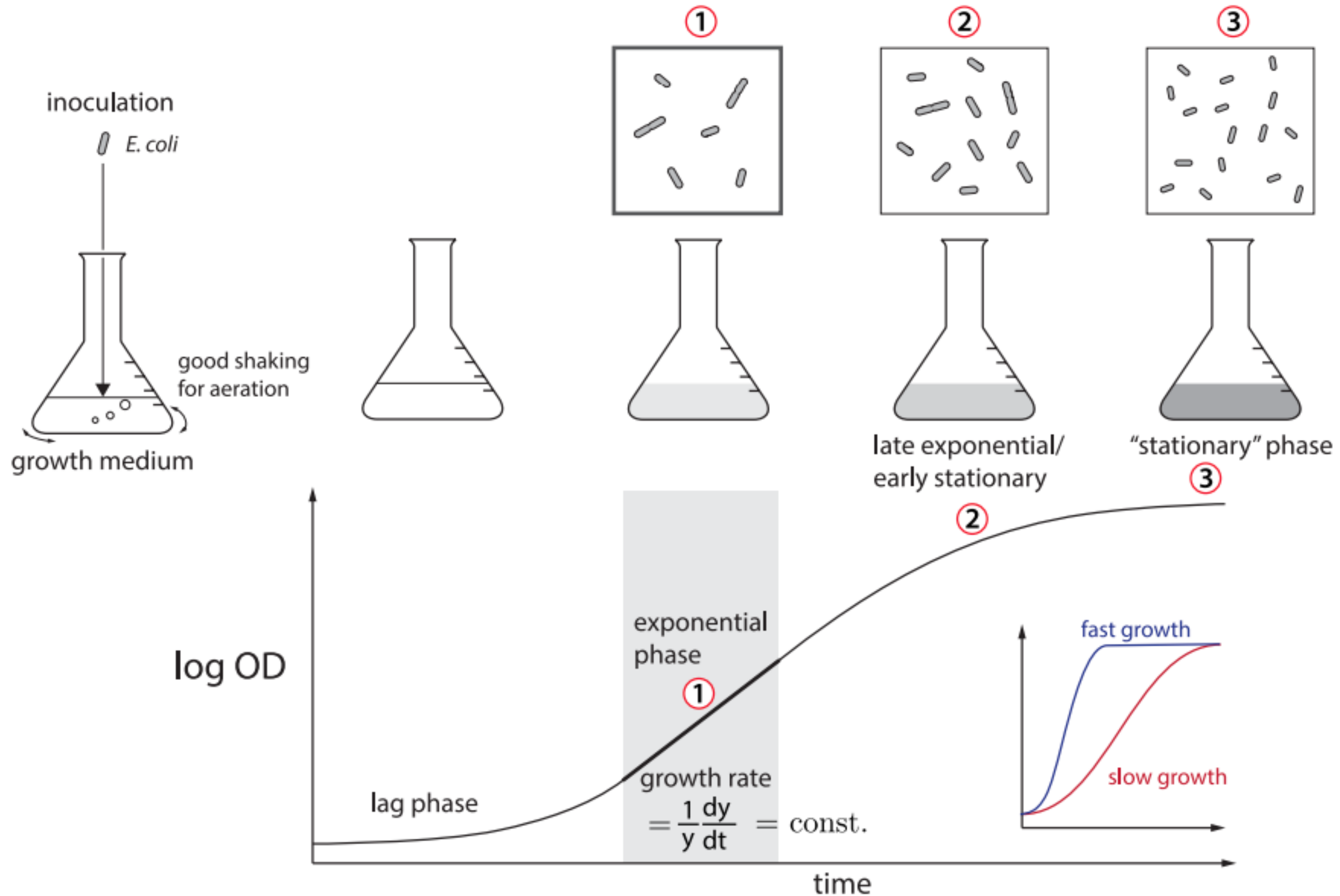


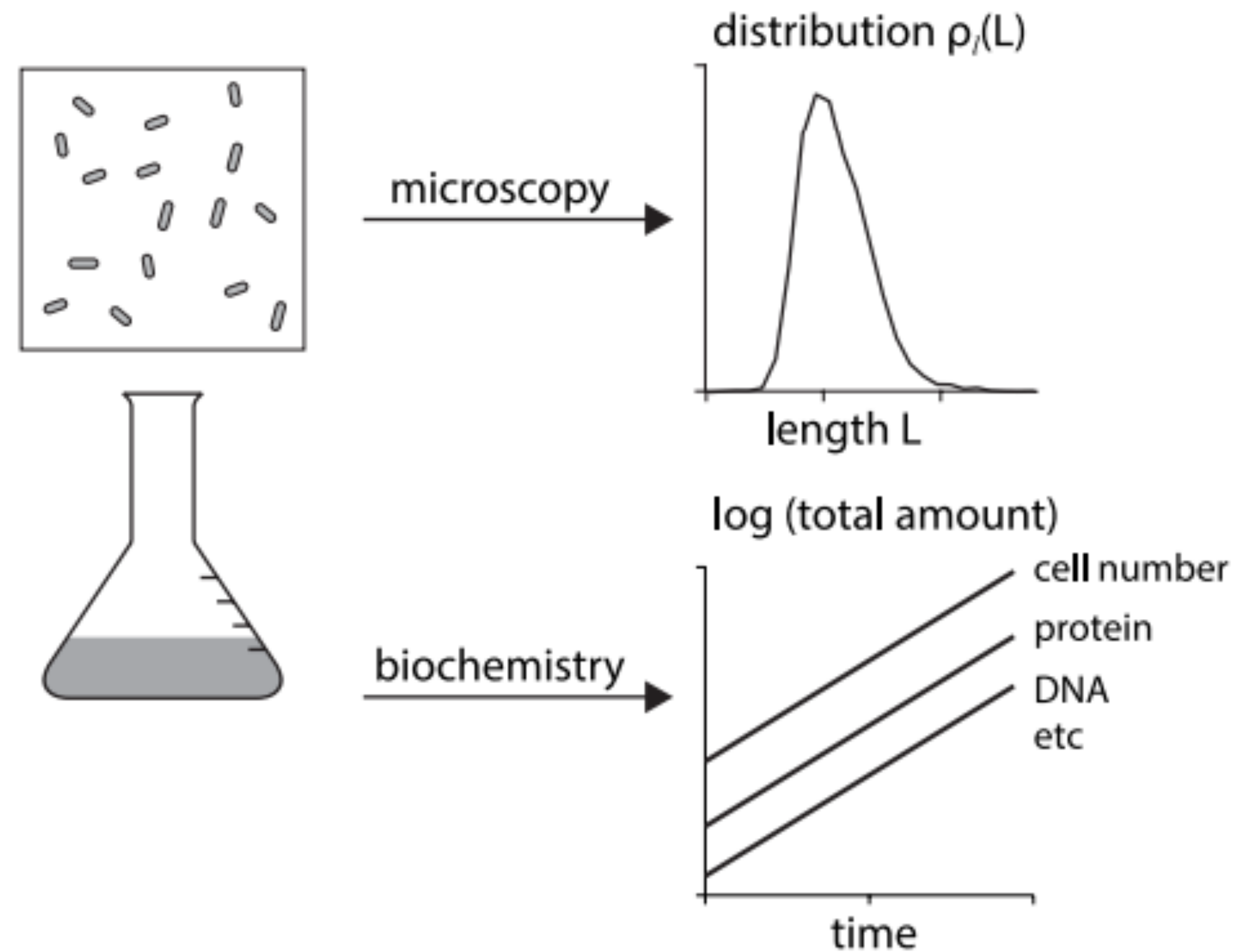
Quantitative Microbial Physiology

Jacopo Grilli
Lecture 2, Feb 18, 2025

Growing bacteria in the lab

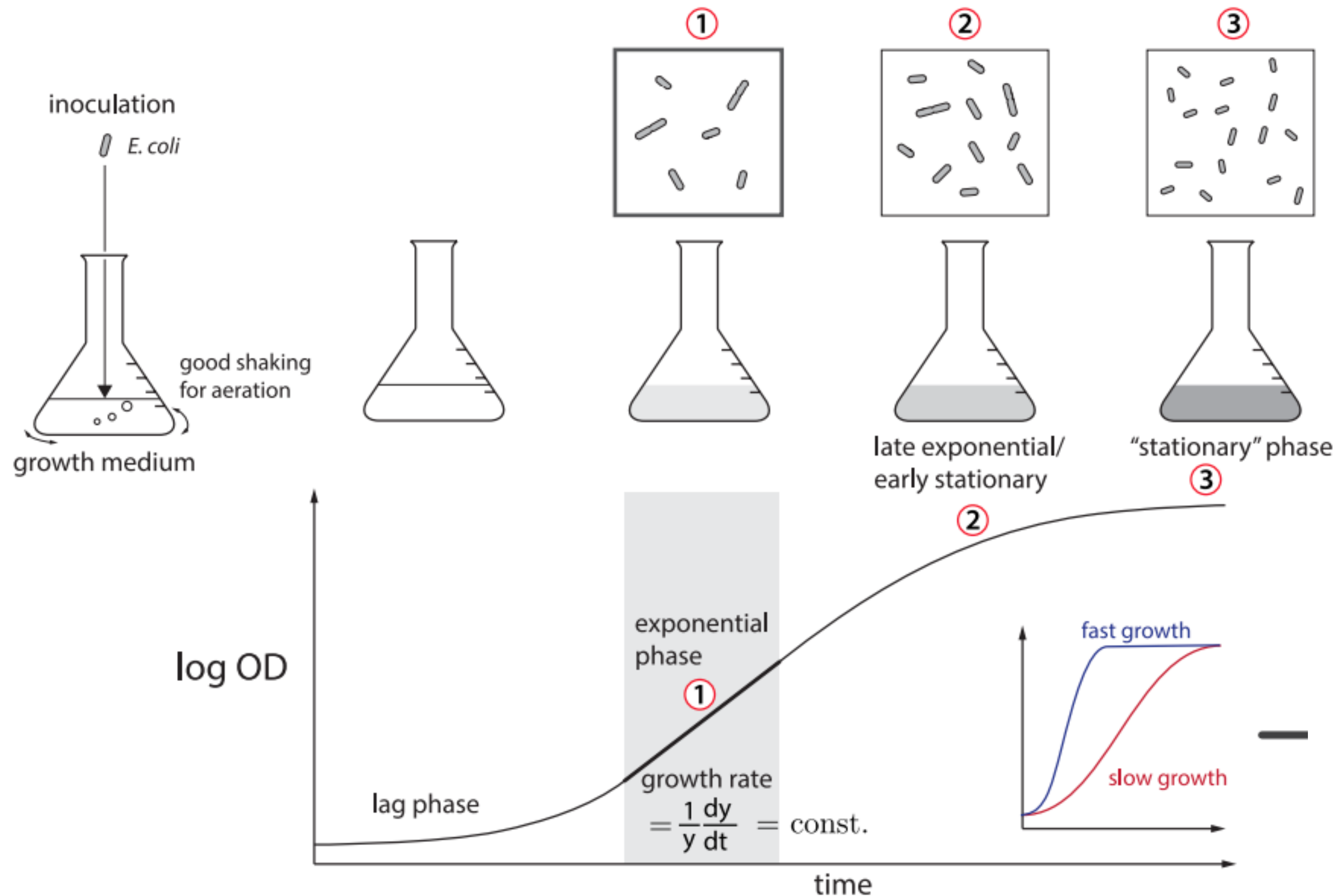


what else can we measure?



when is easier to study physiology?

physiology: biological study of the activities that take place in a cell to keep it alive



Balanced exponential growth

*– the difference between ‘exponential phase’ and ‘balanced growth’
is the difference between watching apples fall and thinking of gravity
E. Schaechter*

What makes up a cell?

TABLE 1. Composition of an average *E. coli* B/r cell^a

Component(s)	% Total dry wt ^b	Amt (g, 10 ¹⁵)/cell ^c	Mol wt	Molecules/cell	No. of different kinds of molecules ^d
Protein	55.0	156	4.0 × 10 ⁴	2,350,000	1,850
RNA	20.5	58			
23 S rRNA		31.0	1.0 × 10 ⁶	18,700	1
16 S rRNA		15.5	5.0 × 10 ⁵	18,700	1
5 S rRNA		1.2	3.9 × 10 ⁴	18,700	1
Transfer		8.2	2.5 × 10 ⁴	198,000	60
Messenger		2.3	1.0 × 10 ⁶	1,380	600
DNA	3.1	8.8	2.5 × 10 ⁹	2.1	1
Lipid	9.1	25.9	705	22,000,000	
Lipopolysaccharide	3.4	9.7	4,070	1,430,000	1
Peptidoglycan	2.5	7.1	(904) _n	1	1
Glycogen	2.5	7.1	1.0 × 10 ⁶	4,300	1
Polyamines	0.4	1.1			
Putrescine		0.83	88	5,600,000	1
Spermidine		0.27	145	1,100,000	1
Metabolites, cofactors, ions	3.5	9.9			800+

^a Calculated for an average cell in a population of *E. coli* B/r in balanced growth at 37°C in aerobic glucose minimal medium with a mass doubling time of 40 min. The cell is defined by dividing the total biomass, or the amount of any of its measured

