AP Biology - Math Review
Basics: There are many basic math skills that you must be able to do to work the more complex math problems in AP Biology. Don't screw up on the basics.
1. Working with decimals, ratios, fractions and percentages
2. Convert scientific notation to standard numbers
3. Report your answer with the number of significant figures that the question requires

PROBLEMS
1) **Two heterozygotes produce 345 offspring**
   What is your expected phenotypic ratio?
   How many individuals are expected to have the   dominant phenotype?
   How many individuals are expected to have the recessive phenotype?

2) In this genetic cross **Aa x aa** there are 714 offspring
   How many individuals are expected to have the dominant phenotype?
   How many individuals are expected to have the recessive phenotype?

3) In a dihybrid cross between two heterozygotes, if you have 360 offspring, what are your expected values?
   Both dominant phenotypes
   One dominant; one recessive
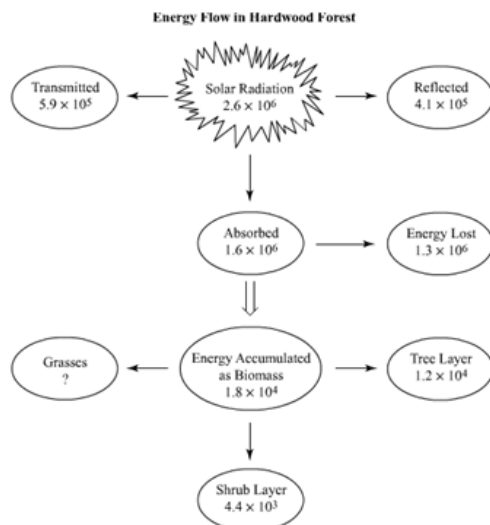   One recessive; one dominant
   Both recessive phenotypes

4) **The following data was observed; fill in the missing values.**

Stage of the Cell Cycle	Number of Cells in each stage	% of Cells in each stage
Interphase	62	
Prophase	31	
Metaphase	12	
Anaphase	8	
Telophase	4	

What percentage of the cells listed above are in mitosis?

Energy Flow in a Hardwood Forest
What percentage of the biomass in the forest community represented is tied up in the grass layer which has a question mark? Give your answer to the nearest whole number.

Energy Flow in Hardwood Forest

Solar Radiation 2.6×10^6
Transmitted 5.9×10^5
Reflected 4.1×10^5
Absorbed 1.6×10^6
Energy Lost 1.3×10^6
Grasses ?
Energy Accumulated as Biomass 1.8×10^4
Tree Layer 1.2×10^4
Shrub Layer 4.4×10^3

5) What percentage of the biomass in the forest community is tied up in the grass layer? **Give your answer to the nearest whole number.**
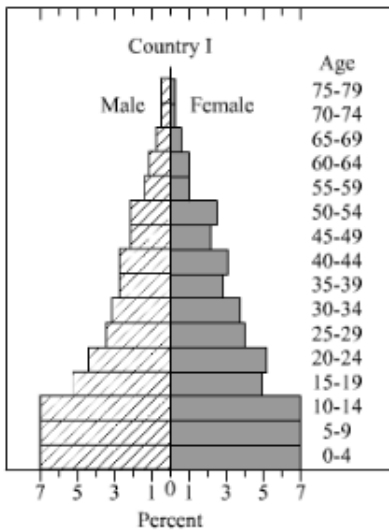
Here is a food pyramid that begins with producers and ends with tertiary consumers. If the producer level contains 25,000 kJ of energy and this pyramid follows the 10% rule, then how much energy gets transmitted to the tertiary consumers?

Tertiary Consumer: Hawk

Secondary Consumer: Frog

Primary Consumer: Grasshopper

Producer: Green Plant
25,000 kJ
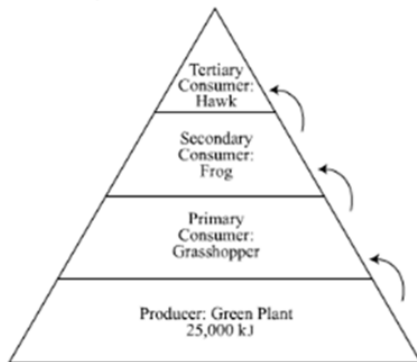
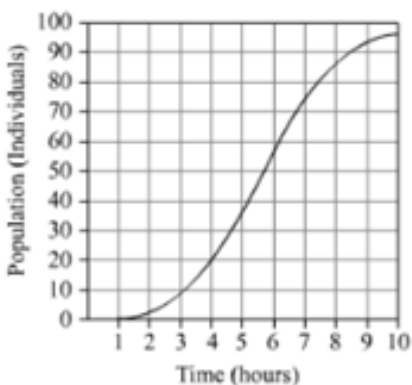6) How much energy gets transmitted to the tertiary consumers?

