Classification, Biodiversity and Conservation

	eukarya	bacteria	archea
nucleus	nucleus presents	no nucleus	no nucleus
DNA arrangement	linear chromosomes with histone proteins	circular DNA without histone proteins	circular chromosomes with histone proteins
plasmid	chloroplast and mtDNA is circular	plasmids often present in cytoplasm	plasmids often present in cytoplasm
ribosome	80s ribosomes in cytosol; 70s ribosomes in chloroplast and mitochondria	70s ribosomes in cytosol	70s ribosomes, small subunits similar to eukaryotic ribosomes, base sequence of rRNA and primary structure of ribosomal protein is similar to eukaryotic ones
cell wall	in plant: cellulose; in fungi: chitin	always present: peptidoglycan	always present but do not contain peptidoglycan
cell division	cell divides by mitosis	cell divides by binary fission	cell divides by binary fission
organelles	contain membrane bound structure: RER, SER, Golgi body, mitochondria, chloroplast, lysosome, centrosome, microtubule	no membrane bound structure	no membrane bound structure
organization	multicellular and unicellular colonies	unicelluar, small groups of cells (blue algae)	unicelluar, small groups of cells
reproduction	asexual reproduction (yeast) and sexual reproduction(gametes)	asexual reproduction	asexual reproduction
membrane	made of phospholipid	made of phospholipid	membrane lipids are unique, they are different from prokaryotes and bacteria

	Animalia	Plantae	Fungi	Protoctista
organization	multicellular higher level of differentiation	multicellular higher level of differentiation	unicellular (yeast) multicellular	mostly unicellular small groups of cells
cell wall	not present	present, made of cellulose	present, made of chitin	some present (algae)
cilia& flagella	some present (ciliated cell, sperm)	some present (male gametes in fern contains flagella)	not present	always present
chloroplast	not present	present	not present	some present (algae)
nutrition	heterotrophic	autotrophic	heterotrophic	heterotrophic, autotrophic (algae)
reproduction	sexual reproduction	asexual, sexual	asexual, sexual	asexual, sexual

- Classification
  - species
    - a group of organisms with similar
      - morphological features
      - physiological features
      - biochemical features
      - behavioral features
    - can interbreed and produce fertile offsprings
    - are reproductively isolated from other species
  - three domains
    - eukarya
    - bacteria
    - archea
  - taxonomic hierarchy
    - domain
    - kingdom
    - phylum
    - class
    - order
    - family
    - genus
    - species
  - four kingdoms
    - animalia
    - plantae
    - fungi
    - protoctista
  - viruses
    - structure
      - capsid (protein musk)
    - genetic material
      - DNA
        - dsDNA
          - T4 bacteriophage
        - ssDNA
          - canine parro virus type II
      - RNA
        - dsRNA
          - morbillivirus: measles
        - ssRNA
          - HIV

