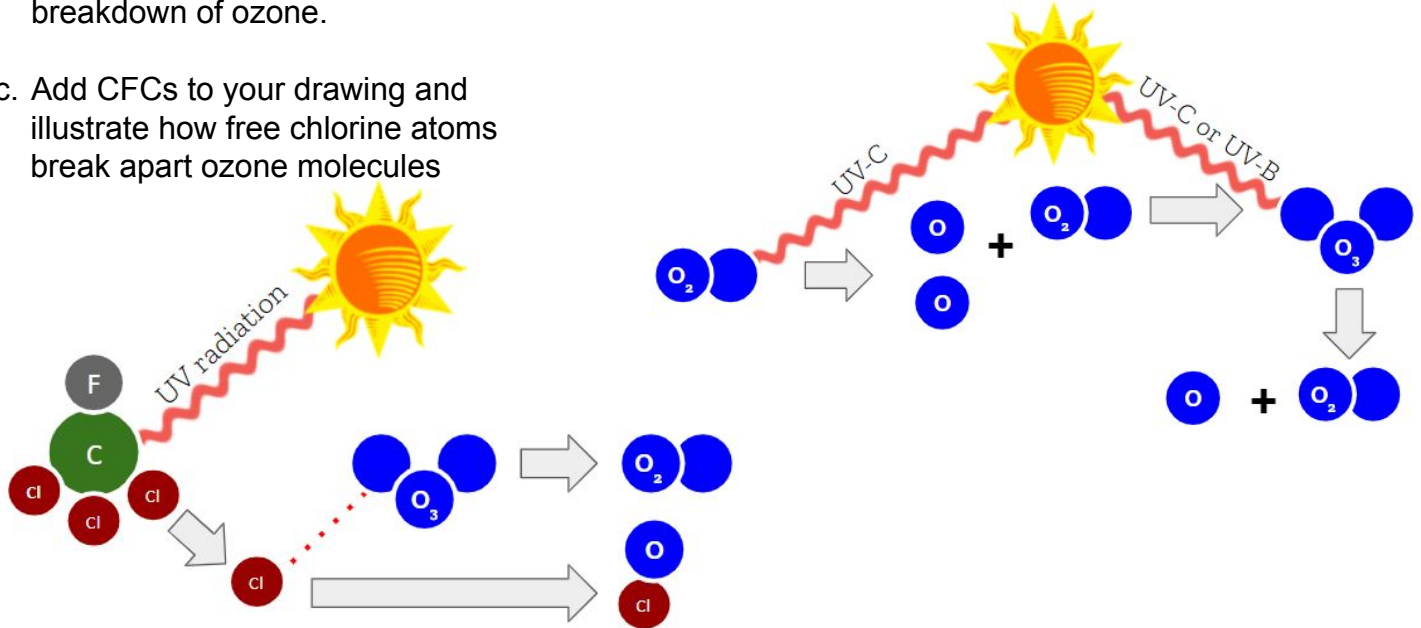


### 9.1 & 9.2 - Stratospheric Ozone Depletion & Reduction of Depletion

- a. **Identify** a specific human health consequence of exposure to UV-B and UV-C radiation and **Describe** how stratospheric ozone protects humans from these forms of radiation **DNA mutation, skin cancer, cataracts** | **stratospheric ozone absorbs energy from UV-B and UV-C radiation, breaking down into O<sub>2</sub> and a free oxygen atom**
- b. Draw out the process of UV-B and UV-C radiation driving the formation of ozone and then the breakdown of ozone.