7)

Study this age structure diagram that shows the human population for India. What percent of the population is under 20?

Country I

Male   Female

Age
75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
0-4

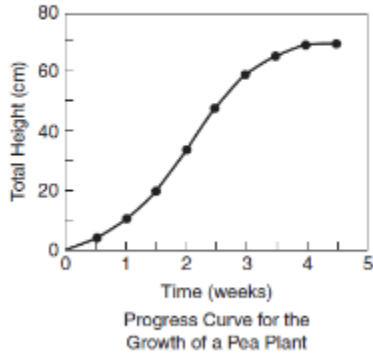7   5   3   1 0 1   3   5   7
Percent

8) What is the rate of change (individuals per hour)?

Population Growth
Use the graph below to calculate the mean rate of population growth (individuals per hour) between hours 6 and 9. Give your answer to the nearest whole number.

Population (Individuals)

100
90
80
70
60
50
40
30
20
10
0

1 2 3 4 5 6 7 8 9 10
Time (hours)

Progress Curve for the
Growth of a Pea Plant

9) The graph shows the growth in cm of a pea plant over a period of 5 weeks. What was the mean growth rate per day between week 1 and week 3? Give your answer to the nearest tenth.

Increase in Atmospheric Carbon Dioxide Concentration at Mauna Loa, Hawaii and Average Global Temperatures
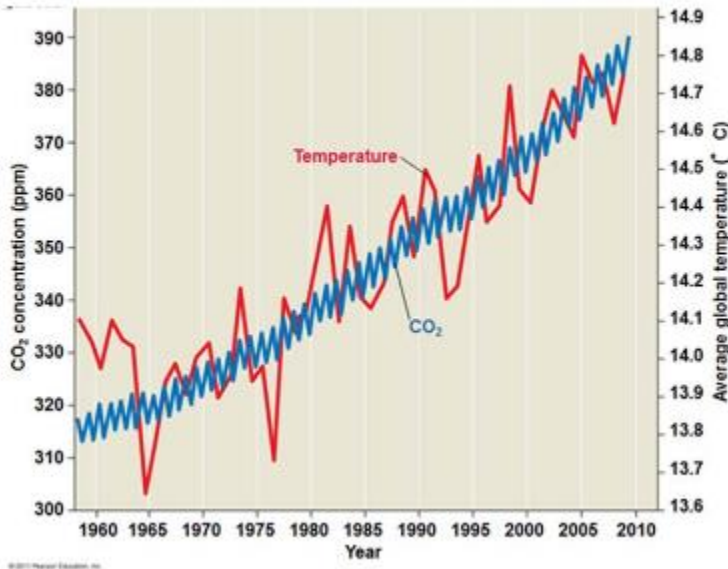
10) Examine the data.
(a) Calculate the rate of increase in CO2 production from 1974
(b) What will be the approximate CO2 concentration in 2100?

Hardy-Weinberg Problems-

11) The allele for the hair pattern called "widow's peak" is dominant over the allele for no "widow's peak". In a population of 100 individuals, 91 show the dominant phenotype.
What is the frequency of the dominant allele?
What is the frequency of the recessive allele?
How many individuals would you expect to be heterozygous for the trait?

12) The ability to taste PTC is due to a single dominant allele (T). You sampled 215 individuals in biology and determined that 150 could taste PTC and 65 could not. How many individuals are each of the three possible genotypes?

3

13) In a population of robins in which the allele for dark head plumage is dominant to the allele for light head plumage, a cold winter leads to the selection against lighter head plumage. When the winter is over, 8% of the remaining birds exhibit light head plumage. If the population is now in Hardy-Weinberg equilibrium, what will be the frequency of the light head plumage in the next generation? Give your answer to the nearest tenth.

14) In a certain population of deer on Fire Island, NY, the allele for a black spot behind the eye is dominant to the allele for no spot. After the hunting season, the percent of deer with no black spot is 17% and the population is in Hardy-Weinberg Equilibrium. What is the frequency for the allele for having no black spot, to the hundredths?

