CONNELL

CO-OP COLLEGE

A level Biology

'Keep warm'

Summer Transition Task

Welcome Year 12

To ensure you make the best start to A level Biology in September, I have created a few tasks for you to complete over the summer holidays.

A level Biology is an amazing A level to study, but it can also be very demanding.

We will be starting Cell Structure for our first module and the tasks that have been set, are aimed to ensure you hit the ground running in September.

Please read through each page of this booklet and answer any questions which follow.

The answers are provided, but please ensure you attempt the questions before looking at them.

Please complete your work on lined paper and mark your answers.

You will need to bring this work with you, for your first lesson.

I look forward to meeting everyone in September. Have an amazing summer.

Dwayne Maynard

Knowledge

2 Cell structure

Cell structure and microscopes

Understanding the structure of cells is a fundamental concept in biology, as every living thing is made up of cells. There are eukaryotic cells (i.e., animal, plant, and fungal cells) and prokaryotic cells (i.e., bacteria). In complex, multicellular organisms, eukaryotic cells become specialised for specific functions.

Microscopes are instruments that have allowed us to observe cell structure and provide evidence to support hypotheses about the roles of cells and organelles.

Magnification and resolution

Magnification	the number of times greater the size of the image is than the size of the real object	$\text{magnification} = \frac{\text{image size}}{\text{size of real object}}$
Resolution	the ability to distinguish between two objects that are very close together – higher resolution means more detail	ribosomes are 25 nm in diameter, so do not interfere with light waves (wavelength of about 400 nm). Therefore they cannot be seen using an optical microscope because its resolution is too low

Staining

Stains are used in microscopy to:

- make cells more visible
- increase contrast
- identify different cell components.

Stains for specific biochemicals are used.

For example, iodine solution stains starch granules blue and black; methylene blue stains genetic material in animal cells blue.

In confocal microscopy, fluorescent dyes can be used to tag specific molecules.

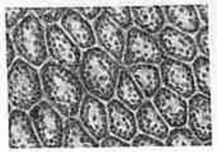
Measuring cells

When using a light microscope, specimens can be measured using two steps:

1 A **stage micrometer** is a slide that has actual scales etched onto it. It is used to calibrate an **eye piece graticule**.

2 An **eye piece graticule** has arbitrary units as a scale for measurement. The scale is used to measure the specimen. The actual measurement of the specimen is calculated using the calibration data (from the stage micrometer).

Microscope images



Plant cells viewed using a light microscope

Chloroplast viewed using a SEM

Microscopes

Microscope	light microscope	transmission electron microscope (TEM)	scanning electron microscope (SEM)	laser scanning confocal microscope (LSCM)
Principles	• uses light to form an image • light that passes through or reflects from the surface of the specimen is seen	• uses electrons to form an image • electrons that pass through the specimen are detected	• uses electrons to form an image • electrons that are reflected from the surface on the specimen are detected	• uses a laser beam to scan an object pixel by pixel, creating a 3D image of the reflected photons. 2D images of higher resolution can also be produced
Functionality	• magnification to 2000× • resolution to 200 nm • living and non-living specimens can be observed	• magnification to 1 000 000× • resolution to 0.2 nm • only dead or non-living specimens can be used	• magnification to 1 000 000× • resolution to 3–20 nm • only dead or non-living specimens can be used	• requires a compromise between resolution, scan time, and photodestruction of the specimen

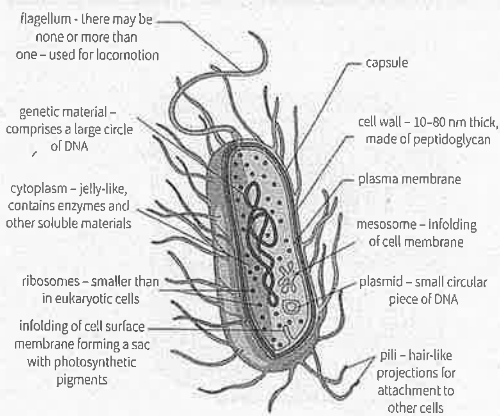
Main organelles in a prokaryotic cell

Prokaryotic cells are much smaller than eukaryotic cells, and differ from them by having:

