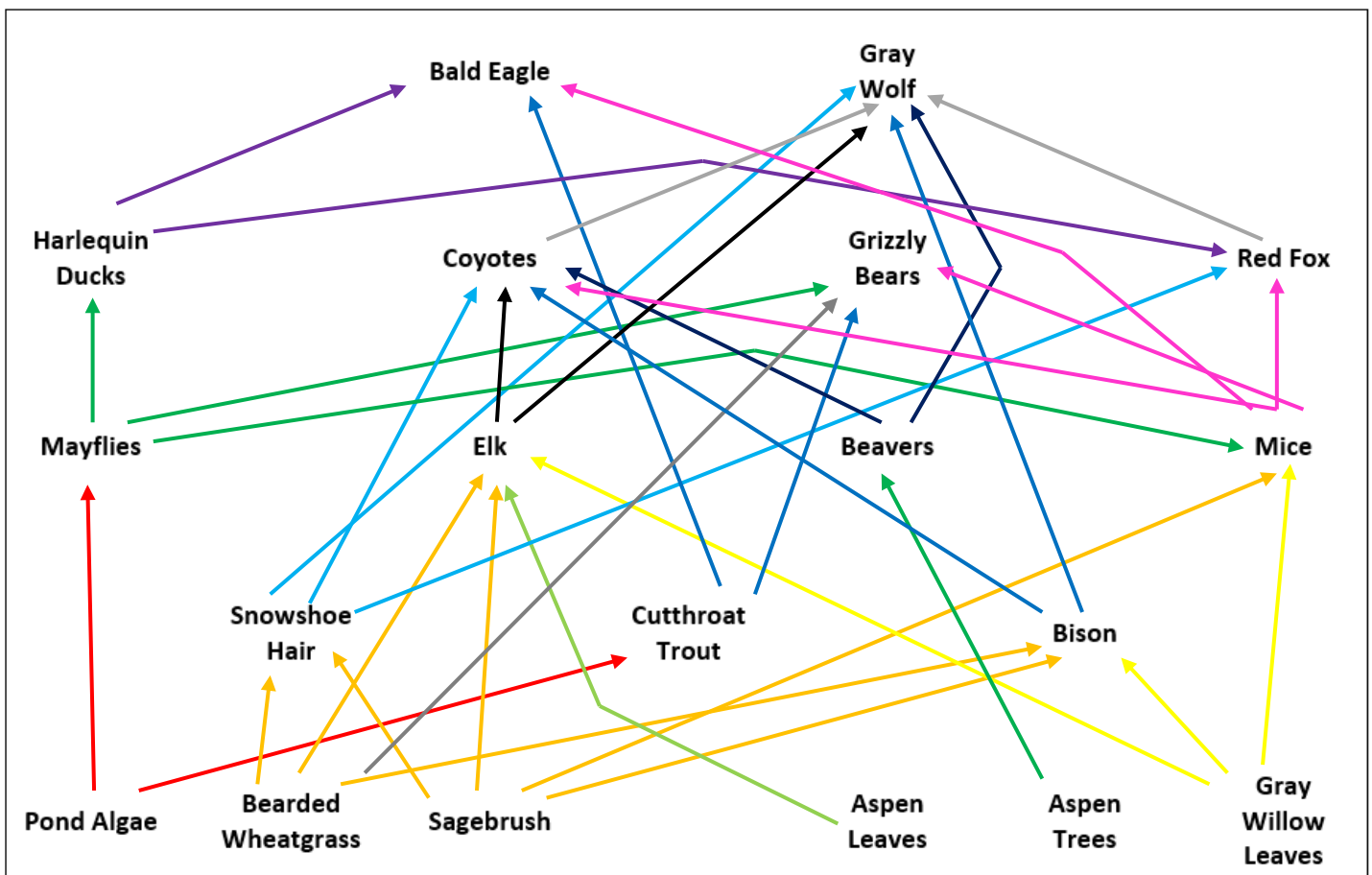


AP - Ecology Packet 2026-2027

**Use chapters in Ecology at openstax.org to complete
Food Web**

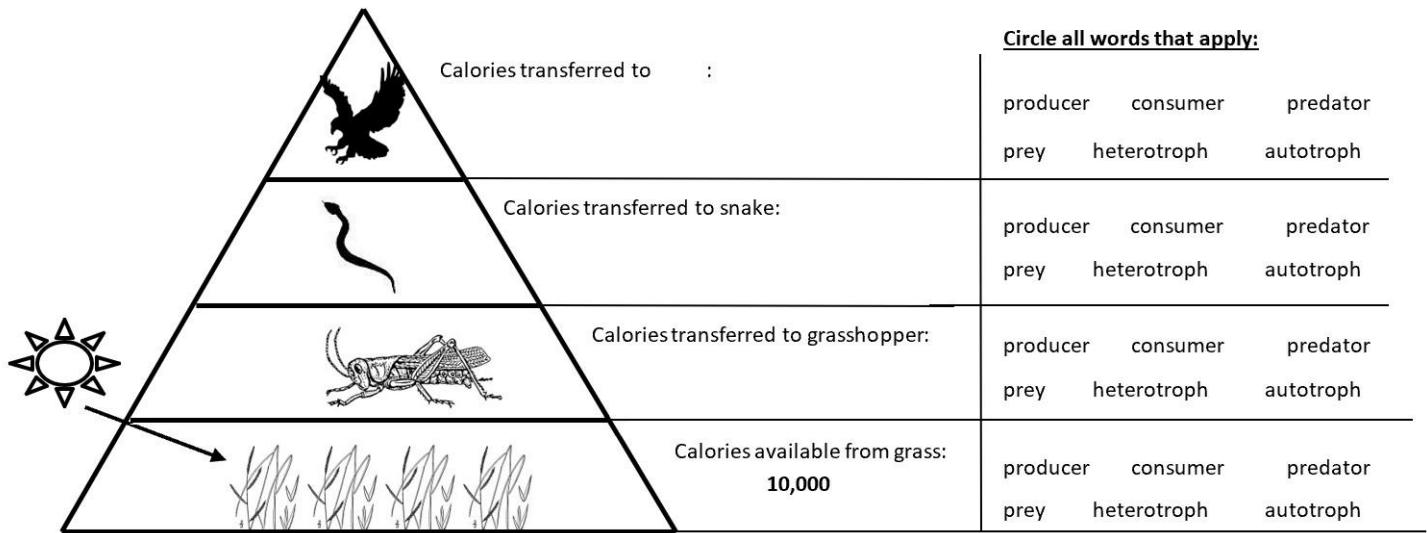
Directions: Food webs use arrows to show predator-prey relationships. In each relationship, the arrow points to the predator. Write a “P” next to the Producers. Write a “H” next to each Herbivore. Write a “C” next to each Carnivore. Write a “O” next to each Omnivore.

- a. Pond algae is eaten by mayflies and cutthroat trout.
- b. Bearded wheatgrass and sagebrush are eaten by elk, bison, snowshoe hares, and mice.
- c. Gray willow leaves are eaten by mice, elk, and bison.
- d. Aspen trees are eaten by beavers. The leaves are eaten by elk.
- e. Mayflies are eaten by harlequin ducks, grizzly bears, and mice.
- f. The snowshoe hare is eaten by coyotes, gray wolves, and red foxes.
- g. Cutthroat trout are eaten by bald eagles and grizzly bears.
- h. Beavers are eaten by coyotes and gray wolves.
- i. Harlequin ducks are eaten by red foxes and bald eagles.
- j. Mice are eaten by coyotes, red foxes, grizzly bears, and bald eagles.
- k. Elk and bison are eaten by coyotes and gray wolves.
- l. Gray wolves may also feed on coyotes and red fox.
- m. Grizzly bears sometimes eat bearded wheat grass.



Food Web Questions:

1. What's the difference between a food chain and a food web?
2. Why are the arrows always drawn from the prey towards the predators?
3. The four plants and algae at the bottom of your food web are the only organisms that do not have any arrows pointing at them. What is their source of energy?
4. If you were to take a walk through a part of Yellowstone National Park, which level of the food web would you expect to see the most of? Least of? Why?
5. One trophic level not shown on this food web is the decomposer. These organisms, which include bacteria, fungi, and some invertebrates, eat dead and decomposing organic matter. If you were to draw a decomposer on this food web, what arrows would be pointing to it?