Combine Hardy-Weinberg expectations with Chi Square Analysis

15. In a certain species of flowering plant, the red allele R is dominant to the white allele, r. A student carried out a cross between a red flowered plant and a white flowered plant. When planted, the 158 seeds that were produced from the cross matured into 92 plants with red flowers and 66 plants with white flowers. Calculate the chi squared value for the null hypothesis that the red flowered parent was a hybrid for the flower color gene. Give your answer to the nearest tenth. Does the data falsify the null?

16. In poultry, the autosomal gene FB produces feathers black in color and another allele, FW, produces white feathers. The heterozygous condition produces feathers of blue color. When a population of white hens was mated to black roosters, the resulting offspring were all blue. These blue offspring were mated with one another. The F2 generation yielded 78 black, 206 blue, and 116 white chickens. Determine the frequency of each allele in the F2 population. Determine if the population is in Hardy-Weinberg equilibrium by calculating the chi-squared value. Give your answer for χ2 to the nearest hundredth.

More Chi Squre

17) A Cellular Biologist wants to double check that statement that cells spend 90 percent of their time in Interphase as compared to the various stages of Mitosis. She grows some *Allium* in her laboratory. She then takes one of the plants, cuts off the root tips, stains the DNA in the cells so as to be able to see the stages of the cell cycle. Her hypothesis states "If cells spend 90 percent of their time in Interphase, then she should be able to calculate the relative time existing between Interphase and Mitosis based upon the cells counted in her specimen." She counted 1000 cells from her preserved specimen under the microscope. Her data are shown below. **Calculate the X^2 to the nearest hundredth**.

Stage of the Cell Cycle	Number of Cells Observed	Number of Cells Expected
Interphase	872	900
Mitosis	128	100

Water Potential

18.   What is the water potential of a cell with a solute potential of -0.67 MPa and a pressure potential of 0.43 MPa?

19.   You measure the total water potential of a cell and find it to be -0.24 MPa. If the pressure potential of the same cell is 0.46 MPa, what is the solute potential of that cell?

20.   Calculate the water potential of a 0.15 M sucrose solution. Assume a temperature of 27C.

21.   Cell A has a solute potential of -2.0 MPA and a pressure potential of 0.5 MPA.
        Cell B has a solute potential of -4.0 MPa and a pressure potential of 0.9 MPA.
        Which way will water flow when the two cells are placed against each other?

22.   A wind borne pollen grain with a solute potential of -3.0 MPA has dried out somewhat after being blown about; this has caused its turgor pressure (pressure potential) to go to 0. It lands on a flower stigma that whose cells have a solute potential of 3.0 MPa and a pressure potential of 1 MPA. Which way will water flow? From the pollen grain to the stigma, or the stigma to the pollen grain? Show how you deduced your answer.

Surface Area

23. In the Diffusion Lab, agar cubes are used to illustrate the relationship of surface area/volume/diffusion rate. Fill in the values missing in the table

Block	cm x cm	Surface Area cm	Volume ml	Surface Area:Volume Ratio
A	2 x 2	24		3:1
B	3 x 3	54	27	
C	4 x 4		64	1.5:1

You use this data to answer questions like this-

Predict- If you put each of the blocks into a solution, into which block would that solution diffuse throughout the entire block fastest? Slowest? How do you explain the difference?
Describe the relationship between the surface area: volume ratio and the percentage of the cube not affected by diffusion.

Gibbs Free Energy $\Delta G = \Delta H - T\Delta S$
G = Free Energy   H = Enthalpy   S = Entropy
T = Temperature in Kelvin Δ represents change in value over time

24) An experiment determined that when a protein unfolds to its denatured (D) state from the original folded (F) state, the change in **Enthalpy** is $\Delta H = H(D) - H(F) = 46,000$ joules/mol. Also the change in **Entropy** is $\Delta S = S(D) - S(F) = 178$ joules/mol. At a temperature of 20^0C, calculate the change in Free Energy ΔG, in j/mol, when the protein unfolds from its folded state.

