### Key Numbers for Cell Biologists

#### Cell sizes:
1. Bacteria (*E. coli*): $\approx 0.7-1.4 \, \mu m$ diameter, $\approx 2-4 \, \mu m$ length, $\approx 0.5-5 \, \mu m^3$ in volume; $10^8-10^9$ cell/ml for culture with OD$_{600}=1$
2. Yeast (*S. cerevisiae*): $\approx 3-6 \, \mu m$ diameter, $\approx 20-160 \, \mu m^3$ in volume
3. Mammalian cell volume: $100-10000 \, \mu m^3$; Hela: $500-5000 \, \mu m^3$ (adherent on slide $\approx 15-30 \, \mu m$ diameter)

#### Concentrations
13. Concentration of 1 nM in:
   - *E. coli* is $\approx 1$ molecule/cell;
   - Hela $\approx 1,000$ molecules/cell
14. Characteristic concentration for a signaling protein $\approx 10 \, nM-1 \, \mu M$
15. Water content: $\approx 70\%$ by mass; General elemental composition (dry weight) of *E. coli*: $\approx C_4H_7O_2N_1$; Yeast $\approx C_6H_{10}O_3N_1$
16. Composition of *E. coli* (dry weight): $\approx 55\%$ protein, $20\%$ RNA, $10\%$ lipids, $15\%$ others
17. Protein conc. $\approx 100 \, mg/ml=3 \, mM. \, 10^6-10^7$ per *E. coli* (depending on growth rate);
   Total metabolites (MW<1kD) $\approx 300mM$

#### Energetics
18. Membrane potential $\approx 70-200 \, mV \rightarrow 2-6 \, k_B T$ per electron ($k_B T=\text{thermal energy}$)
19. Free energy ($\Delta G$) of ATP hydrolysis under physiological conditions $\approx 40-60 \, kJ/mole \rightarrow \approx 20k_B T/molecule$ ATP;
   ATP molecules required to make an *E. coli* cell $\approx 10-50\times10^9$
20. $\Delta G^0$ resulting in order of magnitude ratio between products and reactants concentrations:
   $\approx 6 \, kJ/mol = \approx 60 \, meV = \approx 2 \, k_B T$

#### Diffusion and Catalysis Rate
21. Diffusion coefficient for an “average” protein: in cytoplasm $D \approx 5-15 \, \mu m^2/s \rightarrow \approx 10 \, \mu sec$ to traverse an *E. coli* $\approx 10 \, s$ to traverse a mammalian (Hela) cell; small metabolite in water $D \approx 500 \, \mu m^2/s$
22. Diffusion limited on-rate for characteristic protein $\approx 10^8-10^9 \, s^{-1} M^{-1}$ for a protein substrate of concentration $\approx 1 \, \mu M$ the diffusion limited on-rate is $\approx 10-100 \, s^{-1}$ thus limiting the catalytic rate $k_{cat}$

#### Genomes, Mutation & Error Rates
23. Genome size: *E. coli* $\approx 4\times10^6$ bp; *S. cerevisiae* (yeast) $\approx 12\times10^6$ bp; *C. elegans* (nematode) $\approx 100\times10^6$ bp; *D. melanogaster* (fruit fly) $\approx 120\times10^6$ bp; *A. thaliana* (arabidopsis) $\approx 160\times10^6$ bp; *M. musculus* (mouse) $\approx 3,000\times10^6$ bp; *H. sapiens* (human) $\approx 3,000\times10^6$ bp; *T. aestivum* (wheat) $\approx 17,000\times10^6$ bp
24. Mutation rate in DNA replication $\approx 10^{-10}$ per bp
25. Misincorporation rate:
   - transcription $\approx 10^{-4}$ per nucleotide;
   - translation $\approx 10^{-3}-10^{-4}$ per amino-acid

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Useful biological numbers extracted from the literature. Numbers and ranges should only serve as “rule of thumb” values. References are in the online annotated version at the BioNumbers website. Consult website and original references to learn about the details of the system under study including growth conditions, method of measurement, etc.