Mostly proteins, mostly ribosomes

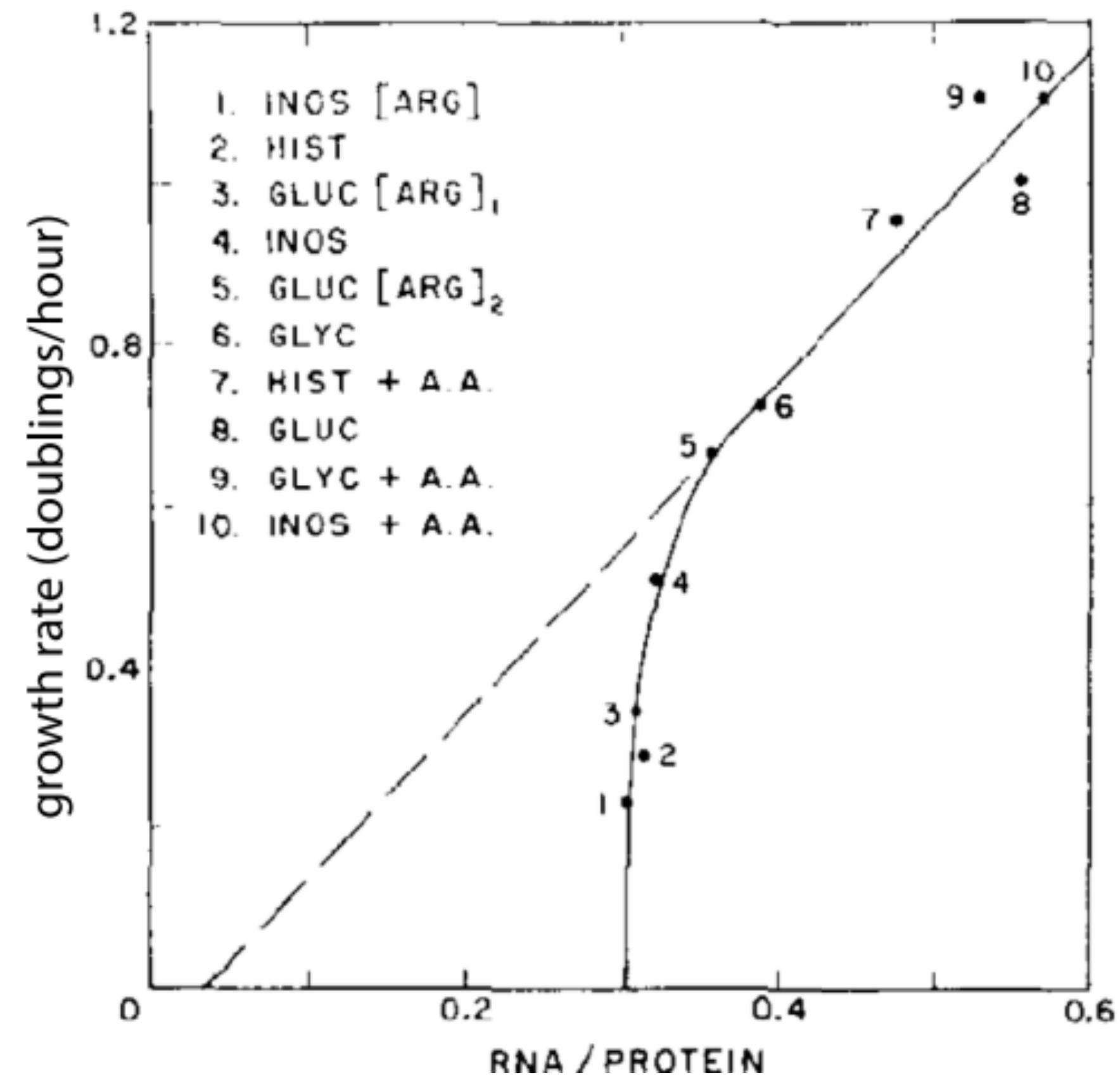
How does this depends on growth condition?

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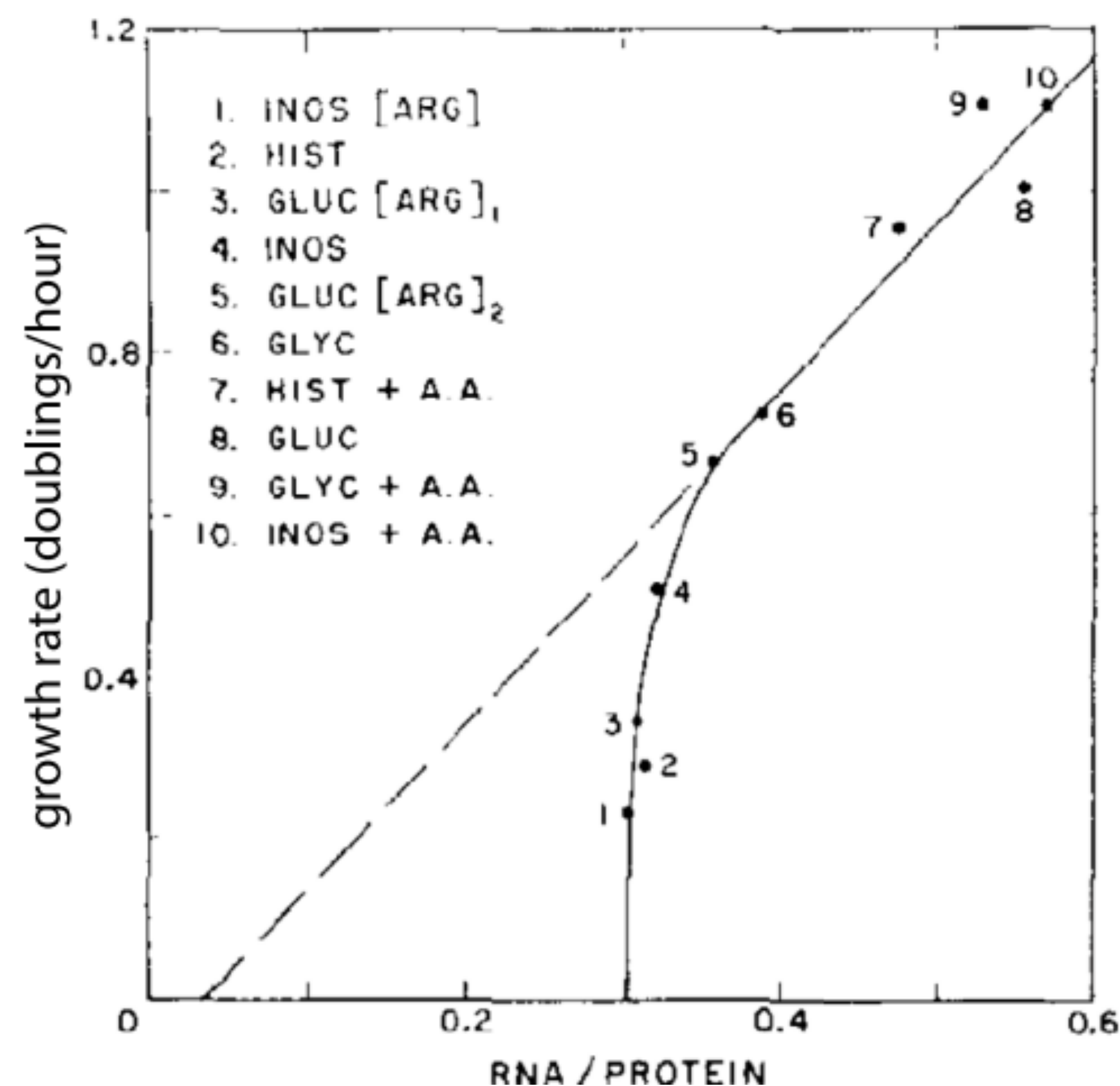
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First growth law: ribosome fraction increases linearly with growth rate