Circle all words that apply:

producer consumer predator
prey heterotroph autotroph

producer consumer predator
prey heterotroph autotroph

producer consumer predator
prey heterotroph autotroph

producer consumer predator
prey heterotroph autotroph

Density Dependent vs. Density Independent Factors

Directions: Read each of statement below involves a situation that will affect the growth of a population. Classify each of the statements as D (density dependent factors) or I (density independent factors).

Description	Type
6. A severe flood brings a lot of sediment and silt into Lake Winnipeg. The turbidity of the lake increases greatly.	
7. A drought decreases the water level in Lake Winnipeg. The carrying capacity of the lake decreases.	
8. Due to the introduction of rainbow smelt, Lake Winnipeg becomes crowded and some fish species do not survive.	
9. Since northern pike prey on yellow perch, an increase in the perch population causes an increase in the pike population.	
10. Many fish die due to an increase in water temperature.	
11. Due to over-fishing, the number of walleyes in Lake Winnipeg decreases.	
12. A population is growing quickly when parasites cause disease to spread quickly.	
13. Since lake sturgeon migrate long distances to spawn, many do not survive the trip.	
14. Competition among ferns for space to grow on the forest floor.	
15. A population of field mice increases after a farmer leaves his field unharvested for a season.	

Response to Stimulus

Directions: Read each description, identify the stimulus and response, and write one word in the box.

Description	Stimulus	Response
16. A prairie dog spies a hawk and squeals a warning.		
17. Plants grow towards the light.		
18. Pill bugs will move towards dark, cool, damp locations (Note: Movement is called taxis; directed movement is kinesis).		
19. Plant secretes a foul-tasting and foul-smelling chemical when broken (bitten).		
20. Birds sing to attract a mate and to identify their territory.		
21. Orange and red coloration in animals usually warns of poison or toxins.		
22. I hear a rattling sound when on a hike, freeze, identify the source (snake), and move slowly away.		
23. A stegosaurus spots a T-rex in the distance and starts swinging its thagomizers (tail spikes) rapidly.		

Invasive vs. Keystone

Directions: Read each description and mark it as "I" for Invasive or "K" for Keystone.

Description	Type
23. Kudzu was introduced to the United States in 1876 at the Philadelphia Centennial Exposition. It was promoted as a forage crop, an ornamental plant, and a check on erosion. It can grow up to a foot a day allowing it to easily outcompete and kill other plants including trees and shrubs.	
24. Gray wolves in the Greater Yellowstone Area were eliminated by 1924 due to concerns about elk, bison, and livestock. Their absence caused elk populations to surge, leading to overgrazing and a decline in plants vital to beavers, fish, and birds, disrupting the ecosystem.	
25. The European crab, transported by ships and sold as bait, has spread to coasts around the world, including North and South America, Australia, South Africa, and Japan. It preys on shore animals like worms and mollusks, and in some areas, has harmed local ecosystems and shellfish industries.	
26. Sea stars were the primary predators of mussels and barnacles in the ecosystem. Without their control, mussels dominated the area, crowding out other species and eliminating benthic algae, which led to the collapse of snail, limpet, and bivalve populations that depended on the algae.	
27. Sea otters are influential to aquatic environments because of their feeding habits. Kelp is allowed to flourish which leads to absorption of high amounts of CO ₂ , preservation of the organisms which rely on kelp for survival, as well as protecting coastlines.	
28. Native to Papua New Guinea and parts of Australia, the brown tree snake was accidentally introduced to Guam after World War II. It has decimated native bird populations on the island, leading to the extinction of several species.	
29. On African grasslands, elephants play a vital role in shaping the landscape and supporting other species. They feed on shrubs and trees, often knocking down large ones, which prevents the area from turning into forest. This helps preserve the open grassland ecosystem.	
30. Cane toads, native to Central and South America, were brought to Australia in the 1930s to manage pests in sugarcane fields. They have since spread throughout the country, poisoning native predators and disturbing local ecosystems.	

Survivorship Curves

Directions: Read each description and identify the survivorship category and circle the correct number.

