Biochemtools MCAT Formula Sheet

Free reference — every formula here has a full interactive calculator with worked steps at biochemtools.com

BIOCHEMISTRY

Peptide charge (Henderson–Hasselbalch, per group)

base: $+1/(1+10^{pH-pKa})$

acid: $-1/(1+10^{pKa-pH})$

pI = pH where net charge = 0

Michaelis–Menten

$v = V_{max}[S] / (K_m + [S])$

Lineweaver–Burk: $1/v = (K_m/V_{max})(1/[S]) + 1/V_{max}$

K_m = [S] at $v = ½V_{max}$

Inhibition	K	V
Competitive	↑ (αK)	unchanged
Uncompetitive	↓ (K/α′)	↓ (V/α′)
Noncompetitive	unchanged	↓ (V/α′)

MOLECULAR BIOLOGY

DNA melting temperature (T_m)

≤14 nt (Wallace): $T_m = 2(A+T) + 4(G+C)$

>14 nt: $T_m = 64.9 + 41(GC-16.4)/N$

Translation

Start: AUG (Met) Stop: UAA, UAG, UGA

DNA → mRNA: T → U

Glycolysis (per glucose)

Net: **+2 ATP, +2 NADH, 2 pyruvate**

Regulated steps: hexokinase, PFK-1 (committed), pyruvate kinase

Citric acid cycle (per turn, per acetyl-CoA)

Produces: **3 NADH, 1 $FADH_2$, 1 GTP, 2 CO_2**

Regulated: citrate synthase, isocitrate dehydrogenase, α-KG dehydrogenase

ATP yield (total, per glucose)

36–38 (classic P/O 3.0/2.0) or 30–32 (modern P/O 2.5/1.5)

Lower/higher of each pair = glycerol-3-P vs. malate-aspartate shuttle

GENETICS

Punnett ratios (complete dominance)

Monohybrid Aa×Aa: 3:1 phenotype

Dihybrid AaBb×AaBb: 9:3:3:1 phenotype

Test cross AaBb×aabb: 1:1:1:1

Hardy–Weinberg

$p + q = 1$ $p^2 + 2pq + q^2 = 1$

$p = (2AA+Aa)/2N$ $\chi^2 = \Sigma(O-E)^2/E$

χ^2 critical (df=1, α=0.05) = 3.84

CHEMISTRY

pH / pOH

Strong acid/base: [H+] or [OH–] = C

Weak acid: $K_a = x^2/(C-x)$; $x = (-K_a + \sqrt{(K_a^2 + 4K_aC)})/2$

pH + pOH = 14 (25°C)

Henderson–Hasselbalch (buffers)

pH = pKa + log([A–]/[HA])

ratio = 10^{pH-pKa}; buffers best at pKa ± 1

Gibbs free energy

$\Delta G = \Delta H - T\Delta S$ (spontaneous if $\Delta G<0$)

$\Delta G = \Delta G°' + RT \ln Q$ crossover $T = \Delta H/\Delta S$

Nernst equation

$E = E° - (RT/nF) \ln Q$

25°C shortcut: $E = E° - (0.0592/n) \log Q$

E=0 at equilibrium; F=96485 C/mol

Beer–Lambert

$A = \varepsilon bc$ $\%T = 100 \times 10^{-A}$

Ideal gas law

$PV = nRT$ R=0.08206 L·atm/mol·K

STP: 1 mol = 22.4 L (0°C, 1 atm)

SOLUTIONS & LAB PREP

Molarity & molar mass

moles = M × V(L) grams = moles × MW

Dilution

$C_1V_1 = C_2V_2$

Serial (n steps, fold F): conc = stock/F^n

PHYSIOLOGY

Osmotic pressure

Osmolarity = i × M $\pi = iMRT$

Blood ≈ 0.30 Osm (isotonic reference)

Cardiac output

CO = HR × SV

Fick: $CO = VO_2 / (CaO_2 - CvO_2)$

Normal resting CO ≈ 5 L/min

Renal clearance

$C_x = (U_x \times V) / P_x$

FF = GFR / RPF

Inulin clearance = GFR (≈125 mL/min); PAH clearance ≈ RPF; normal FF ≈ 20%

biochemtools.com — 24 free interactive tools, no signup. Every formula above has a live calculator that shows the full worked steps.