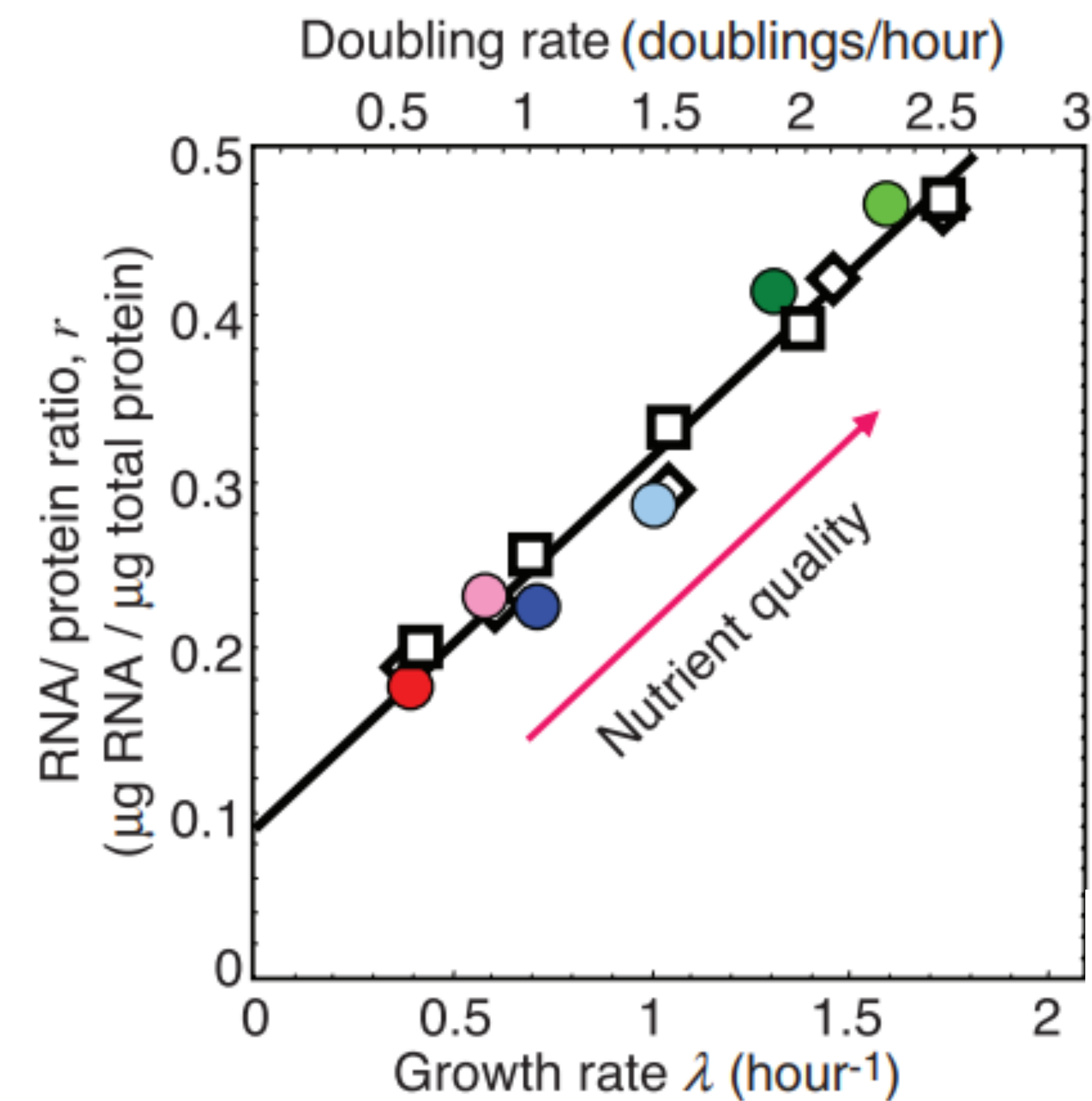


Neidhardt and Magasanik (1960)

First growth law: ribosome fraction increases linearly with growth rate



Neidhardt and Magasanik (1960)



Scott et. al (2010)