- a cytoplasm that lacks membrane-bound organelles
- smaller ribosomes (70S instead of 80S)
- no nucleus, instead they have a single loop of DNA that:
  - is free in the cytoplasm
  - has no associated proteins
- a cell wall that contains **peptidoglycan**, a **glycoprotein.**

In addition, many prokaryotic cells have:

- one or more **plasmids**
- a **capsule** surrounding the cell
- one or more **flagella.**

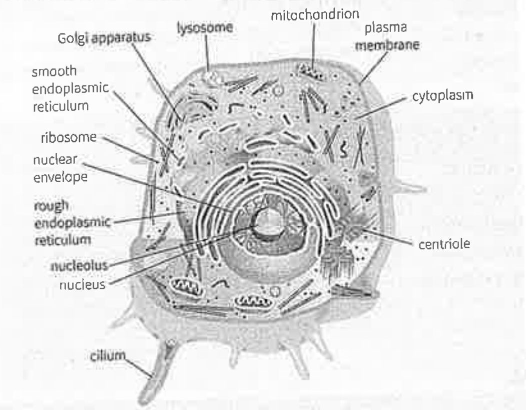


For answers and more practice questions visit www.oxfordrevise.com/scienceanswers

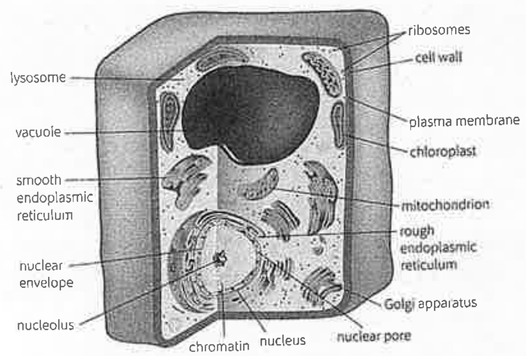
Cell structure and ultrastructure

The light microscope has limitations in magnification and resolution. The use of other types of microscope, using electrons instead of light, has revealed the ultrastructure of cells.

Main organelles in an animal cell



Main organelles in a plant cell



Organelles common to plant and animal cells

Plasma membrane:

- very thin phospholipid bilayer (~ 7 nm) surrounding the cell
- controls exchange between the cell and its environment

Nucleus:

- stores DNA and coordinates the cell's activities, which include growth, intermediary metabolism, protein synthesis, and reproduction
- contains chromosomes (linear DNA strands and associated histone proteins) and one or more nucleoli
- the nuclear envelope has nuclear pores to control exchange between the nucleus and cytoplasm

Mitochondrion:

- ~ 1–10 μm long rod-shaped organelle
- has a smooth outer membrane and an inner membrane highly folded into cristae
- carries out aerobic respiration which takes place in the matrix and on the cristae, producing ATP

Cytoskeleton

The cytoskeleton has three main functions:

1. Giving **mechanical strength** to the cell, to reduce squashing
2. **Aiding transport** within cells including whole organelles
3. **Enabling cell movement.**

Additional organelles

Smooth endoplasmic reticulum (SER) (in plants and animals):

- similar structure to RER, but no ribosomes
- synthesises lipids, steroids, and some hormones (e.g., testosterone and oestrogen).
- synthesises, stores, and transports carbohydrates

Permanent vacuoles (in plants):

- contains sap and helps support the plant

Cell wall (plants, algae, and fungi):

- composed mainly of cellulose in plants
- composed of chitin and cellulose in fungi
- composed of glycoproteins in algae
- provides mechanical strength whilst remaining permeable
- maintains the cell shape and may have pores to connect cells

Chloroplasts (in plants and algae):

- oval-shaped organelles (3–10 μm long)
- surrounded by two membranes
- disc-like thylakoids arranged in stacks called grana
- internal fluid is called the stroma
- the light-dependent reactions of photosynthesis take place on the thylakoid membranes
- light-independent reactions take place in the stroma

Flagella (mostly animal cells and bacteria):

- long, whip-like structures
- involved in motility of the cell

Cilia (mostly animal cells):

- short, hair-like structures
- involved in moving substances past the cell

Centrioles (mostly in animal cells):