Species	Types		
Humans: Typically experience low death rates early in life, with an increase in mortality as they age.	I	II	III
Birds: Experience a relatively steady rate of mortality throughout their lifespan.	I	II	III
Trees: Face high mortality rates in early stages, with only a few surviving to maturity.	I	II	III
Fish: Exhibit high mortality early in life, with only a few individuals reaching adulthood.	I	II	III
Squirrels: Experience a fairly consistent mortality rate throughout their life.	I	II	III
Elephants: Have low mortality during their early years, but mortality increases as they age.	I	II	III
Butterflies: Suffer high mortality early in life, with only a few surviving to reach adulthood.	I	II	III
Bears: Generally experience low mortality in early life, but face higher mortality as they get older.	I	II	III
Frogs: Have high early-life mortality, with only a small percentage reaching maturity.	I	II	III
Grasshoppers: Experience high mortality in early life, with few individuals surviving to adulthood.	I	II	III









Symbiotic Relationships

Directions: Read each description, identify how each species is affected, and then identify which relationship is being described (Parasitism, Mutualism, Commensalism, Predation, Competition).

31. Coyotes and Foxes are predators that eat the same species in the same area. Fights for land among these two species occur frequently.						
Coyotes: + / - / 0	Foxes: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
32. Marine creatures sometimes outgrow their shells leaving them on the ocean floor. Hermit crabs inhabit these empty shells which provides them with protection and shelter, while the previous inhabitant is no longer using the shell.						
Marine Creatures: + / - / 0	Hermit Crabs: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
33. Tapeworms are segmented flatworms that attach themselves to the insides of the intestines of animals such as cows, pigs, and humans. They get food by eating the animal's partly digested food, depriving the host of nutrients.						
Tapeworm: + / - / 0	Mammals: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
34. A wolf is a natural environmental carnivore. The wolf can hunt as a pack or as an individual. A pack of wolves can bring down and eat a whole moose.						
Wolf: + / - / 0	Moose: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
35. One particular type of fungus attaches itself to ants' bodies as they forage for food. These ants unknowingly transport the fungus to fungus gardens located in the ant colony that serve as food for the ants. The fungus then takes over and destroys the garden.						
Fungus: + / - / 0	Ant: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
36. Male Horned Rams will fight with each other for the right to mate with females. The rams will run and slam their horns together until one gives up.						
Rams: + / - / 0	Rams: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
37. Acacia ants inhabit the Bullhornacacia (a type of tree). The ants obtain food and shelter, and the acacia depends on the ants for protection from browsing animals, which the ants drive away. Neither member can survive successfully without the other.						
Ants: + / - / 0	Tree: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
38. Mycorrhizal fungi grow on plant roots and help the plant absorb water and nutrients. The plant provides the fungi with sugars made during photosynthesis.						
Giraffe: + / - / 0	Zebras: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
39. A Remora fish attaches itself to a shark so it can eat the scraps of food left by the shark. It does not harm the shark when it attaches.						
Fish: + / - / 0	Shark: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
40. Honey Guide birds show the badgers where the beehives are. The badgers rip open the hives and eat the delicious honey. Afterwards, the Honey Guide birds eat.						
Birds: + / - / 0	Badgers: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition
41. Different plants and animals are harvested to make the different parts of the cheeseburger. Plants are used to make the bread, milk and other ingredients are used to make the cheese, cows are used to make the beef patty. Humans eat a cheeseburger.						
Plants/Animals: + / - / 0	Humans: + / - / 0	Parasitism	Mutualism	Commensalism	Predation	Competition

Population Distribution

Directions: Analyze each photo, determine what type of population distribution the species follows, and write down the answer in the space provided. (Random, Uniform, Clumped)

<p>Elk</p> 	<p>Brush</p> 	<p>Flowers</p> 	<p>Spiders</p> 
<p>42.</p>	<p>43.</p>	<p>44.</p>	<p>45.</p>
<p>Trees</p> 	<p>Birds</p> 	<p>Penguins</p> 	<p>Elephants</p> 
<p>46.</p>	<p>47.</p>	<p>48.</p>	<p>49.</p>

Ecology Vocab

Directions: Circle the vocabulary term that includes all of the rest.

