Appendix A

AP BIOLOGY EQUATIONS AND FORMULAS

Statistical Analysis and Probability

Mean

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

Standard Deviation*

$$S = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

Standard Error of the Mean*

$$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$$

Chi-Square

$$\chi^2 = \sum \frac{(o-e)^2}{e}$$

Chi-Square Table

p value	Degrees of Freedom							
	1	2	3	4	5	6	7	8
0.05	3.84	5.99	7.82	9.49	11.07	12.59	14.07	15.51
0.01	6.64	9.21	11.34	13.28	15.09	16.81	18.48	20.09

Laws of Probability

If A and B are mutually exclusive, then:

$$P(\text{A or B}) = P(\text{A}) + P(\text{B})$$

If A and B are independent, then:

$$P(\text{A and B}) = P(\text{A}) \times P(\text{B})$$

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

$\bar{x}$ = sample mean

n = size of the sample

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

o = observed results

e = expected results

Degrees of freedom are equal to the number of distinct possible outcomes minus one.

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)

** For the purposes of the AP Exam, students will not be required to perform calculations using this equation; however, they must understand the underlying concepts and applications.*

Rate and Growth		
Rate $\frac{dY}{dt}$ **Population Growth** $\frac{dN}{dt} = B - D$ **Exponential Growth** $\frac{dN}{dt} = r_{max} N$ **Logistic Growth** $\frac{dN}{dt} = r_{max} N \left(\frac{K-N}{K}\right)$ **Temperature Coefficient Q_{10}** † $Q_{10} = \left(\frac{k_2}{k_1}\right)^{\frac{10}{T_2 - T_1}}$ **Primary Productivity Calculation** $\frac{\text{mg } O_2}{\text{L}} \times \frac{0.698 \text{ mL}}{\text{mg}} = \frac{\text{mL } O_2}{\text{L}}$ $\frac{\text{mL } O_2}{\text{L}} \times \frac{0.536 \text{ mg C fixed}}{\text{mL } O_2} = \frac{\text{mg C fixed}}{\text{L}}$ (at standard temperature and pressure)	dY = amount of change dt = change in time B = birth rate D = death rate N = population size K = carrying capacity r_{max} = maximum per capita growth rate of population T_2 = higher temperature T_1 = lower temperature k_2 = reaction rate at T_2 k_1 = reaction rate at T_1 Q_{10} = the factor by which the reaction rate increases when the temperature is raised by ten degrees	**Water Potential (Ψ)** $\Psi = \Psi_P + \Psi_S$ Ψ_P = pressure potential Ψ_S = solute potential The water potential will be equal to the solute potential of a solution in an open container because the pressure potential of the solution in an open container is zero. **The Solute Potential of a Solution** $\Psi_S = -iCRT$ i = ionization constant (this is 1.0 for sucrose because sucrose does not ionize in water) C = molar concentration R = pressure constant (R = 0.0831 liter bars/mole K) T = temperature in Kelvin (ºC + 273)

Surface Area and Volume		
Volume of a Sphere $V = \frac{4}{3}\pi r^3$ **Volume of a Rectangular Solid** $V = lwh$ **Volume of a Right Cylinder** $V = \pi r^2 h$ **Surface Area of a Sphere** $A = 4\pi r^2$ **Surface Area of a Cube** $A = 6s^2$ **Surface Area of a Rectangular Solid** $A = \sum$ surface area of each side	r = radius l = length h = height w = width s = length of one side of a cube A = surface area V = volume Σ = sum of all	**Dilution (used to create a dilute solution from a concentrated stock solution)** $C_i V_i = C_f V_f$ 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* $= -\log_{10} [H^+]$

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† For use with labs only (optional).