- only visible using TEM/SEM
- form spindle fibres involved in mitosis and meiosis
- found at the base of cilia and flagella

Protein production in plant and animal cells

Ribosome

- tiny granules 25 nm in diameter
- site of protein synthesis
- 80S in eukaryotic cells

Rough endoplasmic reticulum (RER)

- an extended system of membrane sacs that runs throughout the cell
- site of protein modification
- encrusted with ribosomes

Golgi apparatus and Golgi vesicles

- stacks of flattened membranes
- collects, processes, and sorts molecules that are then transported in Golgi vesicles to other parts of the cell or secreted out of the cell
- modifies proteins
- makes lysosomes

Lysosome

- a Golgi vesicle that releases lysozyme and contains other hydrolytic enzymes for variety of functions

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Retrieval

Learn the answers to the questions below, then cover t
a piece of paper and write as many as you can. Check a

Questions

1. What is the name of the cell organelle that synthesises proteins?
2. What is the name of the cell organelles that release lysozyme?
3. What is the name of the cell organelle that makes lipids, steroids, and some hormones?
4. Which organelles are involved with protein synthesis?
5. What is the name of the cell organelle that carries out photosynthesis?
6. What is the function of flagella?
7. Describe the structure of a chloroplast.
8. What is the structure and function of cilia?
9. What type of cells are animal, fungal, and plant cells?
10. What type of cells are bacteria?
11. Which three organelles do plant cells have that are not present in animal cells?
12. What is the difference in chemical composition between a eukaryotic plant cell wall and a prokaryotic cell wall?
13. What is the difference between the organelles in a prokaryotic cell and a eukaryotic cell?
14. What is the difference between the ribosomes in a prokaryotic cell and in a eukaryotic cell?
15. Define magnification.
16. How can you calculate the magnification of an object?
17. What is the limitation of light microscopy?

18. Define resolution — the ability to see 2 objects as separate entities; it is the level of detail seen in an image
19. What are the three functions of the cytoskeleton?
   1. mechanical strength
   2. aiding transport within cells
   3. enabling cell movement (e.g., phagocytes and amoebae)

Put paper here

Maths skills

Practise your maths skills using the worked example and practice questions below.

Using standard form

In Biology, it's common to come across extremely large or extremely small numbers that you'll need to work with. To make these more manageable, scientists often convert these numbers into standard form, which presents these numbers in a more concise way.

Standard form is written as:

$$x \times 10^y$$

Where:

x = a number between 1 and 10

y = any positive or negative whole number.

If y is positive, then standard form represents a very big number. If it is negative, it represents a very small number.

For example,

$3\times10^4 = 3\times(10\times10\times10\times10)$

$= 30\,000$

$6\times10^{-3} = \frac{6}{10^3} = \frac{6}{1000}$

$= 0.006$

Worked example

Question

A leaf has 50 000 000 cells on its surface. Give this number in standard form.

Answer

First, you need to break this equation down to find both x and y of:

$$x \times 10^y$$

$50\,000\,000 = 5 \times 10\,000\,000$

So, $x = 5$

Then, you need to find y:

$10\,000\,000 = 10^7$ (there are 7 zeros)

$y = 7$

Therefore, $50\,000\,000 = 5\times10^7$

Question

The diameter of the SARS-CoV-2 viral particle is 0.000 2 mm. Give this number in standard form.

Answer

$0.000\,2 = 2 \div 10\,000$

So, $x = 2$

As there are 4 zeros in 10 000, the power (y) is 4. But, because you had to divide by 10 000, you need to put a minus before our power to convey that it's a small number.

So, $y = -4$.