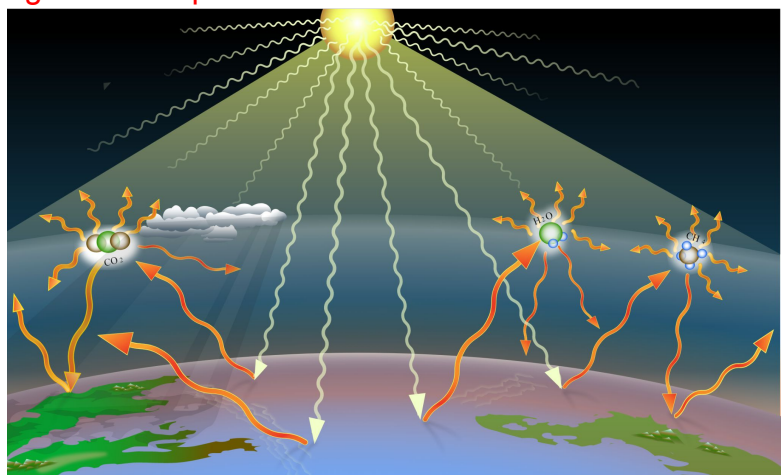
- c. Add CFCs to your drawing and illustrate how free chlorine atoms break apart ozone molecules



- d. **Describe** the purpose of the Montreal Protocol **to transition from CFC use to HCFC use in order to preserve the stratospheric ozone layer**
- e. **Identify** the two environmental benefits of transitioning from CFCs to HFOs **less depletion of stratospheric ozone and less contribution to global warming**

### 9.3 - The Greenhouse Effect

- a. **Describe** how greenhouse gasses warm earth's atmosphere **infrared radiation (heat) released by/emitted from earth's surface is absorbed by greenhouse gasses and then emitted/reradiated back down toward earth's surface, warming the atmosphere**
- b. Draw a picture of the greenhouse effect, demonstrating how  $\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{H}_2\text{O}$  warm earth's atmosphere



# APES Unit 9 Ultimate Review Packet (9.3 - 9.5)

## 9.3 - The Greenhouse Effect (cont.)

- c. **Explain** why water is considered a greenhouse gas, but not considered a major contributor to climate change **water vapor absorbs infrared radiation and reradiates or emits it back down toward earth's surface, but because it has such a short residence time in the atmosphere and is constantly cycling through via the water cycle, it does not have a significant contribution to climate change**
- d. **Define** the term Greenhouse Warming Potential (GWP) and **identify** the two factors that are used to determine the GWP of a given molecule **GWP refers to the ability of a greenhouse gas to contribute to atmospheric warming over a 100 year period, relative to carbon dioxide. The two factors that it accounts for are residence time of the molecule in the atmosphere and its ability to absorb infrared radiation**
- e. **Explain** how the GWP of methane would be determined. **The GWP of methane would be determined by measuring how much infrared radiation it can absorb, relative to CO<sub>2</sub> and how long it remains in the atmosphere, relative to CO<sub>2</sub>.**

## 9.4 - Increase in Greenhouse Gasses

- a. **Identify** and **explain** TWO reasons that sea levels rise as global atmospheric temperature increases **atmospheric warming transfers heat to the oceans, causing thermal expansion, or an increase in the distance of water molecules from each other, raising sea level | atmospheric warming causes glacial and polar ice to melt, contributing runoff into the oceans that increases total ocean volume and raises sea level**
- b. **Describe** one ecological consequence of sea level rise for coastal ecosystems **increase in salinity of estuary ecosystems (resulting in loss of species intolerant to salinity increase), flooding of estuary/coastal ecosystems and conversion to open ocean, increased depth and decreased light penetration in shallow coastal ecosystems like the coral reef**
- c. **Describe** one economic consequence of sea level rise for coastal communities **property damage due to increased flooding, increased insurance premiums, loss of groundwater due to salt water intrusion, cost of relocating inland, cost of building sea walls/other barriers to rising waters**
- d. **Describe** how global warming may result in an increase in the impacts of infectious disease **as global climate warms, the range for disease vectors such as mosquitoes is projected to increase, exposing new regions to the diseases they can transmit**