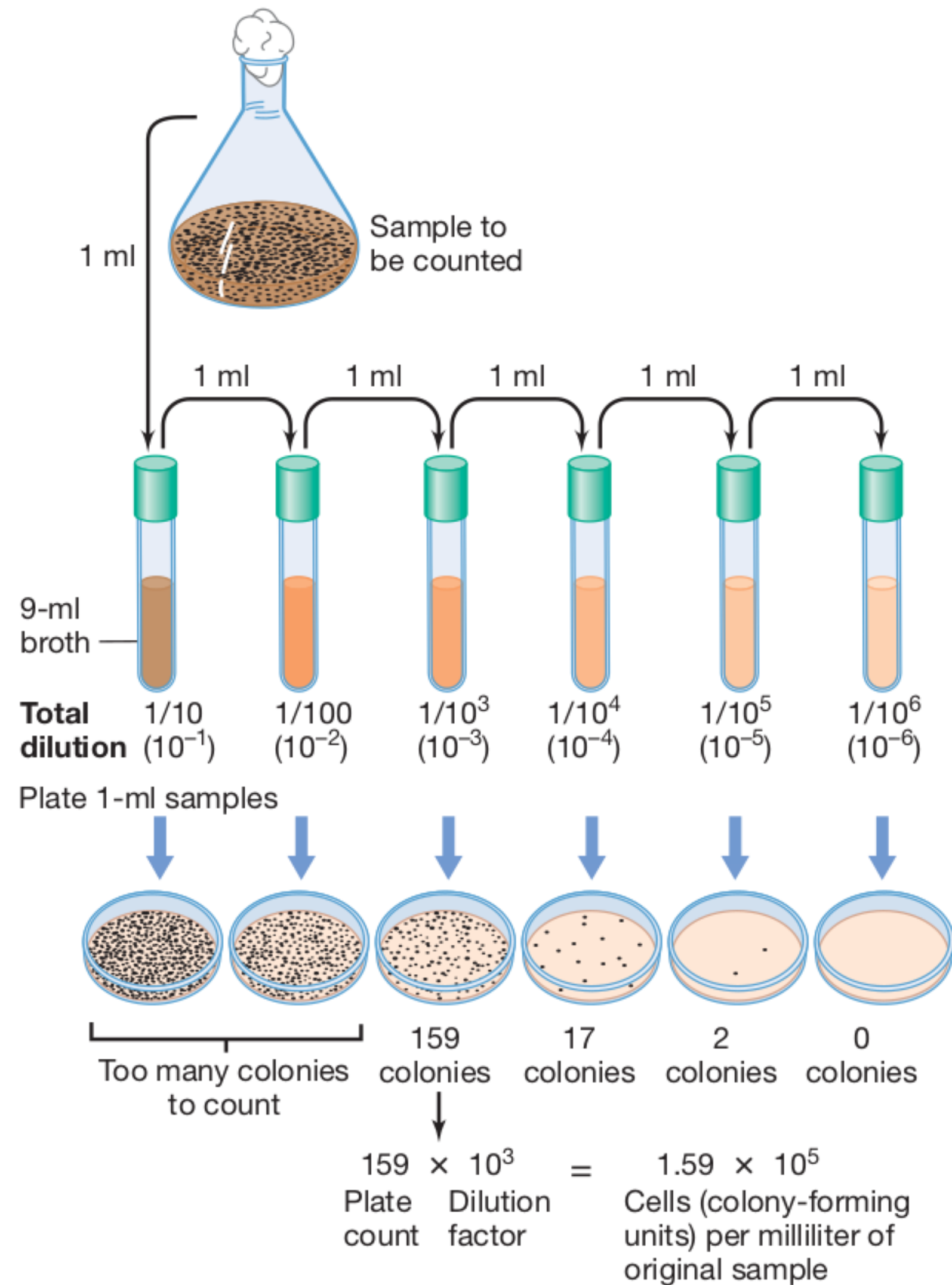
References

Jun et al., 2018 Rep. Prog. Phys. 81 056601

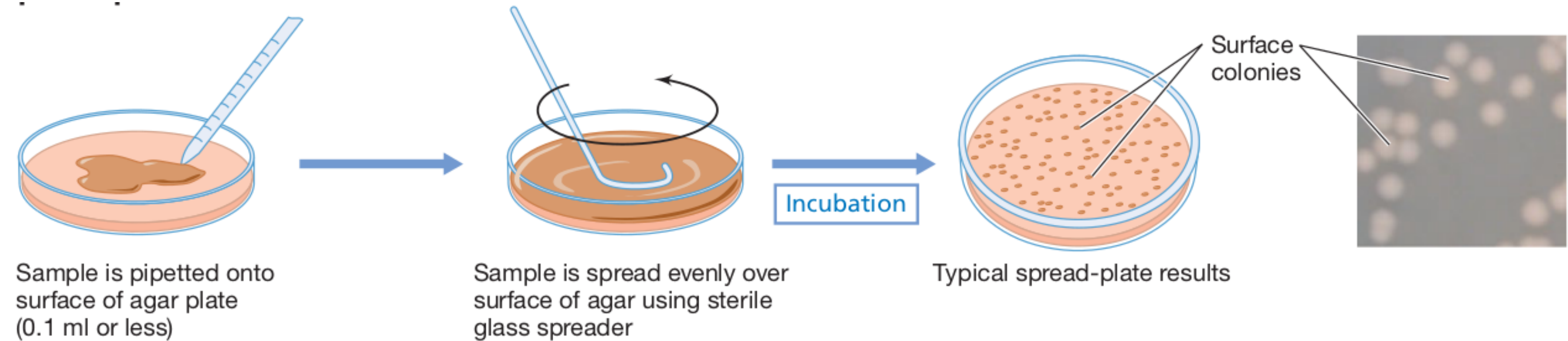
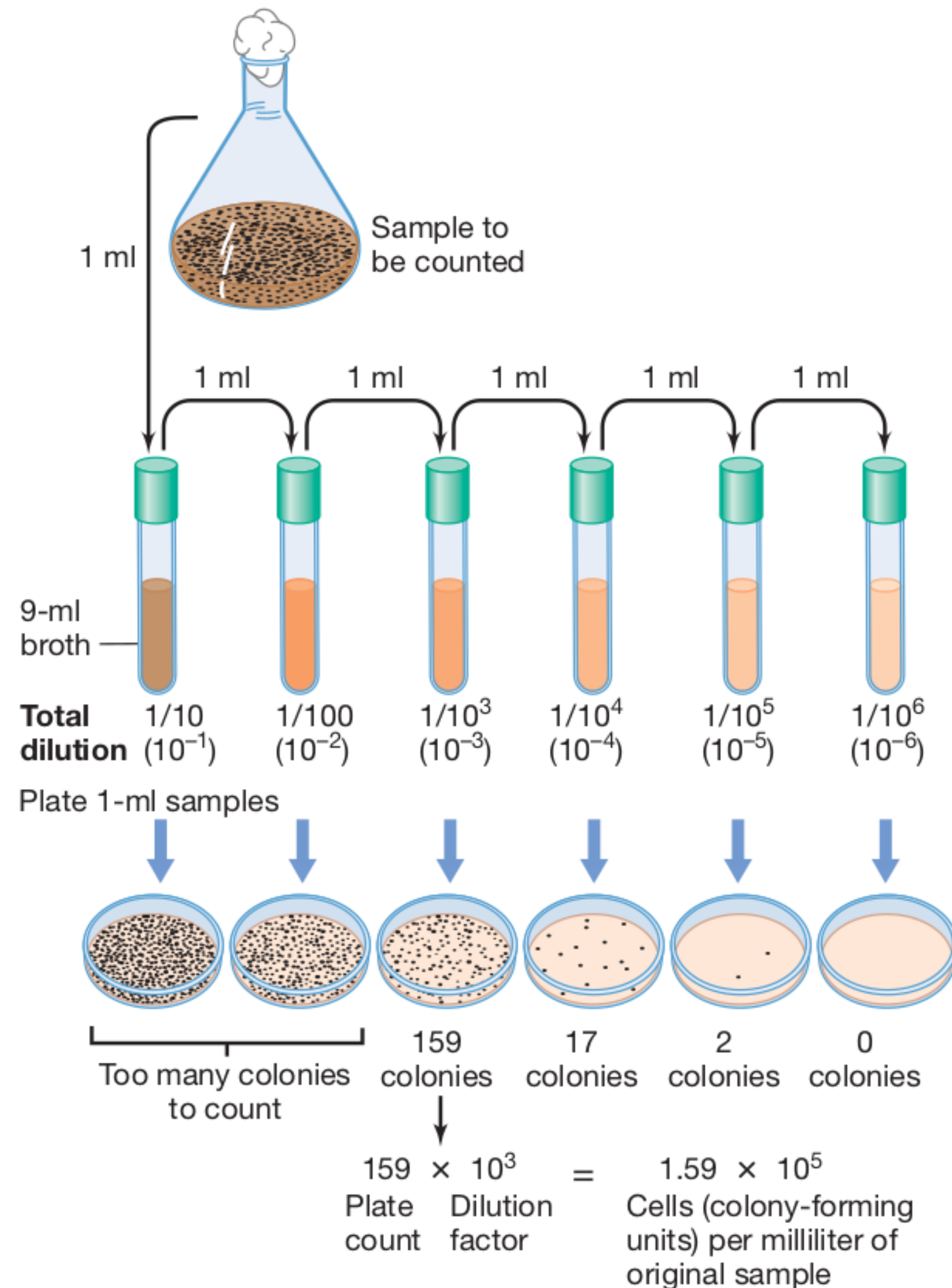
Brock Biology of Microorganisms