Therefore, $0.000\,2 = 2\times10^{-4}$

Practice

Express these values in standard form:

1. 25 000
2. 675 000 000
3. 0.000 078

Express these values in normal form:

4. 4.28×10^{-5}
5. 9.7×10^{12}
6. 2.473×10^{-8}

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Units

*Whatever you're investigating in Biology, **units** are important. Without them, a measurement just doesn't make sense. Sometimes you might need to change between units, so knowing how to do a conversion is a pretty useful skill to have.*

Here Are Some **Common Units** You Might See

Height and Length

kilometres (km)
metres (m)
centimetres (cm)
millimetres (mm)
micrometres (μm)

1 kilometre = 1000 metres
1 metre = 100 centimetres
1 centimetre = 10 millimetres
1 millimetre = 1000 micrometres

Area

square metres (m^2)
square centimetres (cm^2)

1 square metre = 10 000 square centimetres

Mass

kilograms (kg)
grams (g)
milligrams (mg)
micrograms (μg)

1 kilogram = 1000 grams
1 gram = 1000 milligrams
1 milligram = 1000 micrograms

Volume

cubic decimetres (dm^3)
cubic centimetres (cm^3)
microlitres (μl)

1 cubic decimetre = 1000 cubic centimetres
1 cubic centimetre = 1000 microlitres

Time

hours (h)
minutes (min)
seconds (s)
milliseconds (ms)

1 hour = 60 minutes
1 minute = 60 seconds
1 second = 1000 milliseconds

You Might Need To **Convert** Between Units

Knowing how different units are related to each other can come in useful if you need to swap from one to the other. You just have to remember the number you have to multiply or divide by (the **conversion factor**).

When you're converting between units of length, mass or time:

- To convert from a **bigger** unit to a **smaller** unit, you need to **multiply** by the conversion factor.
- To convert from a **smaller** unit to a **bigger** unit, you need to **divide** by the conversion factor.

E.g. from m to cm: 2 m × 100 = 200 cm

Centimetres are smaller than metres, so this needs to be a multiplication.

1 m = 100 cm, so the conversion factor is 100.

E.g. from g to kg: **5000 g ÷ 1000 = 5 kg**

Kilograms are bigger than grams, so this needs to be a division.

1 kg = 1000 g, so the conversion factor is 1000.

Area and **Volume** Are Trickier To Convert

Watch your step now... 1 m = 100 cm **does not** mean that 1 m^2 = 100 cm^2.
The easiest way to convert between units of area or **volume** is to remember that if a unit is **squared** or **cubed**, then you should do the **same** to the standard conversion factor.

1) To convert between units of area, follow this rule:

If the area units are **squared**, you should **square** the conversion factor.

The units are square metres.

E.g. from m^2 to cm^2: 5 m^2 × 10 000 = 50 000 cm^2

The conversion factor for m to cm is 100, so the conversion factor for m^2 to cm^2 is 100^2.
100 × 100 = 10 000

Units

2) To convert between units of volume, follow this rule:

If the volume units are **cubed**, you should **cube** the conversion factor.

The units are cubic decimetres.

E.g. from dm^3 to cm^3: 9 dm^3 × 1000 = 9000 cm^3

1 dm = 10 cm, so the conversion factor for dm^3 to cm^3 is 10^3.
10 × 10 × 10 = 1000

Bernard's attempt to convert his horse into a tea towel was surprisingly successful.

Worked Example

A plant produces 5.4 cm^3 of oxygen in one hour.
Assuming that the rate of production is constant, how much oxygen does the plant produce per minute? Give your answer in mm^3 min^{-1}.

The little '−1' just means 'per'. So mm^3 min^{-1} means mm^3 per minute. Sometimes units can get a bit more complicated, e.g. cm^3 g^{-1} hr^{-1} means cm^3 per gram per hour.

1. ***Work out the volume produced in one minute.***
   1 hour = 60 minutes, so 5.4 cm^3 is produced in 60 minutes.
   Divide by 60 to work out how much is produced per minute. → 5.4 ÷ 60 = **0.09 cm^3 min^{-1}**

   0.09 cm^3 of oxygen is produced in one minute.

2. ***Work out the volume conversion factor.***
   1 cm = 10 mm, so the conversion factor from cm to mm is **10**.
   The units in the question are **cubic**, so the conversion factor needs to be **cubed** too. → The conversion factor = 10^3 = **1000**

3. ***Work out whether to multiply or divide.***
   Millimetres are a **smaller** measurement than centimetres, so you are going from a **bigger** unit to a **smaller** unit.
   That means you need to **multiply** by the conversion factor.

4. ***Multiply the volume in cm^3 by the conversion factor to find the answer.***
   0.09 cm^3 min^{-1} × 1000 = **90 mm^3 min^{-1}**

   Don't forget to use the new units for your answer.

