

Popular BioNumbers | Recent BioNumbers | Key BioNumbers | Amazing BioNumbers

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e.g., [ribosome coli](#), [p53 human](#), [transcription](#), [OD](#)

Key Numbers for Cell Biologists

Cell size

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

Length Scales Inside Cells

4. Nucleus volume $\approx 10\%$ of cell volume
5. Cell membrane thickness $\approx 4\text{-}10\ \text{nm}$
6. "Average" protein diameter $\approx 3\text{-}6\ \text{nm}$
7. Base pair: $2\ \text{nm}$ (D) x $0.34\ \text{nm}$ (H)
8. Water molecule diameter $\approx 0.3\ \text{nm}$

Division, Replication, Transcription, Translation & Degradation Rates at 37°C with a temperature dependence Q10 of $\approx 2\text{-}3$

9. Cell cycle time (exponential growth in rich media): *E. coli* $\approx 20\text{-}40\ \text{min}$; yeast $70\text{-}140\ \text{min}$; human cell line (HeLa): $15\text{-}30\ \text{hours}$
10. Rate of replication by DNA polymerase *E. coli* $\approx 200\text{-}1000\ \text{bases/s}$; human $\approx 40\ \text{bases/s}$. Transcription by RNA polymerase $10\text{-}100\ \text{bases/s}$
11. Translation rate by ribosome $10\text{-}20\ \text{aa/s}$
12. Degradation rates (proliferating cells): mRNA half life $<$ cell cycle time; protein half life \approx cell cycle time

Concentration

13. Concentration of 1 nM in: *E. coli* is $\approx 1\ \text{molecule/cell}$; HeLa $\approx 1,000\ \text{molecules/cell}$
14. Characteristic concentration for a signaling protein $\approx 10\ \text{nM}\text{-}1\ \mu\text{M}$
15. Water content: $\approx 70\%$ by mass; General elemental composition (dry weight) of *E. coli*: $\approx \text{C}_5\text{H}_7\text{O}_2\text{N}_1$; Yeast $\approx \text{C}_6\text{H}_{10}\text{O}_3\text{N}_1$
16. Composition of *E. coli* (dry weight): $\approx 55\%$ protein, 20% RNA, 10% lipids, 15% others
17. Protein conc. $\approx 100\ \text{mg/ml} = 3\ \text{mM}$. $10^9\text{-}10^{10}$ per *E. coli* (depending on growth rate); Total metabolites (MW $< 1\ \text{kD}$) $\approx 300\ \text{mM}$

Energetics

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

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.

Diffusion and Catalysis Rate

21. Diffusion coefficient for an "average" protein: in cytoplasm $D \approx 5\text{-}15\ \mu\text{m}^2/\text{s}$ $\rightarrow \approx 10\ \text{millisec}$ to traverse an *E. coli* $\rightarrow \approx 10\ \text{s}$ to traverse a mammalian (HeLa) cell; small metabolite in water $D \approx 500\ \mu\text{m}^2/\text{s}$
22. Diffusion limited on-rate for characteristic protein $\approx 10^8\text{-}10^9\ \text{s}^{-1}\text{M}^{-1}$ \rightarrow for a protein substrate of concentration $\approx 1\ \mu\text{M}$ the diffusion limited on-rate is $\approx 100\text{-}1000\ \text{s}^{-1}$ thus limiting the catalytic rate k_{cat}

Genome sizes & Error Rates

23. Genome size: *E. coli* $\approx 5\ \text{Mbp}$; *S. cerevisiae* (yeast) $\approx 12\ \text{Mbp}$; *C. elegans* (nematode) $\approx 100\ \text{Mbp}$; *D. melanogaster* (fruit fly) $\approx 120\ \text{Mbp}$; *A. thaliana* (arabidopsis) $\approx 120\ \text{Mbp}$; *M. musculus* (mouse) $\approx 2.5\ \text{Gbp}$; *H. sapiens* (human) $\approx 2.9\ \text{Gbp}$; *T. aestivum* (wheat) $\approx 16\ \text{Gbp}$
24. Number of protein-coding genes: *E. coli* $\approx 4,000$; *S. cerevisiae* $\approx 6,000$; *C. elegans*, *A. thaliana*, *M. musculus*, *H. sapiens* $\approx 20,000$
25. Mutation rate in DNA replication $\approx 10^{-8}\text{-}10^{-10}$ per bp
26. Misincorporation rate: transcription $\approx 10^{-4}$ per nucleotide; translation $\approx 10^{-3}\text{-}10^{-4}$ per amino-acid

Click on a number to see full description and reference www.BioNumbers.org

Вы когда-нибудь искали нужные числа, такие как объема клетки или клеточную концентрацию АТФ, тратя гораздо больше времени, чем бы вы хотели, в Интернете или листая учебники – и всё без особого успеха?

Ну, это происходит не только с вами. Часто удивляет, как трудно найти конкретные биологические числа, даже для свойств, которые были измерены много раз. Чтобы помочь решить эту проблему для всех и каждого, была создана BioNumbers (база данных ключевых чисел в молекулярной биологии). Наряду с числами, вы найдете соответствующие ссылки на оригинальную литературу, полезные замечания, и связанные с ними количественные характеристики.

Хотя мы сделали честную первую попытку упростить процесс поиска полезных биологических чисел, ещё много работы предстоит. Ключевой проблемой является заполнение большого количества пропущенных пунктов. Ещё одна проблема предполагает создание надежной и взыскательной поисковой машины, которая на первой же попытке дает именно те характеристики, которые ищет пользователь на самом деле.

Цитирование BioNumbers, пожалуйста, делайте так: Milo et al. Nucl. Acids Res. (2010) 38: D750-D753. При использовании конкретной записи из базы данных настоятельно рекомендуем вам также указать 6-значный идентификатор BioNumbers, например, "BNID 100986, Milo et al 2010".

Оригинал:

Did you ever need to look up a number like the volume of a cell or the cellular concentration of ATP, only to find yourself spending much more time than you wanted on the Internet or flipping through textbooks - all without much success?

Well, it didn't happen only to you. It is often surprising how difficult it can be to find concrete biological numbers, even for properties that have been measured numerous times. To help solve this for one and all, BioNumbers (the database of key numbers in molecular biology) was created. Along with the numbers, you'll find the relevant references to the original literature, useful comments, and related numbers.

Though we have made an honest first try at simplifying the process of finding useful biological numbers, there is still much work to be done. A key challenge is filling in the large number of missing items. Another challenge involves setting up a reliable and discriminating search engine which on a first try yields the numbers a user is actually interested in finding.

To cite BioNumbers please refer to: Milo et al. Nucl. Acids Res. (2010) 38: D750-D753. When using a specific entry from the database it is highly recommended that you also specify the BioNumbers 6 digit ID, e.g. "BNID 100986, Milo et al 2010".