"Miscellaneous Math"

Energy Flow Through an Ecosystem

NOTE
Numbers represent **kilojoules** of energy per square meter per year $(kJ\ m^{-2}\ yr^{-1})$

Sunlight falling on plant surfaces
7 000 000

Light absorbed by plants
1 700 000

Energy absorbed from the previous trophic level
100

Energy lost as heat 65   Trophic level   10   Energy lost to detritus

25

Energy passed on to the next trophic level

The energy available to each trophic level will always equal the amount entering that trophic level, minus total losses to that level (due to metabolic activity, death, excretion etc.). Energy lost as heat will be lost from the ecosystem. Other losses become part of the detritus and may be utilized by other organisms in the ecosystem.

A

Producers
87 400

50 450

(a)

22 950

7800   Primary consumers

4600   G

B
1600

1330   Secondary consumers   (b)   Detritus   2000

F   10 465   D

90   (c)   19 300

55   Tertiary consumers   (d)

C

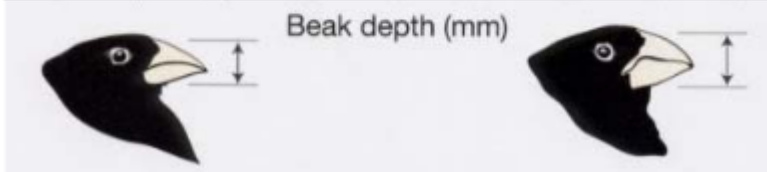Decomposers and detritivores

19 200   E

Heat loss in metabolic activity

25) Calculate the amount of energy remaining at:
a)
b)
c)
d)

26) Geneticists working in an agriculture lab wanted to develop a crop that combines the disease resistance of rye grain with the high crop yielding capacity of wheat grain. Rye grain has a diploid chromosome number (2n) of 14 and wheat grain has a diploid chromosome number of 42. The resulting grain is called triticale and is an alloploidy plant. How many chromosomes are found in the pollen grain of triticale?

27) A study was conducted on the island of Daphne Major in the Galapagos Islands by Peter and Rosemary Grant. This study lasted over 20 year s. The study investigated how the type of seeds available to the finches impacted the depth of their beaks. In years when rain and water were plentiful, the available seeds were smaller and easy to crack. In years experiencing drought, fewer seeds were produced, and the finches had to eat the larger, leftover seeds produced from previous years. During years of drought, birds with a greater beak depth had a selective advantage.

Bird ID Tag Number	Wet Year Beak Depth (mm)	Bird ID Tag Number	Dry Year Beak Depth (mm)
1A	10.81	1B	11.02
2A	8.74	2B	9.65
3A	10.04	3B	11.75
4A	9.75	4B	10.22
5A	9.76	5B	9.86

Beak depth (mm)

Use the data above to determine the increase in the mean of the depth of the beak between the wet and dry years. Give your answer to the nearest hundredth of a millimeter.

28) Carbon Flow in a Grassland Ecosystem
How much carbon (g/m²) is released into the atmosphere as a result of the metabolic activity of herbivores? Give your answer to the nearest whole number.
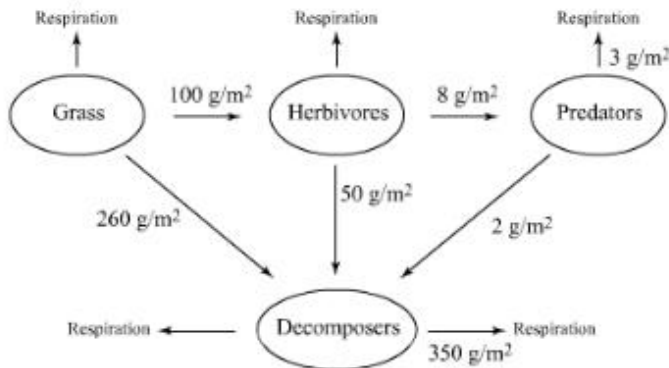
29) In fruit flies, long wings (A) and gray bodies (B) are dominant to vestigial wings and black bodies. In a cross of AaBb x aabb. These are your results-

   123 long wing, gray body
   21 long wing, black body
   27 vestigial wing, gray body
   129 vestigial wing, black body

Calculate the cross over value (recombination frequency) for the offspring of the test cross.

30) There are 4 genes on a single chromosome: A, B, C and D. They exhibit the following crossing over frequencies:

   - A-B = 35%
   - B-C = 10%
   - C-D = 15%
   - C-A = 25%
   - D-B = 25%

   Determine the order of the genes on the chromosome

31) There are 2000 mice living in a field. If 1000 mice are born each month and 200 mice die each month, what is the per capita growth rate of mice over a month? Round to the nearest tenths.

