$N = (40 \text{ m}^3 \times 10{,}000 \text{ g/m3} \times 1.5 \times 10^{12} \text{ cells/g} \times 0.18 \text{ viable cells/total cells}) : 10^{15}$ viable cells = 108 portions

Q1. 9

What is concentration of viruses in 1 mL of water if concentration of viral biomass is 6.3 ng mL^{-1}? Consider that diameter of vial particle 100 nm and its specific density is 1.2.

Solution Q1.9

Mass of the viral particle is $[\pi \times (1 \times 10^{-7} \text{ m})^3/6] \times 1.2 \text{g/m}^3 \times 10^6 = 6.3 \times 10^{-16}$ g/viral particle

Concentration of viruses in 1 mL of water $= 6.3 \times 10^{-9}$ g mL^{-1} / 6.3×10^{-16} g /viral particle

$= 1 \times 10^7$ viral particles mL^{-1}

Tutorial 2. Cell chemistry and structure

Q2.1

What is content of carbon, hydrogen, oxygen and nitrogen in biomass representing with empirical formula $CH_{1.8}O_{0.5}N_{0.12}$

Use the following atomic weights in your calculations: H=1 C=12   N=14 O =16

Solution Q2.1

M.w. of biomass $= 12 + 1.8 + 16 \times 0.5 + 14 \times 0.12 = 23.48$

Content of H $= 1.8/23.48 = 0.077$ g/g

Content of C $= 12/23.48 = 0.511$ g/g

(Mean content of C in biomass is almost always about 50%)

Content of N $= 14 \times 0.12/23.48 = 0.071$ g/g

Content of O $= 16 \times 0.5/23.48 = 0.341$ g/g

Q2.2

What is empiric formula of microbial product if the contents (w/w) of carbon, hydrogen, oxygen and nitrogen in this product are 60%, 10%, 20%, and 10%.

Use the following atomic weights in your calculations: H=1 C=12   N=14 O =16
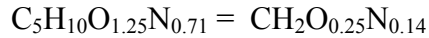
Solution 2.2

Number of C moles in 100 g of product = 60 g/12 g = 5.00

Number of H moles in 100 g of product = 10 g/1 g = 10. 00

Number of O moles in 100 g of product = 20 g/16 g = 1.25

Number of N moles in 100 g of product = 10 g/14 g = 0.71

Molecular content of product can be shown as

$$C_5H_{10}O_{1.25}N_{0.71} = CH_2O_{0.25}N_{0.14}$$

Q2.3

Calculate molar concentration of 16S rRNA-targeted oligonucleotide probe, which is sufficient to detect 10^6 bacterial cells of *Paracoccus denitrificans* suspended in 1 mL of water. Consider that number of ribosomes in cell is 1.5×10^5. Note that one mole of a substance contains 6.023×10^{23} molecules (Avogadro's number).

Solution Q2.3

Concentration of 16S rRNA-targeted oligonucleotide probe = 10^6 cells mL^{-1} x 1.5×10^5 ribosomes (target molecules) $cell^{-1}$ / 6.023×10^{23} molecules/mole
= 2.5×10^{-13} mole mL^{-1} = 25 pmole/ml = 2.5×10^{-10} M = 25 nM = 25 nmole/L

Q2.4

What is content of lipids (g/g) in spherical algal cell shown in Figure below? Diameter of cell is 28μm, and diameter of the lipid globules is 6 μm. Density of cell cytoplasm and cells wall is 1.04 g/cm^3; density of lipid globules is 0.8 g/cm3.

Solution Q2.4

Volume of spherical cell is $V_c = \pi D^3/6 = 11,488$ μm^3;

Volume of spherical lipid inclusions $V_l = 6 \times \pi d^3/6 = 678$ μm^3;

Volume of cell cytoplasm and cell wall $V_s = 10,810$ μm^3;

Content of lipids = 0.8x 678 μm^3 / (1.04 x 10,810 + 0.8x 678 μm^3) = 542/ 11784 = 46 mg of lipids /g of biomass

Q2.5

Calculate the average number of ribosomes in the cell of *E. coli*. Consider that quantity of rRNA in cell is 15% of dry cell mass, there are 3500 nucleotides in one ribosome, average molecular weight of one nucleotide is 348; average dry mass of one cell is 2×10^{-12} g. Note that one mole of a substance contains 6.023×10^{23} molecules (Avogadro's number).

Solution Q2.5

Average number of ribosomes in cell of E. coli = (0.15 g rRNA/g dry biomass x 2×10^{-12} g dry biomass/cell) / (3500 moles of nucleotides/ribosome x 348 g/mole of nucleotide : 6.023×10^{23} molecules/mole) = (0.3 g rRNA$\times10^{-12}$ /cell) : (1.22 x 10^6 g rRNA/ mole ribosome : 6.023×10^{23} molecules/mole) = 1.48×10^5 = 148,000 ribosomes/cell.

Tutorial 3   Metabolism and biodegradation

Q3.1

Determine substances that can be produced from glucose ($C_6H_{12}O_6$), hydrogen sulphide (H_2S), or hydrogen (H_2) by fermentation, anaerobic respiration, and respiration.

Solution Q3.1

Process of energy production	Substrates		
	Glucose ($C_6H_{12}O_6$)	Hydrogen sulphide (H_2S)	Hydrogen (H_2)
	Products		
Fermentation	$C_2H_5OH + CO_2$	No products	No products
Anaerobic respiration	$CO_2 + H_2O$	S, SO_4^{2-}	H_2O
Respiration	$CO_2 + H_2O$	SO_4^{2-}	H_2O

There cannot be any fermentation products from hydrogen sulphide (sulphur is reduced to maximum) or hydrogen (it is reduced to maximum).   Organic (glucose) and inorganic