- Biodiversity
  - ecosystem
    - a relatively self-contained interacting community of organisms, and the environment in which they live and with which they interact
    - an ecosystem in a global perspective — biosphere
    - the location where the organisms live within the ecosystem — habitat
    - the role of an organism in an ecosystem — niche
    - all of the organisms of the same species present in the same place and same time — population
    - all of the organisms of different species living in an ecosystem — community
      - grass → grass hopper → pigeon → stray cat
  - the variation of organisms which can be assessed at level
    - species diversity
      - the number of different species in the ecosystem and their relative abundance
      - the ecosystem with higher species diversity are more stable than those with lower species diversity as they are more resilient to environmental changes
        - rainforest
        - coral reef
    - habitat diversity
      - the number and range of ecosystem and habitats
    - genetic diversity
      - the genetic variation within each species
  - random sampling
    - using quadrats
      - Mark the Study Area: Define and mark the boundaries of the area you want to study.
      - Choose Quadrat Size: Select an appropriate size for the quadrat frame
      - Randomly Select Quadrat Locations: Use a random number generator to pick coordinates within the study area where quadrats will be placed.
      - Place Quadrats: Place the quadrat frame at each selected location.
      - Count Organisms: Within each quadrat, count the number of each species of interest and record the data.
      - Analyze Data: Calculate the species diversity, percentage cover and species frequency of each species per quadrat to estimate their abundance in the entire area.
    - mark-release-recapture method
      - target: mobile organisms
      - steps
        - develop a method to cature the organisms without harming them
        - mark the captured organism
        - release the captured organisms
        - wait for long time toallow the individuals to mingle with the population
        - set up the trap to capture the species again
        - estimate the number of species in the area
      - $N = \frac{M \times C}{R}$
        - N = estimated population size
        - M = number of individuals marked in the first sample
        - C = total number of individuals captured in the second sample
        - R = number of marked individuals recaptured in the second sample
    - line/ belt transect
      - line transect
        - steps
          - line transect help to show how species distribution changes with physical condition in the area
          - layout a measuring tape in a straight line across the sample area
          - record the identity of the organism at equal distance along the tape
      - belt transect
        - given that species density in different attitude
        - place quadrats ar regular interval along the tape and record abundance of each species within each quadrats
    - Simpson's index of diversity
      - measure number of different species in an area but also the evenness of abundance across the different species
      - used to quantify the biodiversity of an area
      - $d = 1 - \left(\sum \left(\frac{n}{N}\right)^2\right)$
        - D represents Simpson's Diversity Index.
        - n denotes the total number of organisms of each species.
        - N is the total number of organisms of all species within the community.
      - if D1>D2, then the species diversity in habitat I is greater than species diversity in habitant II
  - correlation
    - scatter graph
      - there is a relationship between two variables
      - best fitted line
    - correlation coefficent (r)
      - the gradient of the best fitted line
      - -1<r<0: negatively correlated
      - r=0: no correlation
      - 0<r<1: positively correlated
    - Pearson's linear correlation
      - determines whether there is a linear correlation between two variables
      - citeria: quantitative data; normal distribution
      - if r is close to 1, then the two variables are positively correlated
      - if r is close to -1, then the two variables are negatively correlated
      - if r is equal to 0, then there is no correlation
      - $r = \frac{\sum xy - n\bar{x}\bar{y}}{(n-1)S_x S_y}$
        - **r** = correlation coefficient
        - **x** = no. of species A
        - **y** = no. of species B
        - **n** = no. of readings
        - $\mathbf{S_x}$ = standard deviation of species A
        - $\mathbf{S_y}$ = standard deviation of species B
        - $\bar{x}$ = mean no. of species A
        - $\bar{y}$ = mean no. of species B
    - Spearman's rank correlation
      - determine whether two variables are correlated
      - citeria: the data does not follow normal distribution
      - null hypothesis: there is no correlation betweeen the two variables
      - $r_s = 1 - \left(\frac{6 \times \sum D^2}{n^3 - n}\right)$
        - r_s = spearman's rank coefficient
        - D = difference in rank
        - n = number of samples
      - if rs>critical value, there is a correlation between the two variables,then the null hypothesis can be rejected, meaning there is a correlation between two variables