Scott et al., Science 2010

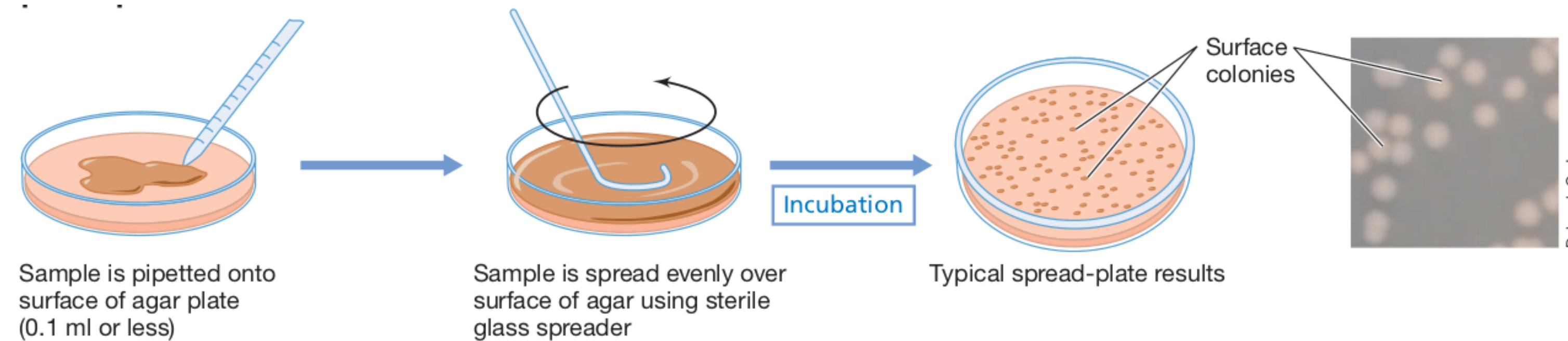
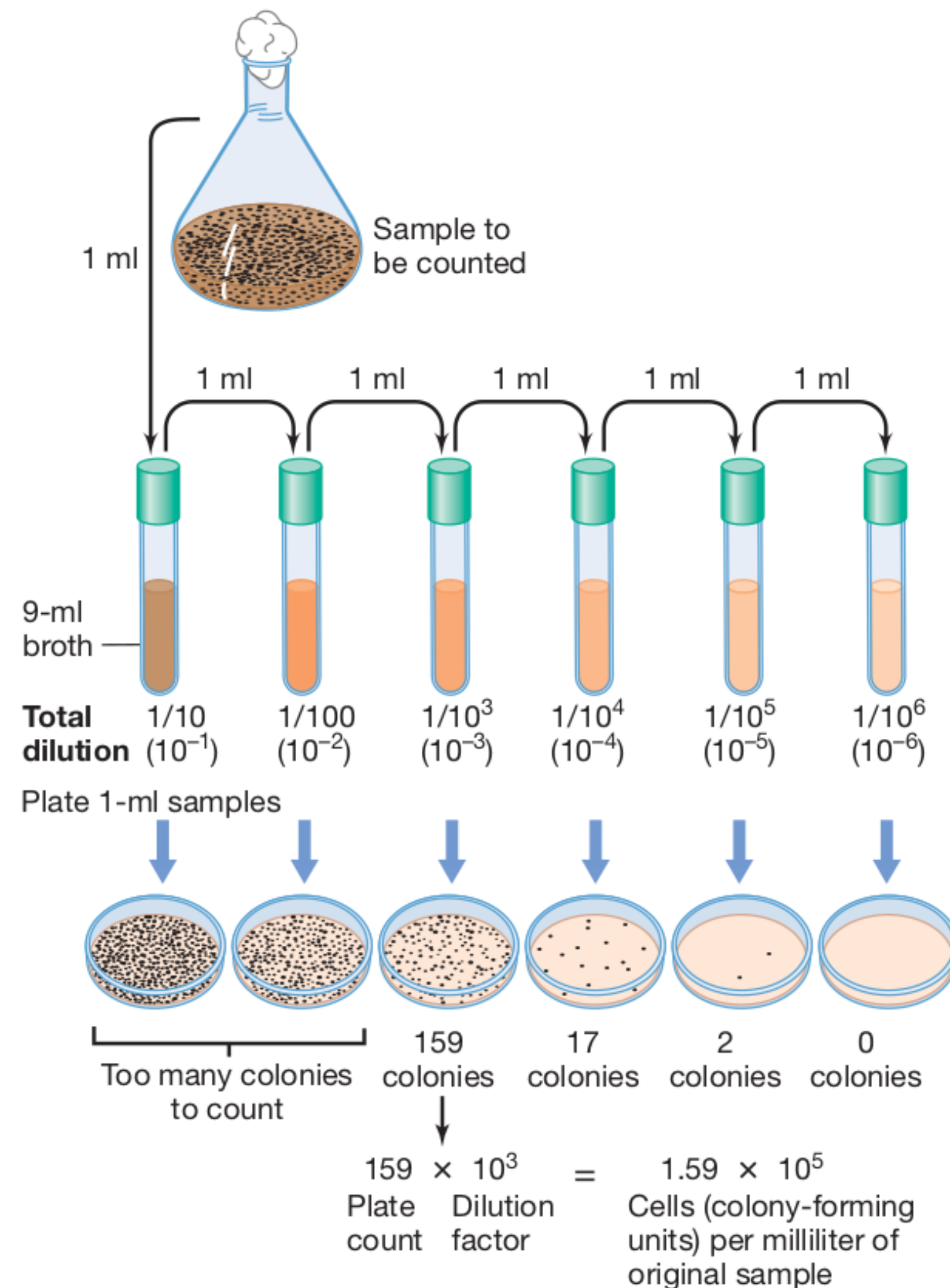
How is growth (cell density) measured? viable counts



