersal	
benefits of pollen	plants are no longer dependent on water to transport sperm	
gymnosperm	naked seed, no flower/fruit, cones	cycadophyta, gingkophyta, gnetophyta, coniferophyta
fascicles	needle like leaf bundles (reduce stomata, need for excess photosynthesis)	
resin ducts	defend against predators	

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Seeded plants (cont)

angiosperm	vessels, seeds, fruits	300 families, 369400 species, dominated terrestrial environment for 100+ million years
monocots	one cotyledon, parallel veins, scattered vascular tissue, fibrous root, floral organs in 3s	
eudicots	two cotyledon, reticulate vein, ringed vasc tissue, taproot, flower organs in 4/5s	
pericarp	outer skin of flower (epi/meso/endocarps)	
simple fruit	apple	
aggregate	raspberry	
multiple	pineapple	
double fertilization	sperm (n) + egg (n) + nucleus (n) = 3n	

vascular plant anatomy

epidermis	waxy cuticle, guard cells, stomata, protective hairs, glands	
periderm	replaces epiderm	
parenchyma	thin walls	mesophyll (ground)
collenchyma	thick walls, flexible support	

vascular plant anatomy (cont)

sclerenchyma	thick walls w/ lignin for support (nonliving)	
xylem	water/-minerals (roots to leaves)	both dead: tracheids (long,-narrow) vessel elements (small,thick)
phloem	nutrients (leaves to roots)	sieve tube (sugars travel, living no nucleus) companion (helper)
indeterminate meristem	grow throughout life	
primary	height (apex)	
secondary	girth	
monocot root	distinct rings	
eudicot	star-like bundles	
root cap	zone of cell division, elongation, differentiation	
apical	dome shaped mass of dividing cells at shoot tip	
vascular cambium	secondary growth in xylem	woody plants
cork cambium	periderm	all gymnosperms, many eudicots

vasc plant transport

passive transport	high to low concentration	via phospholipid bilayer, aquaporins, transporters, or channel proteins
active	low to high	via proton pumps, transport proteins (carrier proteins)
long distance bulk flow	through xylem/-phloem	roots to shoots
apoplast	through cell wall	
symplast	through cytoplasm	
route	cortex via apo/sym, endodermis (checkpoint for selective passage), casparian strip (blocks apoplast transfer, to cylinder made of suberin)	
suberin	complex biopolymer found on inner face of primary cell walls	
gutlation	progressive absorption capacity in roots (root pressure)	
transpiration	evaporation of water from stomata	
adhesion/cohesion	creates water columns	

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vasc plant transport (cont)

tension	negative pressure created by evaporating water molecules	
guard cells	open/close to balance water conservation	
transl-ocation	movement of nutrients via actively loaded phloem (source to sink)	by pressure flow
source	leaves	
sink	flower	
auxin	growth, fruit development, slow leaf loss, cell division	
ehylene	ripen fruit	
absisic acid	shed leaves, seed dormancy	

fungi

45,000 known species, estimated 2/3 million	relatives to animals	
saprot-rophs	heterotrophs that obtain nutrients from organic material	
non-motile	grow toward food source	
mycorr-hizae	mutualism w/ plant roots	
mycelia	networks of branched hyphae adapted for absorption	maximizes surface:v-olume ration (long, skinny)

fungi (cont)

multin-ucleate hyphae	1- septate, 2 - coenocytic, 1/2 - pseudo	
cryptomyc-ota/micro-sporidions	parasitic, freshwater, marine, soil, closely related to fungi	
chytridom-ycota	1st to evolve, zoospores, freshwater/marine, decomp-osers, parasites, mutualists	
zoopag-omycota	nonflagellated spores, some endoparasites	
mucoro-mycota	zygospore fungi (fast growing molds, parasite, pathogens), mycorrhizal	arbuscular mycorr-hizae
ascomycota (sac fungi)	plant pathogens, decomp, symbionts (ascocorp = produce spores, conidi-ophores = branches)	8 spores per ascus
basidi-omycota	mushrooms (basidium, basidiocarp)	
mutualists	mycorrhizae, endophytes, lichen	

animals

protist ancestors (choanofl-agellates)	600 mya	
spicules	skeleton like structure pieces	
mesophyll	semi fluid matrix w/ amoeboid cells, produce spicules	
all chordates	notochord, dorsal hollow nerve cord, pharyngeal slits, post anal tail	
monotremes	hard shelled amniotic egg, milk from sweat glands (no nipples)	platypus
marsupial	true pouch w/ nipples	koala, opossum
epithelial	secrete, absorb, excrete, filter	simple (1 layer) stratified (multiple layer)
connective	loose (few fiber), fibrous (semi solid, many fibers), adipose, cartilage, bone (rigid matrix), blood	
muscular	skeletal, cardiac, smooth	

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animals (cont)

negative feedback	keep variable close to value (do opposite)	sensor, control center, effector
positive feedback	amplifies signal	clotting, labor contractions

ecology

organismal	individual	anatomy/physio/behavior
populations	group of individuals	pop size (how/why)
community	species	interactions
ecosystem	energy flow/chem cycling	
landscape	mosaic of ecosystems	controlling exchange
global	regional exchange	
global air circulation pattern	colling trade winds blow from E to W in tropics (deflection of wind from vertical paths near equator)	30 N/S desert (dry air descends), 60 N/S wet (air mass rise, release precipitation), poles dry/frigid
gyres	multiple currents working together	
biomes	vegetation, climate, physical (but not species)	
ecotone	area of transition between biomes	
type 1 curve	low death rates at birth	humans, elephants

ecology (cont)

type 2	constant death	squirrels, annual plants, lizards
type 3	high death rates at birth	fish, marine invert, long lived plants
semelparity	bing bang reproduction (once and then die)	annual plants
iteroparity	repeated reproduction	humans
exponential growth	J shaped (ideal)	
logistic	S (realistic)	
batesian	nonvenom pretends venomous	
mullerian	bad tasting	
aposematic coloring	indicate poison	
competetive exclusion principle	no 2 species using exact resources can coexist	
eco niche partition	separate role	
temporal	opposite schedules	
fundamental niche	ideal, wider area	
realized niche	w/ competitor, narrow	
character displacement	tendency of populations to diverge in characteristics when sympatric	different beak morphology
bottom up control	what they eat, affected by food at lower level	

ecology (cont)

top down	what eats them, affected by abundance of consumers at higher levels	
flow of energy	cannot be recycled	light
net primary production	amt available to consumers (1/2 of GPP)	
terrestrial primary production	most in tropics (moisture, sunlight, temp, nutrients)	
net secondary production	amt of emergy organism consumes/uses for growth	
assimilation	amt of energy organism uses for above+respiration	
energy transfer only 10% efficient		
movement corridors	connect fragmented habitats	
water cycle	enter by drinking/absorption, leave by evaporation, transpiration, peeing	
carbon	enter plants via photosynthesis, return by respiration, volcanoes, fossil fuels	

ecology (cont)		
nitrogen fixation	conversion of unusable nitrogen to NH4 and NO3	
assimilation	uptake of NH4 and NO3 by plants	
ammonification	N2 to NH3 to NH4	
nitrification	NH4 to NO2 to NO3	
denitrification	NO3 to N2	
phosphorus cycle	rock weathering adds PO4(-3) to soil, to plants, biomolecules to animals	
decomposition/excretion	phosphate returned to soil/water	
ecosystem services	natural ecosystems help sustain human life	purification, detox, nutrient cycling, moderating weather, organism interactions

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