50.	Trophic Level	Food Web	Food Chain	Arrow
51.	Parasitism	Commensalism	Mutualism	Symbiosis
52.	Organism	Ecosystem	Population	Community
53.	Omnivore	Consumers	Carnivore	Herbivore
54.	Producers	Plants	Algae	Bacteria
55.	Ecosystem	Biotic Factor	Biosphere	Abiotic Factor
56.	Grasslands	Biome	Rainforest	Boreal Forest
57.	Evaporation	Precipitation	Water Cycle	Transpiration
58.	Low Temperature	Little Rainfall	Tundra	Permafrost
59.	Community Ecology	Invasive Species	Symbiosis	Keystone Species
60.	Abiotic Factors	Biomass	Biodiversity	Ecosystem

Simpson's Diversity Index

Directions: Complete the following problems using the equation: $D = 1 - \sum \left(\frac{n}{N}\right)^2$

Students are not required to memorize this formula but must know the meaning of the symbols:

D = diversity index

Σ = the sum of

N = total number of organisms of all species found

n = number of individuals of a particular species

Calculate the Diversity Index for each location and determine which has a higher value.

61. An area of the Black Forest in Germany contains 134 pitch pines, 24 Douglas firs, and 53 red pines.

62. Mindo (a city in Ecuador) has 832 toucans, 392 red headed barbets, 3 golden headed quetzals, 500 tanagers, 899 parrots, and 50 white capped dippers.

Exponential vs. Logistic Growth

N = Population size	r = growth rate of population	K = Carrying Capacity	dN/dt = growth rate of population
Exponential Growth: $dN/dt = rN$	Logistic Growth: $dN/dt = rN \frac{(K - N)}{K}$	$r = (\text{Births} - \text{Deaths})/N$	

Directions: Read each question below carefully, determine the correct equation to use, and calculate for the variable being asked for in the question. Show your work.

63. A population of 20 velociraptors has 4 babies in one breeding season. However, 2 of the older velociraptors die off due to old age. What is the growth rate of this population of velociraptors?

64. A population of 100 mice has a growth rate of 0.2.

a. In an exponential growth environment, what is the population growth rate for this population?

b. What if the population of mice had a carrying capacity of 1000?

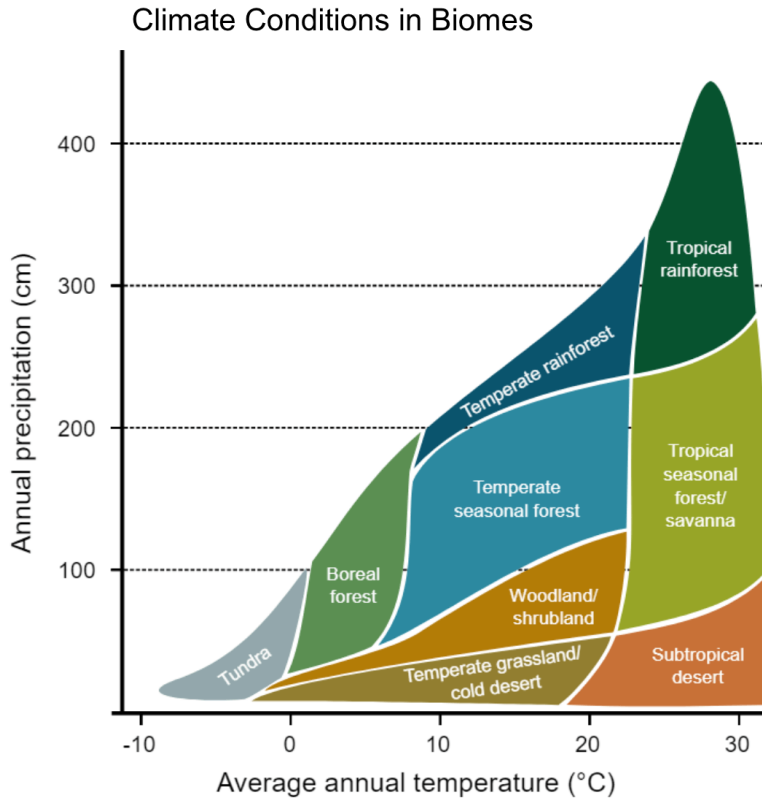
65. A population of 500 mice live in a similar environment. They also have a growth rate of 0.2.

a. In an exponential growth environment, what is the population growth rate for this population?

b. What if the population of mice had a carrying capacity of 1000?