Practice Questions

Q1 Convert the following:
a) 42 kg to grams. b) 5 m^3 to cubic centimetres. c) 2000 cm^2 to square metres.

Q2 The body of a locust is 7.1 cm long and its mass is 1.8 g.
a) What is its length in metres? b) What is its mass in milligrams?

Q3 An adult human's kidneys process approximately 1200 cm^3 of blood every minute.
a) What is this volume in cubic decimetres?
b) How much blood is processed by the kidneys every second? Give your answer in mm^3.

I asked my gran about units and she taught me how to crochet...
A simple trick for perfectly converted units is to always check your answer — the number of small units should always be greater than the number of big units. If it's the other way round, you've probably gone the wrong way.

Rounding

*Sometimes a calculation will give you a number with **loads of digits** after the decimal point. Rather than writing them all down, **rounding** can **cut out** a load of those digits while keeping the **value** of the number roughly the **same**. Neat.*

Rounding Gives Long Numbers A Sensible Length

The transpiration rate of a plant is found by the calculation: 2.9 cm³ ÷ 15 min

2.9 cm³ ÷ 15 min = 0.19333333333333333333333333... cm³min⁻¹

As the digits go further to the right, they get smaller in value.

The answer rounded to **ten** digits after the decimal place is: 0.1933333333 cm³min⁻¹

More digits makes the rounded answer more accurate as it is closer to the real value of the answer.

The answer rounded to **five** digits after the decimal place is: 0.19333 cm³min⁻¹

The answer rounded to **two** digits after the decimal place is: 0.19 cm³min⁻¹

Rounding to fewer digits makes the answer less accurate but the number is easier to use.

You Can Round to a Certain Number of Decimal Places...

Say you were rounding 4.26866 to 2 decimal places. Here's what you'd do:

1) Find the position of the **last digit**.

1 2 3 4 5
4.26866

Start counting from the decimal point. You're rounding to **two** decimal places, so the last digit is the **second** one to the right.

2) Look at the next digit to the **right**. 4.26866

The next digit is more than 5, so round the last digit up from 6 to 7.

3) If that digit is **less than 5**, the last digit stays the **same**. If the digit is **5 or more**, round **up** the last digit.

4.26866 → 4.27

Don't give any more digits after the second decimal place.

...or to a Certain Number of Significant Figures

Rounding to significant figures is the **same** as rounding to decimal places, except for one thing — instead of counting from the decimal point, start counting from the **first digit** that **isn't zero**.

This is the **first** significant figure — start counting from here.

1 2 3 4 5
0.0020546

These zeros aren't significant figures — they just tell you how small the number is.

Any zeros **after** the first significant figure **are included** as significant figures.

So 0.0020546 to 3 significant figures would be 0.00205.

Rounding

If you're not told how to round your answer, you can **work out** the number of significant figures that you should round to by looking at the measurements you're using in the calculation.

Just **count** the number of significant figures for each measurement and use the **lowest** number of significant figures for your answer.

For example: 1.2 ÷ 1.85 = 0.648648648... = 0.65

2 significant figures — 3 significant figures — So the answer should be rounded to 2 significant figures. — Round the last digit up to 5.

You should always use the lowest number of significant figures because the fewer digits a measurement has, the less accurate it is. Your answer can only be as accurate as the least accurate measurement in the calculation.

Worked Example

The growth rate of a plant is 0.023735 cm hour⁻¹. What is the rate to:
a) **3 decimal places?** b) **3 significant figures?**

1. ***For part a), first find the position of the last digit.***
Start counting from the decimal point.
The last digit is in the third decimal place.

1 2 3
0.023735

The last digit is 3.

2. ***Then look at the next digit to the right to round the number to 3 decimal places.***

The next digit is 7. 0.023735 — 7 is more than 5, so round the last digit up to 4.

0.023735 = **0.024 (3 d.p.)**

It's helpful to let anyone reading your answer know how you've rounded it — d.p. just stands for decimal places.

3. ***For part b), first find the position of the last digit.***
Start counting from the first digit that isn't a zero.
The third digit along is the third significant figure.

Ignore these two zeros.

1 2 3
0.023735

The last digit is 7.

