BIOLOGY 4FF3, Introductory Computational Biology
Recapitulation for section Genes - modeling, logarithms, information and probability theories, Mendel's Laws, Bayes' Theorem

$P(j) = n_j / n$
    n_j enumerates sample members that are known to possess property j
    n enumerates members in the sample
    P(j) resides in the interval [0, 1]

$\Sigma P(j) = 1$
    the summation is performed over all j

$P(j \text{ or } k) = P(j) + P(k)$
    mutually exclusive properties j or k

$P(\sim j) = 1 - P(j)$
    ~ means ‘not’

$P(j \text{ and } k) = n_{j \text{ and } k} / n$
    the joint probability for properties j and k

$P(j) = \Sigma P(j \text{ and } k)$
    sum over k

$P(k) = \Sigma P(j \text{ and } k)$
    sum over j

$P(j) = n_{j \text{ and } k} / n_k = P(j) P(k)$
    independent properties j and k

$S = - \Sigma (P(j) \text{Log}_2[P(j)])$

$I = -\Delta S = S_i - S_f = - \Sigma (P(j)_i \text{Log}_2[P(j)_i]) + \Sigma (P(j)_f \text{Log}_2[P(j)_f])$
    the summation is performed over j states initially i and finally f
    discerning the states often requires careful consideration

$P(j \mid k) = n_{j \text{ and } k} / n_k = P(j \text{ and } k) / P(k)$
    generally; reduces to P(j) = P(j) P(k) if j and k are independent

$P(j \text{ or } k) = P(j) + P(k) - P(j \text{ and } k)$
    generally; reduces to P(j or k) = P(j) + P(k) if j or k are mutually exclusive

$P(H \mid d) = P(d \mid H) P(H) / (P(d \mid H) P(H) + P(d \mid \sim H) P(\sim H))$
    Bayes’ Theorem

all equations may be applied to genetic data

Recapitulation for section Cell (ultrastructure and organisation) - trigonometry, stereology

Trigonometry

θ	Sin[θ]	Cos[θ]
0	0	1
π / 6	1 / 2	Sqrt[3] / 2
π / 4	1 / Sqrt[2]	1 / Sqrt[2]
π / 3	Sqrt[3] / 2	1 / 2
π / 2	1	0

'CAST' rule

Tan[π] = Sin[π] / Cos[π]

$V_V = A_A = L_L$
Delesse Principle

$p = n_{\cap}\, z$
Perimeter

$S_V = p / A$
Surface Density

$N_A = N_V\, D$
Numerical Density

$D = 6\,(V / S) = 6\,(V_V / S_V) = 6\,(A_A / S_V)$
$= 6\,(n_{corners}\, z^2 / (4\,A)) / (n_{intersections}\, z / A)$
typical diameter for spherical objects

Recapitulation for section Individual (growth and scaling principles) - power functions, linear transformations, linear regression

Mathematical Model:	$Y = a X^b$	Power Function
Mathematical Tools:	$\mathrm{Log}[Y] = \mathrm{Log}[a] + b\,\mathrm{Log}[X]$	Logarithmic Transformation
	a, b, r^2	Least-Squares Regression
Particular Hypotheses:	$L \propto S^{1/2}$	geometric similarity
	$L \propto M^{1/3}$	
	$S \propto M^{2/3}$	
	…	
	$L \propto D^{2/3}$	elastic similarity
	$L \propto M^{1/4}$	
	$D \propto M^{3/8}$	
	…	
Metabolism:	$P_{met} \propto M^{3/4}$	

Recapitulation for sections Population (growth characteristics) - logistic equation (continuous) and Population (growth dynamics) - logistic equation (discrete), chaos theory , phase space, differential equations

Mathematical Model $N(t) = N(0)\ e^{k\ t}$ Exponential Equation

Mathermatical Tool $Log[N(t)] = Log[N(0)] + k\ t$ Logarithmic Transformation

Mathematical Model $N(t) = K / (1 + e^{\ r\ (C - t)})$ Logistic Equation
(continuous)
r = growth rate
C = $C_{K\ ./\ 2}$ (*i.e.*, t at which N(t) = K / 2)

Mathematical Tool $Log[(N(t) / K) - 1] = r\ C_{k\ /\ 2} - r\ t$ Logarithmic Transformation

Mathematical Model $N_{t\ +\ 1} = N_t\ r_{difference}\ N_t\ (K - N_t)$ Logistic Equation
(discrete)
$r_{difference}$ = growth rate
K = carrying capacity

Recapitulation for section Ecosystem (environmental) - fractals, iteration, complex numbers

Fractal

entities that occupy or exhibit non-Euclidean dimension D

Iteration

repetitive process with which fractals can be created

e.g., the Mandelbrot Set is obtained by iterating $z_{n+1} = z_n^2 + C$,

where z_{n+1} and C are complex numbers

Complex Numbers

z = a + i b, where i = Sqrt[-1]