32) The net annual primary productivity of a particular wetland ecosystem is found to be 8000 kcal/m^2. If respiration by the aquatic producers is 12,000 kcal/m^2 per year, what is the gross annual productivity for this ecosystem in kcal/m^2 per year? Round to the nearest whole number.

33) Joe has a 2 g/L solution. He dilutes it and creates 3 L of a 1 g/L solution. How much of the original solution did he dilute? Round to the nearest tenths.

34) Data taken to determine the effect of temperature on the rate of respiration in a goldfish is given in the table below. Calculate Q$_{10}$ for this data. Round to the nearest whole number.

Temperature (C)	Respiration Rate (Min)
16	16
21	22

Multiple Choice-
1. A large population of laboratory animals has been allowed to breed randomly for a number of generations. After several generations, 36% of the animals display a recessive trait (*aa*), the same percentage as at the beginning of the breeding program. The rest of the animals show the dominant phenotype, with heterozygotes indistinguishable from the homozygous dominants. What is the most reasonable conclusion that can be drawn from the fact that the frequency of the recessive trait (aa) has not changed over time?
    a. The population is undergoing genetic drift.
    b. The two phenotypes are about equally adaptive under laboratory conditions.
    c. The genotype AA is lethal.
    d. There has been a high rate of mutation of allele A to allele a.

2. What is the estimated frequency of allele *a* in the gene pool?
    a.   0.18
    b.   0.40
    c.   0.60
    d.   0.70

3. In a Hardy-Weinberg population with two alleles, *A* and *a,* that are in equilibrium, the frequency of the allele a is 0.7. What is the percentage of the population that is homozygous for this allele?
    a.   3
    b.   9
    c.   30
    d.   49

Questions 4-6 In a hypothetical population of 1,000 people, tests of blood-type genes show that 160 have the genotype AA, 480 have the genotype AB, and 360 have the genotype BB.

4. What is the frequency of the *A allele?*
    a.   0.001
    b.   0.002
    c.   0.100
    d.   0.400

5. What percentage of the population has type O blood?
    a.   0
    b.   10
    c.   24
    d.   48

6. If there are 4,000 children born to this generation, how many would be expected to have AB blood under the conditions of Hardy-Weinberg equilibrium?
    a.   100
    b.   960
    c.   1,920
    d.   2,000

7. Consider a polysaccharide consisting of 576 glucose molecules. The total hydrolysis of the polysaccharide would result in the production of
    a.   575 glucose molecules.
    b.   575 water molecules.
    c.   576 glucose molecules.
    d.   A and B only

Refer to the information below to answer question 8 & 9

You are studying three populations of birds. Population 1 has ten birds, of which one is brown (a recessive trait) and nine are red. Population 2 has 100 birds. In that population, ten of the birds are brown. Population 3 has 30 birds, and three of them are brown. Use the following options to answer the questions:

A.   Population 1
B.   Population 2
C.   Population 3
D.   They are all the same.
E.   It is impossible to tell from the information given.

8.   In which population is the frequency of the allele for brown feathers highest?
        a.   A
        b.   B
        c.   C
        d.   D

9.   In which population would it be *least* likely that an accident would significantly alter the frequency of the brown allele?
        a.   A
        b.   B
        c.   C
        d.   D

10.   Upon chemical analysis, a particular protein was found to contain 556 amino acids. How many peptide bonds are present in this protein?
        a.   139
        b.   554
        c.   555
        d.   556

11.   One liter of a solution of pH 2 has how many more hydrogen ions (H^+) than 1 L of a solution of pH 6?
        a.   4 times more
        b.   400 times more
        c.   4,000 times more
        d.   10,000 times more

12.   During a laboratory experiment, you discover that an enzyme-catalyzed reaction has a ΔG of -20 kcal/mol. If you double the amount of enzyme in the reaction, what will be the ΔG for the new reaction?
        a.   -40 kcal/mol
        b.   -20 kcal/mol
        c.   0 kcal/mol
        d.   +20 kcal/mol

13. Starting with a fertilized egg (zygote), a series of five cell divisions would produce an early embryo with how many cells?
    a. 4
    b. 8
    c. 16
    d. 32

14. How many unique gametes could be produced through independent assortment by an individual with the genotype *AaBbCCDdEE?*
    a. 4
    b. 8
    c. 16
    d. 32