4. ***Then look at the next digit to the right to round the number to 3 significant figures.***

The next digit is 3. 0.023735 — 3 is less than 5, so the last digit stays the same.

0.023735 = **0.0237 (3 s.f.)**

s.f. is a short way of saying 'significant figures'. You might also see it written as 'sig. fig.'

Practice Questions

Q1 Write down the following amounts:

a) 0.0719 g s⁻¹ to 3 decimal places

b) 8.045 dm³ to 2 significant figures

Q2 A student is calculating the average growth rate of a tray of seedlings by dividing the average change in seedling height by the incubation time. The average change in seedling height is 17.5 cm and the incubation time is 60 days.
What is the average growth rate (in cm day⁻¹)?
Give your answer to an appropriate number of significant figures.

My sheepdog's no good at maths — he can only round up...

Rounding isn't glamorous, I admit, but it comes in really useful when you end up with an answer that's as long as your arm. Don't round any numbers until right at the end of a calculation though, or you'll lose the accuracy of the measurements.

Answers for Units and Rounding sheets

Page 9 — Units

1 a) 42 kg × 1000 = **42 000 g**

b) 5 m^3 × 100^3 = **5 000 000 cm^3**

c) 2000 cm^2 ÷ 100^2 = **0.2 m^2**

2 a) 7.1 cm ÷ 100 = **0.071 m**

b) 1.8 g × 1000 = **1800 mg**

3 a) 1200 cm^3 ÷ 1000 = **1.2 dm^3**

b) 1200 cm^3 ÷ 60 = 20 cm^3

20 cm^3 × 1000 = **20 000 mm^3**

Page 11 — Rounding

1 a) 0.072 $g\,s^{-1}$

b) 8.0 dm^3

2 17.5 cm ÷ 60 days = **0.29 cm day^{-1} (2 s.f.)**

Answers for the Cells Retrieval Task are on the next page

Retrieval

Learn the answers to the questions below, then cover the answers column with a piece of paper and write as many as you can. Check and repeat.

Questions	Answers
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3 What is the name of the cell organelle that makes lipids, steroids, and some hormones?	smooth endoplasmic reticulum
4 Which organelles are involved with protein synthesis?	nucleus, rough endoplasmic reticulum (RER), ribosomes, Golgi apparatus and vesicles
5 What is the name of the cell organelle that carries out photosynthesis?	chloroplasts
6 What is the function of flagella?	locomotion
7 Describe the structure of a chloroplast.	oval-shaped organelle, 3–10 µm long surrounded by two membranes, with disc-like thylakoids arranged in stacks called grana; the internal fluid is called the stroma
8 What is the structure and function of cilia?	made of microtubules, cilia are short, hair-like structures involved in moving substances past the cell
9 What type of cells are animal, fungal, and plant cells?	eukaryotic
10 What type of cells are bacteria?	prokaryotic
11 Which three organelles do plant cells have that are not present in animal cells?	permanent vacuole, cell wall, and chloroplasts
12 What is the difference in chemical composition between a eukaryotic plant cell wall and a prokaryotic cell wall?	plant cell walls contain cellulose; bacterial cell walls contain peptidoglycan, a glycoprotein
13 What is the difference between the organelles in a prokaryotic cell and a eukaryotic cell?	prokaryotic cells lack membrane-bound organelles
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16 How can you calculate the magnification of an object?	magnification = image size ÷ actual size of object
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Worked example

Question

A leaf has 50 000 000 cells on its surface. Give this number in standard form.

Answer

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$50\,000\,000 = 5 \times 10\,000\,000$

So, $x = 5$

Then, you need to find y:

$10\,000\,000 = 10^7$ (there are 7 zeros)

$y = 7$

Therefore, $50\,000\,000 = 5\times10^7$

Question

The diameter of the SARS-CoV-2 viral particle is 0.000 2 mm. Give this number in standard form.

Answer

$0.0002 = 2 \div 10\,000$

So, $x = 2$

As there are 4 zeros in 10 000, the power (y) is 4. But, because you had to divide by 10 000, you need to put a minus before our power to convey that it's a small number.

So, $y = -4$.

Therefore, $0.0002 = 2\times10^{-4}$

Practice

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