Biology 115 Fall Final Review

Scientific Method

Observation

Hypothesis

Design experiment

Test hypothesis, analyze data

Share results/revise hypothesis

Shared characteristics between all organisms

DNA

Ability to reproduce

Homeostasis

Plasma membranes

Ribosomes

Metabolic pathways

Three main domains

Bacteria-peptidoglycan

Archaea-lacks peptidoglycan

Eukaryotes-membrane bound organelles

Biodiversity

Highest at equator

Wetter & warmer = more primary produces

History of Evolutionary Theory

Aristotle

Observation: cows/deer have multiple stomachs + weak teeth

Hypothesis: complex stomachs make up for lack of dental complexity

Conclusion: species are perfectly designed and unchanging through time

Al-Jahiz

Observation: a rat will eat any animal weaker than itself.

Hypothesis: The strongest animals survive to reproduce.

Conclusion: every weak animal devours those weaker than itself. Cycle of necessity for food and hunting.

George Cuvier

Observation: species persist unchanged in fossil record until they disappear.

Hypothesis: species become extinct, due to catastrophic event

Conclusion: Species exist in one form until an extinction event and don't change gradually from one form to another.

Jean Baptiste Lamarck

Observation: moles are blind, mammals have teeth, birds lack teeth

Hypothesis: environment gives rise to change in animals

Animals become more complex and "move up the evolutionary ladder" Transmutation of species.

Charles Lyell

Observation: certain species are found in geologic strata that were tied to warmer climate than is currently found in that place.

Hypothesis: Climate has changed over time.

Conclusion: Earth shaped by slow-moving forces that are still occurring today.

Charles Darwin

Observation: Closely related finches in Galapagos have a gradation in beak shape.

Hypothesis: One species had been taken and modified for different ends.

Conclusion: Biological traits become more or less common in a population as a result of the reproductive success of the organisms exhibiting these traits (Natural Selection)

Alfred Wallace

Observation: Geographical barriers often separate closely related species.

Hypothesis: Closely related species are never separated by great distances.

Conclusion: When closely related species are separated by some barrier, environmental pressures on variation within the species causes them to adapt to their local environment.

Charles Darwin

Observation: If enough offspring survive, species fertility allows population growth. Population remains roughly same size over time.

Hypothesis: Limited resources=struggle for survival within a species.

Observation: Individuals in a population vary significantly from one another and variation in inheritable.

Hypothesis: Individuals less suited to the environment are less likely to survive/reproduce. Individuals more suited to environment are more likely to survive/reproduce.

Conclusions: Populations change over time to adapt to their environment and these variations accumulate over time to form new species.

Gregor Mendel

Observation: Crossing white flowers with purple flowers yields only purple flowers, but breeding these offspring together results in a mix of white and purple flowers

Hypothesis: Hereditary units are either dominant or recessive.

Conclusion: Law of Segregation-each parent passes one copy of an allele to offspring, whichever copy is dominant is expressed.

R. A Fisher

Modern Synthesis

Genetic mechanisms and natural observations can explain all evolutionary phenomena.

Evolution is gradual: small genetic changes regulated by natural selection accumulate over long periods

Natural selection is main mechanism of change

Studying populations, rather than individuals, is key

Natural Selection

Natural selection-Non-random gradual process through which traits become more or less prevalent in population.

Adaptation-favored trait that survives through natural selection.

Fitness-potential for survival and reproductive success.

Genetic Drift

Genetic drift-Random; by change, some organisms have more offspring than others

Founder effect-Potion of genome lost, population rebuilds with survivors.

7 factors that contribute to genetic diversity:

Random mutations

Natural selection

Genetic drift

Gene flow-movement of individuals into population

Recombination

Sexual selection-non random mating

Genotype/phenotype interactions

Phylogenies

Monophyletic group-any group that contains a common ancestor and all descendants of that common ancestor.

Root-common ancestor (beginning)

Node-where a development changes the tree.

Clade-a group of organisms that are more closely related to each other than any other group, implying a shared most recent common ancestor.

Paraphyletic group-contains common ancestor and descendants

Polyphyletic group- descendants but no common ancestor.

Homologous trait-any feature shared by more than 2 species and a common ancestor.

Ancestral Trait-original form of trait possessed by common ancestor.

Derived Trait- new condition of trait

Symplesiomorphy- shared ancestral trait; found in 2+ organisms with original common ancestor

Synapomorphy- shared derived trait; found in 2+ organisms with most recent ancestor.

Speciation

Allopatric speciation-physical barrier separate two halves of population.

River through middle

Sympatric speciation-two different species forming for reason other than physical barrier. Species live in same area but are different.

Niche choice

Polyploidy

Disruptive Selection

Resource partitioning

History of Life on Earth

Fossil-preserved trait or remains of ancient organisms

Radiometric dating

Radioactive isotopes "decay" at a known rate

Alpha decay- alpha particle is lost

Beta decay- emitting an electron

Gamma decay- emit electromagnetic radiation; move to lower energy state

Half-life-the time it takes for ½ the atoms in a radioisotope to decay to a stable state.