Biomes

Directions: Read each question and use the graph to write down an answer.



66. What is the highest average annual temperature that would be found in a grassland biome?
67. What is the range (lowest and highest) of annual average temperatures for a temperate grassland biome?
68. What is the lowest average annual precipitation in a tropical rainforest biome?
69. What is the range (lowest and highest) of annual average precipitation in a boreal forest biome?
70. What is the highest average annual precipitation and temperature in the subtropical desert biome?
71. Which biomes can have both an annual average precipitation of less than 200 cm precipitation and a temperature below 5°C?
72. Which biome has the widest range of annual temperature?

Energy Data

Directions: The table below lists the average amount of energy (KJ/m²/year) in different organisms that people use for food. Calculate the average and the standard error of the mean for the producers and consumers. Make a bar graph to compare the relative amounts energy in each organism. Use one color for producers and another color for consumers.

Organism	Type	Energy (KJ/m ² /year)
Milk (cow)	Consumer	1,800
Eggs (chicken)	Consumer	840
Chicken	Consumer	800
Pork (pig)	Consumer	800
Beef (cow)	Consumer	550
Fish	Consumer	8
Cane sugar	Producer	14,650
Beet sugar	Producer	8,300
Potatoes	Producer	6,700
Corn	Producer	6,700
Apples	Producer	6,300
Rice	Producer	5,200
Oranges and grapefruits	Producer	4,200
Peanuts	Producer	3,850
Peaches	Producer	3,800
Carrots	Producer	3,400
Wheat cereal	Producer	3,400
Other vegetables	Producer	840

Answer the following:

73. What is the average energy and standard error of the mean for the producers?

74. What is the average energy and standard error of the mean for the consumers?

75. Which organisms (producers or consumers) can offer more energy (on average)?

76. Do you think it is more efficient for people to eat plant products or animal products? Why?

Ecosystem Energy Problems

Directions: Read each question carefully, calculate the answer, and show your work. (Remember the 10% rule)

77. A wolf in a simple food web feeds on elk and rodents, which feed on plant material.

- a. The ecosystem in takes $600,000 \text{ kcal/m}^2/\text{year}$. If this ecosystem covers approximately $10,000 \text{ m}^2$. What is the total energy (kcal) supplied to wolves within the ecosystem over a year period?

- b. A single wolf can survive on $120,000 \text{ kcal/year}$. How many wolves can be supported in the ecosystem?

Energy Pyramid Problems

Directions: Read each problem, calculate your answer, show your work, and circle your answer.

78. In a wetland environment, there is $20,810 \text{ kcal/m}^2/\text{year}$ captured by producers. In the primary consumer, $3,368 \text{ kcal/m}^2/\text{year}$ moved to the next trophic level. In the secondary consumers, $383 \text{ kcal/m}^2/\text{year}$ was taken in. The tertiary consumers took in $21 \text{ kcal/m}^2/\text{year}$.

- a. Draw the Energy Pyramid for the ecosystem.
- b. Calculate the ecological efficiency of each trophic level.
- c. If there were $5,060 \text{ kcal/m}^2/\text{year}$ of decomposers in this ecosystem, what would be the total biomass?

Chi Square Problem

A population of wildflowers exists in three color variants: red, pink, and white. Researchers hypothesize that bees preferentially visit certain flower colors, potentially affecting reproductive success and allele frequencies over time. To test this, they planted an equal number of red, pink, and white flowers in a field and observed the number of bee visits over a day. The scientists collected data on the number of visits per flower color (in the table below). Calculate if there is a preference for flower color by the bees using the chi-square equation.

Observed Number of Bee Visits:			
Flower Color	Red	Pink	White
Number of Visits	50	90	60

Null Hypothesis:

Alternative Hypothesis:

χ^2 Value =

Degrees of Freedom =

Critical Value =

Probability level (alpha)						
df	0.5	0.10	0.05	0.02	0.01	0.001
1	0.455	2.706	3.841	5.412	6.635	10.827
2	1.386	4.605	5.991	7.824	9.210	13.815
3	2.366	6.251	7.815	9.837	11.345	16.268
4	3.357	7.779	9.488	11.668	13.277	18.465
5	4.351	9.236	11.070	13.388	15.086	20.517