## 9.5 - Global Climate Change

- a. **Explain** why Earth has experienced a fairly consistent pattern of global climate change over the past 800,000 years **consistent variation in Earth's orbit around the sun (obliquity, eccentricity, axial precession) has exposed Earth to periods of more direct and less direct solar radiation, causing a consistent pattern of global climate change**
- b. **Identify** TWO pieces of evidence scientists have used to measure historic temperature and CO<sub>2</sub> concentrations of Earth's atmosphere over the past 800,000 years and **describe** how one of these pieces of evidence is used to determine either historic atmospheric temperature or CO<sub>2</sub> level **fossil records of foraminifera can be used to determine atmospheric temperature as they have specific, known temperature tolerances which can indicate temperature during the period of time they became fossilized | air bubbles contained in ice cores contain the same concentration of CO<sub>2</sub> as Earth's atmosphere at the time the ice layers were formed | the ratio of O<sup>16</sup> to O<sup>18</sup> in ancient ice core samples can indicate temperature of Earth's atmosphere when those layers of ice formed since warmer temperatures lead to more O<sup>18</sup> isotope formation**

## APES Unit 9 Ultimate Review Packet (9.5 - 9.6)

### 9.5 - Global Climate Change (cont.)

- c. **Identify** TWO reasons that Earth's poles have warmed more than other regions on Earth and **Explain** one of these factors **the thermohaline circulation redistributes equatorial heat out toward the poles via surface ocean currents moving poleward from the tropics | positive feedback loop of melting polar ice, causing more dark ocean water surface to absorb more sunlight and convert it to more heat, which melts even more polar ice**
- d. **Explain** how melting tundra permafrost generates a positive feedback loop that contributes to global warming **as Earth's atmosphere warms, permafrost in the tundra melts, releasing methane stored beneath it due to anaerobic decomposition of organic matter, which in turn contributes to the greenhouse effect and warms the planet more, causing more permafrost melting and more methane release**
- e. **Explain** how melting polar ice generates a positive feedback loop that causes more warming **melting of polar ice decreases the amount of sunlight reflected from polar regions and exposes more dark/low albedo ocean water beneath it, which absorbs more sunlight, causing more polar warming and melting of more ice**
- f. **Identify** TWO ecological consequences of rising sea level in coastal regions **flooding or loss of barrier islands leading to coastal erosion, increase in salinity of estuary or low-lying freshwater coastal wetlands, decreased photosynthesis in coral reef ecosystems, flooding of estuary ecosystem causing loss of habitat/breeding grounds**
- g. **Explain** how melting of polar ice sheets can disrupt thermohaline circulation **melting of polar ice contributes cold, freshwater to the ocean, which remains at the surface because freshwater is less dense than saltwater. This cold, freshwater mass doesn't sink and contribute to surface-deep ocean water mixing and can prevent warmer surface water currents such as the Gulf Stream from moving poleward**
- h. **Explain** how atmospheric circulation in the Hadley Cell has been altered by climate change **Hadley Cell circulation has expanded further out from the equator/poleward due to the decrease in difference between tropical and polar temperature**
- i. **Describe** how climate change has destabilized the polar jet stream **the decrease in temperature/pressure difference between subtropical and polar regions has weakened the path of the jet stream, causing greater variability/fluctuation in its latitudinal position**

### 9.6 - Ocean Warming

- a. **Describe** one way that ocean warming has caused migration of marine organisms **since warmer waters hold less dissolved oxygen, many species of fish have migrated deeper/poleward to colder waters with more dissolved oxygen**
- b. **Describe** how ocean warming has disrupted reproduction of marine organisms **some sea turtle species have lost coastal hatching grounds as ocean warming causes sea level to rise, some sea turtle species have experienced skewed sex-ratios because hatchling gender is temperature dependent in these species**
- c. **Describe** the mutualistic relationship between coral and algae **coral provide organic matter/nutrients/CO<sub>2</sub> to the algae and the algae provide sugars which the coral use for energy**
- d. **Explain** the process of coral bleaching **as ocean temperatures rise above the range of tolerance for the algae living in the reef, they leave/are expelled from the reef, causing the reef to lose its color and placing the coral in a stressed state due to loss of the sugar (energy) algae were providing**

