

## 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	7.81	9.49	11.07	12.59	14.07	15.51
0.01	6.63	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:

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

If A and B are independent, then:

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

#### **Hardy-Weinberg Equations**

$$p^2 + 2pq + q^2 = 1 \quad p = \text{frequency of allele 1 in a population}$$

$$p + q = 1 \quad q = \text{frequency of allele 2 in a population}$$

$\bar{x}$  = sample mean

$n$  = sample size

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

$o$  = observed results

$e$  = expected results

$\Sigma$  = sum of all

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

#### **Metric Prefixes**

<b>Factor</b>	<b>Prefix</b>	<b>Symbol</b>
$10^9$	giga	G
$10^6$	mega	M
$10^3$	kilo	k
$10^{-1}$	deci	d
$10^{-2}$	centi	c
$10^{-3}$	milli	m
$10^{-6}$	micro	$\mu$
$10^{-9}$	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)

<b>Rate and Growth</b>		<b>Water Potential ( <math>\Psi</math> )</b>
<b>Rate</b> $\frac{dY}{dt}$	$dY$ = amount of change $dt$ = change in time	$\Psi = \Psi_p + \Psi_s$ $\Psi_p$ = pressure potential $\Psi_s$ = solute potential
<b>Population Growth</b> $\frac{dN}{dt} = B - D$	$B$ = birth rate $D$ = death rate	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.
<b>Exponential Growth</b> $\frac{dN}{dt} = r_{\max}N$	$N$ = population size $K$ = carrying capacity	<b>The Solute Potential of a Solution</b> $\Psi_s = -iCRT$
<b>Logistic Growth</b> $\frac{dN}{dt} = r_{\max}N\left(\frac{K - N}{K}\right)$	$r_{\max}$ = maximum per capita growth rate of population	$i$ = ionization constant (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 ( $^{\circ}\text{C} + 273$ )
<b>Simpson's Diversity Index</b> Diversity Index = $1 - \sum\left(\frac{n}{N}\right)^2$ $n$ = total number of organisms of a particular species $N$ = total number of organisms of all species		<b>pH</b> = $-\log[\text{H}^+]$
<b>Surface Area and Volume</b>		
<b>Surface Area of a Sphere</b> $SA = 4\pi r^2$	<b>Volume of a Sphere</b> $V = \frac{4}{3}\pi r^3$	$r$ = radius $l$ = length $h$ = height $w$ = width
<b>Surface Area of a Rectangular Solid</b> $SA = 2lh + 2lw + 2wh$	<b>Volume of a Rectangular Solid</b> $V = lwh$	$s$ = length of one side of a cube $SA$ = surface area $V$ = volume
<b>Surface Area of a Cylinder</b> $SA = 2\pi rh + 2\pi r^2$	<b>Volume of a Cylinder</b> $V = \pi r^2 h$	
<b>Surface Area of a Cube</b> $SA = 6s^2$	<b>Volume of a Cube</b> $V = s^3$	