- Conservation
  - extinction
    - climate change
      - green house gases → global warming → change in disturbution of terristial ecosystem
      - organisms migrate to cooler latitude or high attitude
      - rise of sea level leads to higher competition between species
      - temperature of sea rises → coral reefs are sensitive to temperature and pH value → coral bleaching
      - the frequency of natural catastrophes increase
    - loss of habitat
      - deforestation
      - conversion of wetland for agriculture
    - waste products of houses
      - industrial pollution
        - SO2
          - combustion of fossil fuels
          - change pH of soil
          - few animals can survive and reproduce in acidic environment
        - plastic
        - detergent containing P and N → eutrophication
        - air conditioner and fridge: CCl2F2 → ozone layer to disappear
        - printing
        - dye
    - overexploitation of resources
      - sea otters are hunted for their furs
      - decrease in number of sea otter lead to explosive increase in sea urchius
      - sea urchins eat through storms of help forest
      - keystone species: species that play a central role in a ecosystem
    - invasive alien species
  - reasons to maintain biodiversity
    - moral and ethical reasons — human have no right to drive other species to extinction
    - ecological reasons
      - the higher biodiversity is, the less likely
      - the ecosystem becomes unbalanced by changes in environment
    - economical reasons — eco-tourism
    - aesthetic reasons — poems, photographs and paintings
    - agricultural reasons — uniform genotypes
      - low genetic diversity
      - maintain the biodiversity to keep potential useful alleles from the wild plant
      - seed banks
    - environmental reasons
      - plant absorb CO2 — reduce the effect of increasing CO2 in the atomsphere
      - bacteria/ fungi decompose — break down organic substances into inorganic substance and maintain carbon cycle, nitrogen cycle and phosphate cycle
  - methods of conservation
    - endanger species — a species that is close to extinction
    - general rule
      - keep in nature habitat — if the ecosystem is still available
      - captured and placed in captivity — the habitat is lost or extremely dangered
    - conserved areas
      - natural park/ reserve — without human access, industrial activity, hunting
      - marine parks — prevent overfishing and pollution
    - zoos and botanic gardens
      - zoos
        - functions
          - provide invaluable resources for research — study behaviors, gentic and habitat
          - assisted reproduction
            - In vitro fertilization (IVF)
              - fertilization of eggs occurs outside of the female egg
              - steps
                - extract eggs from the ovaries using a needle and collect sperms from the males
                - the semen is mixed with the eggs in a petri dish
                - fertilization occurs zygotes form and develop into embryos
                - embryos are cultured for a couple days
                - the embryos are then transferred to the mother or a surrogate mother
                - embryo transfer can avoid the risks of pregnancy for the vulnerable female so that she can provide many eggs for multiple offspring
            - artificial insemination — inject semen into the uterus of a female
          - educate the publics about endangered species
          - fundraise for endangered species
          - reintroduce the endangered species into the habitats
        - problem with zoo
          - animals become habituated to the zoo environment
          - captive breeding reduces genetic diversity — cause inbreeding depression
          - some animals do not breed in capativity
      - botanic gardens
        - establish a population of the endangered plant species collected from the wild
        - function
          - research reproduction and growth in different plant species research on the restoration of the habitats for the species
          - educate the public, raise awareness of the endangered species
      - frozen zoos and seed bank
        - function of frozen zoos
          - store eggs, sperm or embryos at very low temperature (-196 degree celsius)
          - store material can be used for IVF and genetic engineering
        - function of seed bank
          - store the plant species in dry and low temperature environment
          - maintain gene pool
          - to conserve endangered species
    - invasive alien species
      - a species that has moved to an ecosystem where it was previously unknown
      - impact on ecosystem
        - decline in predators
        - decline in preys
        - competition between invasive species and native species that occupy a similar niche
        - decrease in biodiversity
      - impact on human
        - on economy
        - carry pathogens and infect humans
    - conservation organization
      - CITES
        - the convention on international trade in endangered species of wild flora and fauna
        - a global agreement signed by 150 countries
        - to control the trade of endangered species and their products
        - there are three appendices
          - appendix I
            - speices that are endangered or facing extinction
            - regulation: all trades in the species or its products are prohibited
          - appendix II
            - species are not currently endangered, but will be unless trade is regulated
            - regulation: only granted if an export permits
          - appendix III — permits are required for regulate trade
      - IUCN
        - the international union of the conservation of nature
        - assess the conservation status of animals and plants
        - red list: endangered species
      - purpose of them
        - raise awareness to the public
        - fundraising for research of endangered species
        - ban illegal hunting and trading of endangered species