# APES Unit 9 Ultimate Review Packet (9.7 - 9.8)

## 9.7 - Ocean Acidification

- Identify** the main cause for ocean acidification **an increase in atmospheric CO<sub>2</sub> concentration**
- Write out the chemical equation that demonstrates the formation of carbonic acid in the ocean  
$$\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \text{ (carbonic acid)}$$
- Write out the chemical expression that demonstrates how the formation of carbonic acid in the ocean increases the concentration of H<sup>+</sup> ions in ocean water  
$$\text{H}_2\text{CO}_3 \rightarrow \text{H}^+ + \text{HCO}_3^- \text{ (bicarbonate ion)}$$
- Explain** how ocean acidification impacts shell-building or exoskeleton-building marine organisms **ocean acidification causes a decrease in the availability of free carbonate ions in ocean water, which makes it more difficult for organisms to build/maintain calcium carbonate shells/exoskeletons**
- Identify** the relationship between oceanic CO<sub>2</sub> concentration and ocean pH **inverse relationship - as oceanic CO<sub>2</sub> concentration increases, ocean pH decreases**
- Describe** what a lower pH value indicates about the acidity and ion concentration of a solution **the lower the pH of a solution, the more acidic it is and the greater the concentration of H<sup>+</sup> ions**

## 9.8 - Invasive Species

- Describe** how an invasive species is defined **a species that can survive outside of its native habitat and threatens/outcompetes native species**
- Identify** TWO characteristics that make a species more likely to become invasive **Diverse habitat/food adaptability or ability to utilize wide range of food/habitat resources (generalist species), high biotic potential/rate of reproduction, quick to reach sexual maturity (r-selected species), aggressive/competitive feeder**
- Identify** the means of introduction and **explain** one ecological impact of a specific invasive species **zebra mussels entered the Great Lakes in the ballast water of large ships and are transported to inland lakes and rivers by small recreational boats. They aggressively feed on algae, decreasing turbidity of water but also competing for this key food source | kudzu vine was introduced as an erosion control species, especially in the Southern US. It grows extremely rapidly and climbs over native vegetation, blocking sunlight from reaching it | Cane toads were introduced in Australia to control cane beetle populations that were damaging sugarcane crops. They rapidly reproduced and outcompeted native amphibians and small reptiles for food sources**
- Describe** TWO methods humans can use to control the spread of invasive species **laws that prohibit the transport of firewood from regions known to be infected with wood-boring insects, thinning stands of trees/removing dead or diseased trees from forests infested with fungal or insect disease, removal/cleaning of aquatic invasive species off boats transported between inland rivers/lakes, physical removal of invasive plants and re-establishment of natives**
- Describe** an economic consequence of invasive species **lost tourism revenue if flora/plants in an ecosystem are damaged by disease, lost fishing profits/recreational fishing revenue if native fish populations are decreased by invasive species, lost agricultural/timber products if invasive insects/pathogens damage crops/trees, cleanup cost of removing invasive species**

# APES Unit 9 Ultimate Review Packet (9.9 - 9.10)

## 9.9 - Endangered Species

- a. **Identify** TWO characteristics that make a species more likely to become extinct **narrow food/habitat requirements (specialist species), slow rate of reproduction/few offspring at a time (K-selected species)**
- b. **Describe** TWO environmental or ecological factors that can make a species more likely to become extinct **introduction of an invasive species can increase competition for resources and make a species more prone to extinction, rapid ecosystem change (temp, rainfall, drought, etc.) can make a species more likely to become extinct, competition from other native species for food, water, or habitat resources may cause a species to become extinct, global climate change leading to rapid habitat loss**
- c. **Describe** a human action that can reduce the likelihood of a species becoming extinct **establishment of wildlife refuges/preserves to protect a species from human disruptions, captive breeding programs to re-establish wild populations, listing of species as endangered which enables: purchasing land critical to their habitat needs to prevent development/loss of habitat, monitoring and restricting their trade/hunting, more strict laws/penalties for illegal poaching of endangered species**
- d. **Describe** a piece of legislation that can be used to protect invasive species in the United States **Endangered Species Act protects endangered species by allowing the EPA to purchase & protect habitat/breeding grounds of endangered species, prevents trade/poaching/hunting/harvesting of endangered species, and to re-establish original population sizes of endangered species**
- e. **Describe** an international agreement that can be used to protect invasive species **CITES (Convention on the International Trade of Endangered Species) is an international agreement by many countries to monitor and prevent the trade of endangered species**