15. When crossing a homozygous recessive with a heterozygote, what is the chance of getting an offspring with the homozygous recessive phenotype?
    a. 0%
    b. 25%
    c. 50%
    d. 75%

16. Two true-breeding stocks of pea plants are crossed. One parent has red, axial flowers and the other has white, terminal flowers; all F_1 individuals have red, axial flowers. If 1,000 F_2 offspring resulted from the cross, approximately how many of them would you expect to have red, terminal flowers? (Assume independent assortment).
    a. 65
    b. 190
    c. 250
    d. 565

17. Given the parents *AABBCc* x *AabbCc,* assume simple dominance and independent assortment. What proportion of the progeny will be expected to phenotypically resemble the first parent?
    a. 1/4
    b. 1/8
    c. 3/4
    d. 3/8

18. A woman and her spouse both show the normal phenotype for pigmentation, but both had one parent who was an albino. Albinism is an autosomal recessive trait.
    What is the probability that their first child will be an albino?
    a. 0
    b. 1/4
    c. 1/2
    d. 3/4

19. Huntington's disease is caused by a dominant allele. If one of your parents has the disease, what is the probability that you, too, will have the disease?
    a. 1
    b. 3/4
    c. 1/2
    d. 1/4

20. Cinnabar eyes is a sex-linked recessive characteristic in fruit flies. If a female having cinnabar eyes is crossed with a wild-type male, what percentage of the F1 males will have cinnabar eyes?
   a. 0%
   b. 25%
   c. 50%
   d. 100%

21. An achondroplastic male dwarf with normal vision marries a color-blind woman of normal height. The man's father was six-feet tall, and both the woman's parents were of average height. Achondroplastic dwarfism is autosomal dominant, and red-green color blindness is X-linked recessive. They have a daughter who is a dwarf with normal color vision. What is the probability that she is heterozygous for both genes?
   a. 0
   b. 0.25
   c. 0.50
   d. 1.00

22. Cytosine makes up 38% of the nucleotides in a sample of DNA from an organism. Approximately, what percentage of the nucleotides in this sample will be thymine?
   a. 12
   b. 24
   c. 31
   d. 38

23. If $\Psi P = 0.3$ MPa and $\Psi S = -0.45$ MPa, the resulting Ψ is
   a. +0.75 MPa.
   b. -0.75 MPa.
   c. -0.15 MPa.
   d. +0.15 MPa.

24. At the summit of a high mountain, the atmospheric pressure is 380 mm Hg. If the atmosphere is still composed of 21% oxygen, what is the partial pressure of oxygen at this altitude?
   a. 0 mm Hg
   b. 80 mm Hg
   c. 160 mm Hg
   d. 380 mm Hg

25. To measure the population density of monarch butterflies occupying a particular park, 100 butterflies are captured, marked with a small dot on a wing, and then released. The next day, another 100 butterflies are captured, including the recapture of 20 marked butterflies. One would estimate the population to be
   a. 200.
   b. 500.
   c. 1,000.
   d. 10,000.

26. A population of ground squirrels has an annual per capita birth rate of 0.06 and an annual per capita death rate of 0.02. Estimate the number of individuals added to (or lost from) a population of 1,000 individuals in one year.
   a. 120 individuals added
   b. 40 individuals added
   c. 20 individuals added
   d. 400 individuals added

27.   Consider a field plot containing 200 kg of plant material. Approximately how many kg of carnivore production can be supported?
   a.   200
   b.   100
   c.   20
   d.   2

28.   You are doing a mark-recapture experiment to determine the population size of MendAliens living on an island. Initially you capture, mark, and release 130 MendAliens. A few days later, you capture 90 MendAliens, 20 of which are marked. What is your estimate of the population size of the MendAliens?
   a.   14
   b.   29
   c.   130
   d.   585

29.   10,000 kcal of producer would support approximately _____ kcal of tertiary consumer.
   a.   1
   b.   0
   c.   1,000
   d.   10

#30)

By convention, 1 map unit distance on a chromosome is the distance within which recombination occurs 1 percent of the time. The rate of crossing-over can be used to determine the order of linked genes on a chromosome. Here are the map distances for one set of genes on a chromosome. Which choice below gives the correct order of these genes?

	A	B	C	D
A	-	40	3	18
B	40	-	37	22
C	3	37	-	15
D	18	22	15	-

○ (A) ABCD

○ (B) BCDA

○ (C) ACDB

○ (D) ABDC