Appendix A

AP BIOLOGY EQUATIONS AND FORMULAS

STATISTICAL ANALYSIS AND PROBABILITY

Standard Error	Mean
$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$	$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$
Standard Deviation	**Chi-Square**
$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$	$\chi^2 = \sum \frac{(o-e)^2}{e}$

s = sample standard deviation (i.e., the sample based estimate of the standard deviation of the population)

$\bar{x}$ = mean

n = size of the sample

o = observed individuals with observed genotype

e = expected individuals with observed genotype

Degrees of freedom equals the number of distinct possible outcomes minus one.

CHI-SQUARE TABLE

Degrees of Freedom

p	1	2	3	4	5	6	7	8
0.05	3.84	2.99	7.82	9.49	11.07	12.59	14.07	15.51
0.01	6.64	9.32	11.34	13.28	15.09	16.81	18.48	20.09

LAWS OF PROBABILITY

If A and B are mutually exclusive, then P (A or B) = P(A) + P(B)

If A and B are independent, then P (A and B) = P(A) x P(B)

HARDY-WEINBERG EQUATIONS

$p^2 + 2pq + q^2 = 1$ — p = frequency of the dominant allele in a population

$p + q = 1$ — q = frequency of the recessive allele in a population

METRIC PREFIXES

Factor	Prefix	Symbol
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p

Mode = value that occurs most frequently in a data set

Median = middle value that separates the greater and lesser halves of a data set

Mean = sum of all data points divided by number of data points

Range = value obtained by subtracting the smallest observation (sample minimum) from the greatest (sample maximum)

RATE AND GROWTH

Rate dY/dt **Population Growth** dN/dt=B-D **Exponential Growth** $\frac{dN}{dt} = r_{max}N$ **Logistic Growth** $\frac{dN}{dt} = r_{max}N\left(\frac{K-N}{K}\right)$	dY= amount of change *t* = time B = birth rate D = death rate *N* = population size *K* = carrying capacity r_{max} = maximum per capita growth rate of population
Temperature Coefficient Q_{10} $Q_{10} = \left(\frac{k_2}{k_1}\right)^{\frac{10}{t_2 - t_1}}$ **Primary Productivity Calculation** mg O_2/L x 0.698 = mL O_2 /L mL O_2/L x 0.536 = mg carbon fixed/L	t_2 = higher temperature t_1 = lower temperature k_2 = metabolic rate at t_2 k_1 = metabolic rate at t_1 Q_{10} = the *factor* by which the reaction rate increases when the temperature is raised by ten degrees

SURFACE AREA AND VOLUME

Volume of a Sphere $V = 4/3\ \pi\ r^3$ **Volume of a Cube (or Square Column)** V = l w h **Volume of a Column** $V = \pi\ r^2\ h$ **Surface Area of a Sphere** $A = 4\ \pi\ r^2$ **Surface Area of a Cube** A = 6 a **Surface Area of a Rectangular Solid** A = Σ (surface area of each side)	r = radius l = length h = height w = width A = surface area V = volume Σ = Sum of all a = surface area of one side of the cube

Water Potential (Ψ)

$\Psi = \Psi p + \Psi s$

Ψp = pressure potential

Ψs = solute potential

The water potential will be equal to the solute potential of a solution in an open container, since the pressure potential of the solution in an open container is zero.

The Solute Potential of the Solution

Ψs = – iCRT

i = ionization constant (For sucrose this is 1.0 because sucrose does not ionize in water.)

C = molar concentration

R = pressure constant (R = 0.0831 liter bars/mole K)

T = temperature in Kelvin (273 + °C)

Dilution – used to create a dilute solution from a concentrated stock solution

$C_iV_i = C_fV_f$

i = initial (starting)

C = concentration of solute

f = final (desired)

V = volume of solution

Gibbs Free Energy

$\Delta G = \Delta H - T\Delta S$

ΔG = change in Gibbs free energy

ΔS = change in entropy

ΔH = change in enthalpy

T = absolute temperature (in Kelvin)

pH = – log [H+]