How is growth (cell density) measured? viable counts

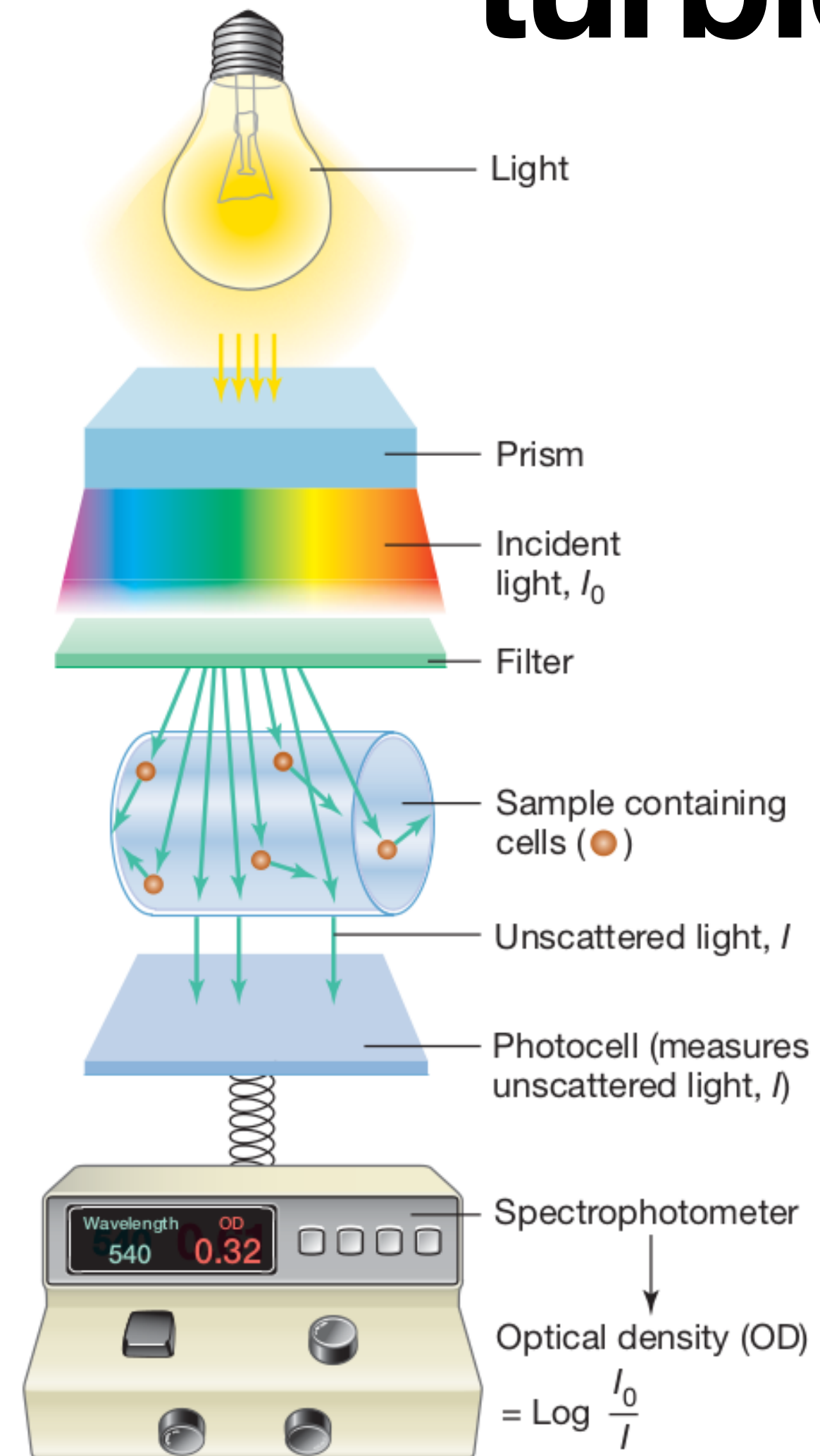
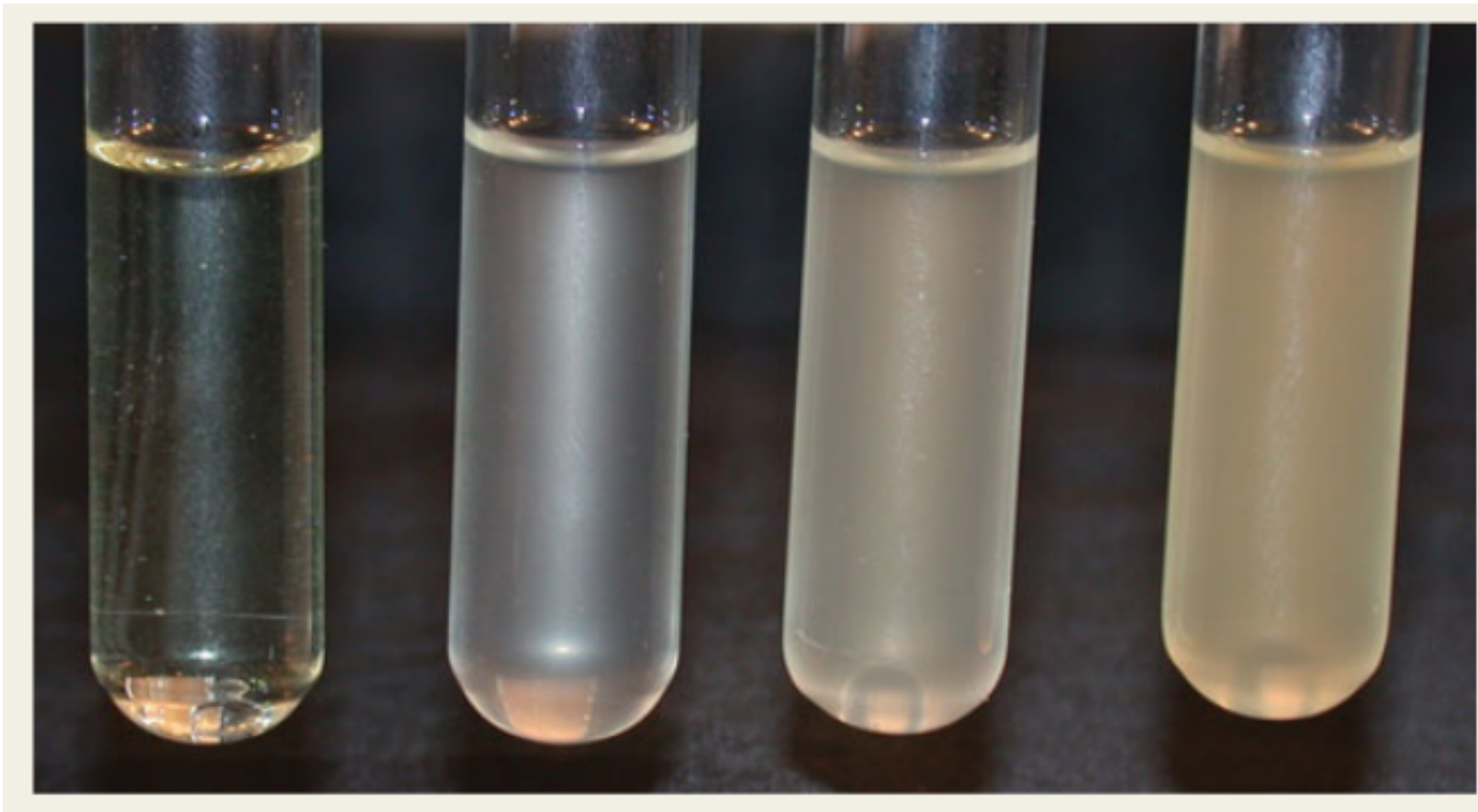