## 9.10 - Human Impacts on Biodiversity

- a. **Identify** the 6 major causes for declining biodiversity using the acronym HIPPCO
  - H - **habitat loss**
  - I - **invasive species**
  - P - **population growth (humans)**
  - P - **pollution**
  - C - **climate change**
  - O - **overharvesting/overhunting**
- b. **Identify** TWO anthropogenic causes of habitat loss **deforestation for timber/agriculture/development, urbanization, draining wetlands for development, mining, construction of dams, removing coastal wetlands for aquaculture/tourism access/development**
- c. **Describe** how habitat fragmentation occurs and **explain** one consequence it can have for a population **roads/pipelines/agriculture/urban sprawl can segment once continuous habitat stretches into smaller patches/islands. This can reduce gene flow/genetic diversity in the population by making populations smaller, can make it difficult for large territorial animals to have sufficient hunting areas or to find mates, can intensify the edge effect which increases exposure to competition with other species/contact with human disturbances**
- d. **Propose a solution** to reduce the effects of habitat fragmentation **habitat corridors/wildlife overpasses/tunnels that allow members of a population to move between habitat fragments**
- e. Explain one reason that human population growth can lead to biodiversity loss **increased human population leads to: more agricultural land which leads to deforestation/hab. loss, more FF consumption which leads to more CO<sub>2</sub> emissions and a more rapid rate of climate change**

## APES Unit 9 Ultimate Review Packet (9.10)

### 9.10 - Human Impacts on Biodiversity (continued)

- e. *(continued)* Explain one reason that human population growth can lead to biodiversity loss  
increased human population leads to: more mining of metals/FFS which leads to habitat loss, more need for homes and urbanization which leads to habitat loss
- f. **Identify** a specific pollutant and **explain** how it leads to a loss of biodiversity pesticides from agricultural runoff can kill/cause gender imbalances in aquatic populations, fertilizers in agricultural runoff/CAFO waste/untreated sewage/organic enrichment can cause eutrophication leading to decline in dissolved oxygen in aquatic ecosystems and loss of aquatic species, PCBs/DDTs/methylmercury can biomagnify in food chains and cause cancer/birth defects in the populations of top predators,  $\text{NO}_x/\text{SO}_x$  can lead to acid rain which can decrease population sizes of sensitive aquatic and terrestrial species
- g. **Identify** and **explain** a specific way in which climate change contributes to a loss of biodiversity climate change causes shifting/shrinking of biomes which can decrease population sizes of species dependent on those biomes or cause extinction if they can't adapt or migrate quickly enough, climate change causes sea level rise which floods coastal ecosystems such as mangroves/salt marshes/coral reef and decreases populations of species that depend on these ecosystems for habitat/breeding grounds, climate change causes ocean warming which decreases dissolved oxygen/leads to coral bleaching, global climate causes melting of polar ice which decreases habitat for polar species causing their populations to decline or become extinct, global climate change shifts precipitation patterns which can cause some regions to become too dry to support plant species which causes loss of these species/consumers that depend on them
- h. **Explain** how overharvesting of a species can decrease biodiversity or cause extinction of the species harvesting a species at a rate faster than it can repopulate/reproduce will cause the population size to decrease, which decreases genetic diversity and can put the species at risk of extinction (smaller gene pool is more susceptible to additional disruptions like habitat loss, climate change, disease, invasive species)
- i. **Describe** how human food production has caused a decrease in biodiversity organisms that are used by humans as food sources have become domesticated and experienced a decline in species diversity/genetic diversity, expansion of agricultural land has caused a decline in biodiversity due to clearing land which causes habitat loss for native species, application of pesticides to agricultural crops causes death in non-target species and decreases their population sizes/genetic diversity