Carbon-14 dating

Igneous rock-incursions into sedimentary rocks

Potassium-40

Uranium-238

Paleomagnetic dating-relates rocks to patterns in Earth's magnetic fields.

Ferromagnetic rocks cool in lava=bands point in direction of magnetic field.

Plate techtonics- geophysics of major land movement

Mass extinctions

Ice Age

Volcanoes

Meteorite Impact

Behavior

Behaviors can have genetic basis

Selective breeding

Gene knock-outs

One mutation can cause change

Individual behaviors can be shaped by natural selection

Behavior itself within a species can be modified through natural selection

Communication

Olfactory

Pheromones-odorants used for communication; chemical compound secreted or excreted that triggers social response within a species

Alarm Signal Pheromones

Insect leaves pheromone to indicate danger/caution

Territorial (food marking)

Ants to mark trail for food

Sex pheromones

Rats; female rats secrete pheromone that physiologically changes them for a period of time.

Vomeronasal Organ-flehmen response (facilitates transfer of pheromones to vomeronasal organ).

Visual Signals

Bioluminescence/Color Changing

Gestures

Pecking beak of parent bird for food

Primate use head and arm gestures

Body position-wagging tail, pressure

Acoustic Signals

Alarm call-pure tone, travels distance, hard to localize

Territorial call-cover broad frequency range, temporal structure-localize

Mating call-broad frequency range, temporal structure-localized

Transfer of information

Learning and Intelligence

Habituation- decrease in behavior due to repeated stimuli

Sensitization-increase in behavior due to repeated stimuli

Mating Systems & Social Behavior

Polygamy (promiscuity)

Polyandry- 1 female with multiple males

More offspring diversity; sperm competition ensure reproductive success

Polygyny- 1 male, multiple females

Female defense polygyny-males cluster females into herds to protect them

Resource defense polygyny-male defends territory where females live

Polygynandry- 2 or more males consistently breeding with 2 or more females

Monogamy (1 male, 1 female)

Social monogamy-social behavior, shared territory, proximity of male & female

Sexual monogamy- exclusive sexual relationship between 1 male and 1 female

Genetic monogamy- DNA analysis to confirm all offspring are related to each other. DNA evidence of monogamy. 1 male and 1 female exclusive reproduction.

Territoriality & Mate Choice

Territorial behavior- behavior used by animals to actively deny other animals access to habitat or resources.

Obtain resources necessary for reproductive success

Resource defense polygyny

Males set up and defend territory with good resources, females choose

Female defense polygyny

Males defend females from other males; keep females together in a group

Not necessarily female choice

Lekking

Males gather to engage in communal displays or territorial defense

Females choose

Inter vs. Intra selection

Intersexual selection- physical traits

Intrasexual selection- physical strength

Intro to Ecology

5 levels at which Ecology can be studied

Organism-individuals and immediate environment

Population-group of individuals of same species and local habitat in which they live

Community-interlacing populations of different species and particular geographic area in which they interact

Ecosystem-interacting communities and abiotic environment

Abiotic factors

Atmospheric conditions

Weather

Climate

Temp

Ppt.

Humidity

Wind direction/speed

Seasonality

Length of day

Latitude affects photoperiod, temp, ppt. patterns

Global Air Circulation

Solar energy

Earth's rotation

Speed of rotation

Global Ocean Currents

Position of continents, water temp, water density

Topography

Variation in elevation of Earth's surface

Influences velocity of water flow, ppt. patterns, temp., pressure, light penetration, oxygen concentration.

Nutrient Cycles

Nitrogen Cycle

Majority of Nitrogen gas in atmosphere

Excess of Nitrogen runoff from land into ocean

Can be dangerous bc increased nutrients increases producers, increases bloom of algae/cyanobacteria which is negative bc using more Oxygen than can produce

N fixation by bacteria ammonification by bacteria and fungi nitrification by bacteria to No2- nitrification by bacteria to NO3- denitrification by bacteria

Water Cycle

Saltwater 97.5%

Freshwater 2.5%

Glacier & permanent snow cover- 68.9%

Groundwater- 30.8%

Lakes of Rivers 0.3%

Water in oceans evaporation into atmosphere ppt. to ground flora & fauna underground aquifers seepage, springs ground water storage

Carbon Cycle

Carbon-life's energy currency

Primary producers convert inorganic carbon into carbohydrates through photosynthesis

Four main storage centers for carbon:

Atmosphere

Terrestrial biosphere

Deep ocean vents

Soil sediments

CO_2 in atmosphere taken in by photosynthesis, stored in plant biomass (some lost in respiration) and some stored in animals. CO_2 stored in soil units, some stored/put back into atmosphere by microbial respiration and decomposition. Some CO_2 stored as fossil fuels. A lot of CO_2 stored in ocean sediments (deep ocean).

Trophic Levels

Trophic level- position organisms holds in a food chain

Autotrophs-make own food

Heterotrophs- organisms that consume other organisms for food.