How is growth (cell density) measured? viable counts

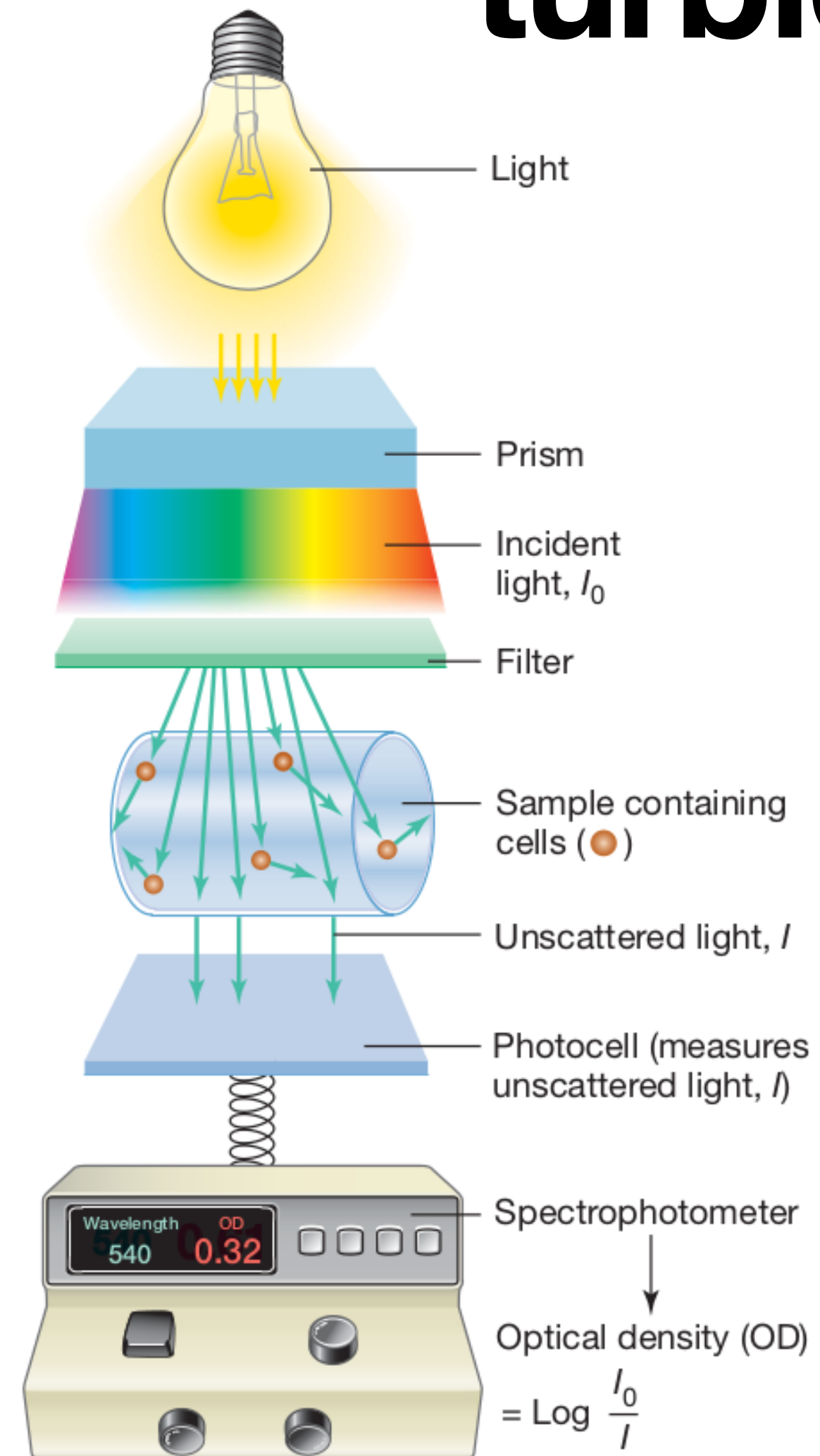
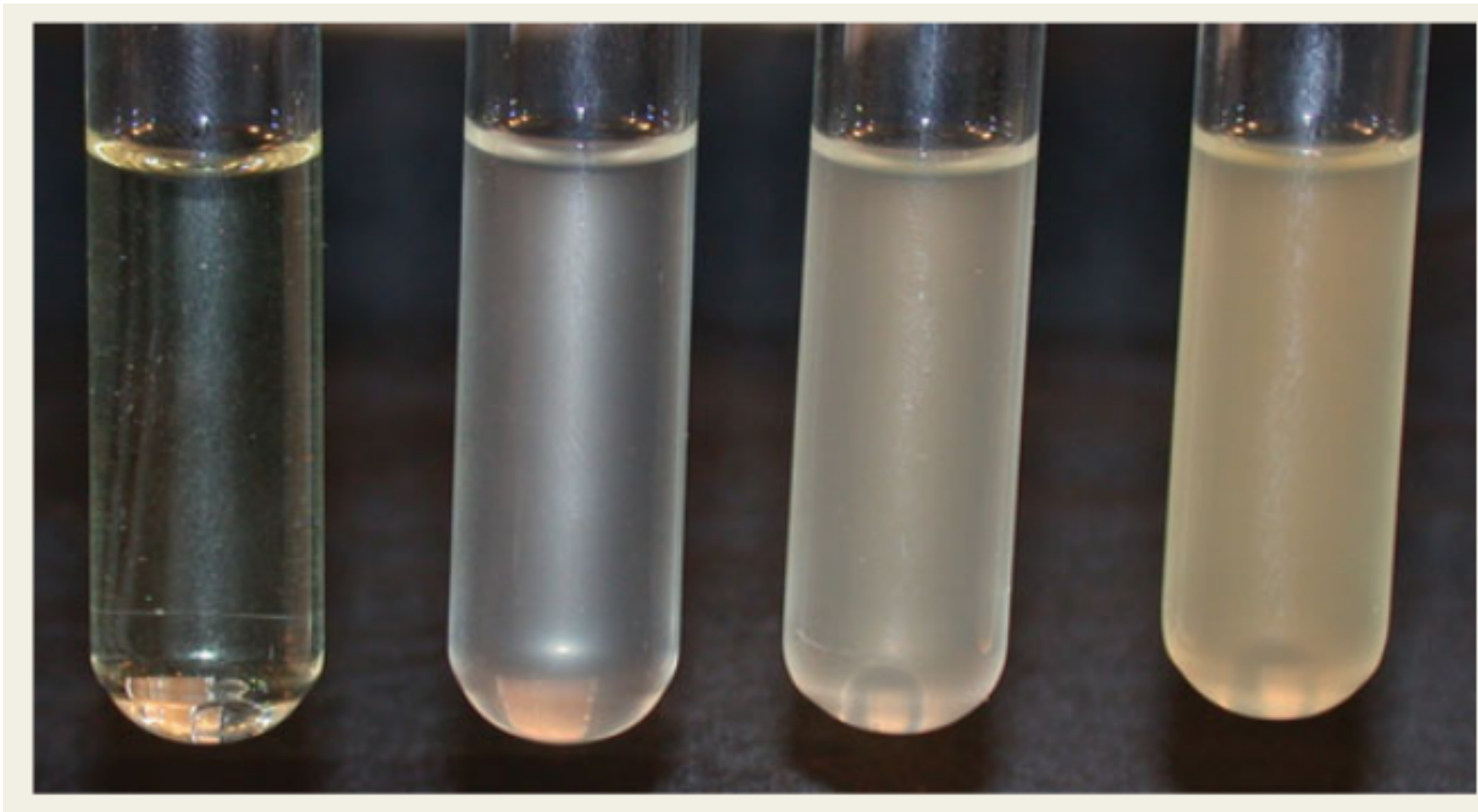


output:
CFU/ml (colony forming units)
how many viable cells there are

How is growth (cell density) measured? turbidity methods



How is growth (cell density) measured? turbidity methods



output:
Optical Density (OD)
1 OD₆₀₀ ~ 3 × 10⁷ cell/ml (E. coli)