Herbivores-eat primary produces

Omnivores- eat plants and animals

Carnivores- eat animals

Detritivores- convert dead plant/animal matter from organic to inorganic compounds

Biomass Transfer Efficiency

Organisms only convert up to 10% of chemical energy from food into energy stored as body tissues.

Every time energy moves up a trophic level, it loses 90% of energy (from previous level)

Need 10 primary producers to support one herbivore (primary consumer)

Need 10 primary consumers to support one secondary consumer (carnivore)

Net Primary Productivity

NPP- rate per unit area at which an ecosystem creates primary producers

Can be estimated by measuring differing wavelengths of light reflected from Earth's surface

Heat, sunlight, temperature, ppt. , soil nutrients affect NPP

Terrestrial NPP

Highest around equator

Varies with temp. and ppt.

Increases with increasing temp.

Increases with increasing ppt. up to a certain point, then decreases

Aquatic NPP

Coastline

Highest NPP occurs in areas with nutrients runoff from land

Population Ecology

Population will grow or decline exponentially as long as environment experienced by all individuals in population remains constant

Life history strategies—time course of growth, development, reproduction, death for average individual.

Survivorship- fraction of individuals that survive from birth to different life stages

Type 1 survivorship-high juvenile survival, most mortality occurs among other individuals

Type 2 survivorship- individuals die at equal rates, regardless of age

Type 3 survivorship- high juvenile death rate, low mortality among the other ages

How population grow overtime

Additive growth-add a known, constant # of individuals per time

Multiplicative growth-constant multiple of population per time.

Density Dependence- population growth slows as population increases

Logistic growth- initially exponential growth, as density increases, growth levels off bc an increase in population density leads to a lack of resources

at carrying capacity- population is at equilibrium; # of individuals supported indefinitely (as long as no major changes w/I environment occur)

Life History Classification

r selection-based on per capita rate of increase

strongest in species colonizing new/disturbed habitats

high levels of disturbance lead to ongoing 'r' selection

disturbance-mechanism/process that limits plants by destroying plant biomass

approximates type III survivorship-high juvenile mortality, high adult survivorship

k selection- based on carrying capacity of logistic growth equation

Favors more efficient use of resources

Most prominent where species population are near carrying capacity most of the time

Found in fairly constant/predictable environments

Shows either Type I or Type II selection

r vs. k selection

Population Attribute	r selection	k selection
Intrinsic rate of increase	High	Low
Competitive ability	Not strongly favored	Highly favored
Development	Rapid	Slow
Reproduction timing	Early	Late
Body size	Small	Large
Offspring	Many, small	Few, large
Examples	Deer mouse	Elephant

Life History Strategies pt. 2

Opportunistic (r selection)- maximize colonizing availability across unproductive environments

Low juvenile survival

Low #'s of offspring

Early reproductive maturity

Equilibrium- steady level of reproduction when resources are abundant or stable

High juvenile survival

Low #'s of offspring

Late reproductive maturity

Periodic- take advantage of infrequent periods favorable for reproduction

Low juvenile survival

High numbers offspring

Late maturity

Urban Ecology

Abiotic Factors

Water-availability, cleanliness

Air quality- sources of pollution: cars, factories, electricity

Light availability- light pollution; effect on wild animals

Weather- severe weather affects urban areas differently than undeveloped areas

Climate- changing climate changes energy and water use realities of urban areas

Biotic Factors

Vegetation

Non-native plantings

Habitat fragmentation-bottle neck effect

Domesticated animals

Waste disposal

Feral dog packs

Effects of cats on bird populations

Wildlife

Specialist vs. Generalists

Specialist- selected, competitive

Generalists- good at breeding

Spread of disease

Human/wildlife conflict

Physiological Ecology

Endothermy- use of mainly metabolic heat to raise body temperature

Change amount of heat in body by insulation

Birds, mammals

Physical thermoregulation

Requires:

Efficient supply of oxygen

Widespread and consistent food supply

Ability to obtain and process food quickly & efficiently

Insulation to prevent heat loss

Pros	Cons
Independence from temperature extremes, both temporal & spatial	Requires more & higher quality food & water
Dispersal into new (colder) environments	Endothermy is energetically "expensive"
Extension of activity (nocturnal)	90% of the energy taken in is used for heat production <10% of energy assimilated is available for growth and reproduction

Ectothermy-gain heat from external source

Use behavior to thermoregualte

Sunning

Usually most active during warm parts of day

Some nocturnal ectotherms

Pros	Cons
Lower cost/strategy to live: lower metabolic rate, require less food than endotherms	Activity constrained by fluctuating temp.
20% energy used for thermoregulation 80% for growth and reproduction	Slower response time when cold
Able to inhabit some environments not open to endotherms	Most can't survive very cold environments
Less need for water; can inhabit more arid climates	

Vertebrates response to changing environment temperature

Behavioral

Cold: seek warmer place, increase activity, increase insulation, increase food intake

Heat: seek shade, decrease activity, decrease insulation

Physiological

Cold: increase metabolic rate, shivering, piloerection, vasoconstriction, non-shivering thermogenesis

Heat: panting, sweating, vasodilation