2020 AUSTRALIAN SCIENCE OLYMPIAD EXAM

JUNIOR SCIENCE OLYMPIAD

2020 Australian Junior Science Olympiad Exam

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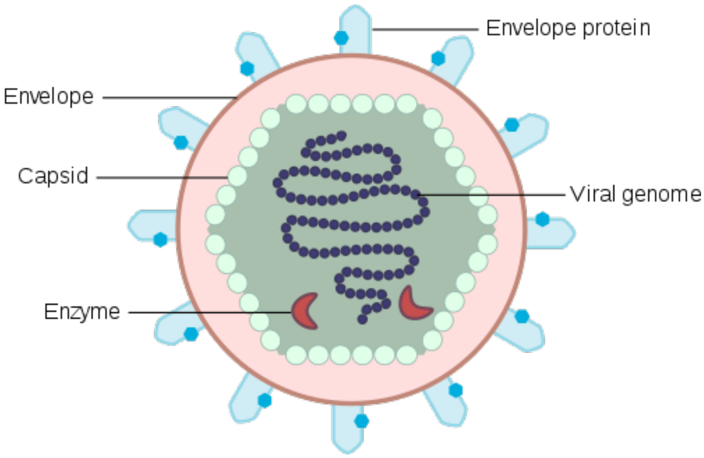
Number	Question text
1.	Living organisms are generally divided into kingdoms. Over time, a number of different methods of classification have been proposed, and the number of kingdoms is not universally agreed on. However, the groupings of plants, animals, fungi, protists (protozoa) and bacteria usually feature in the list. Which of the following would be found in an animal cell but not a bacterial cell? A. DNA B. Ribosomes C. Plasma membrane D. Cell wall E. Mitochondria
2.	Organisms that do not have the ability to produce or synthesis their own food are called: A. Autotrophs B. Anaerobic C. Photosynthetic D. Heterotrophs E. Decomposers
3.	A virus is a tiny infectious particle that replicates only inside the living cells of an organism. Since they were first identified in the late 1800s, viruses have been found in almost every ecosystem on Earth and are the most numerous type of biological entity. The study of viruses is known as virology. Viruses can infect all types of life forms, from animals and plants to bacteria. Viruses cannot self-replicate, but when a virus particle infects a cell in a host organism, the cell is forced to rapidly produce thousands of identical copies of the original virus. Compared to living organisms, viruses are simple structures, with no organelles. They are essentially a tiny capsule containing a strand of DNA. The surface of the capsule has proteins on it that are important to the function of the virus. The DNA inside the capsule contains the information to build the surface proteins so that more virus particles can be made.  *DEXi/CC0* Viruses are not generally classified as being alive. Which of the following is a reason for this? A. Viruses rely on other organisms for their continued existence B. Viruses can be destroyed by exposure to alcohol or soap C. Viruses don’t have a nucleus D. Viruses can’t self-replicate

4. Life on Earth has been evolving for about 4 billion years. We know from multiple sources of evidence that for any given species, evolution requires the following factors:

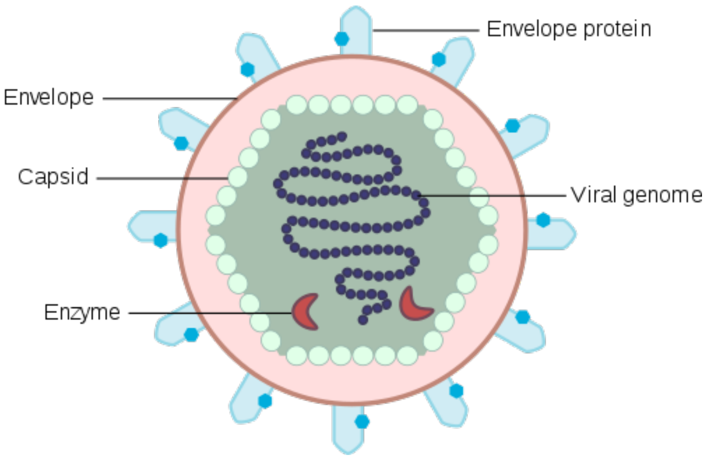
- genetic diversity within the population
- inheritance of genetic material from one generation to the next
- natural selection
- plenty of time

One of the reasons that viral diseases can be difficult to manage is the speed with which viruses evolve. For instance, because the family of influenza viruses is constantly evolving, new flu vaccines must be produced each year.

Consider the following four statements. Which statement is NOT a reason why viruses could evolve more quickly than, for example, mammals?

A. Viruses have a relatively high mutation rate, which means a lot of genetic variety.
B. One host can produce millions of viruses, so the virus population size is large.
C. Viruses reproduce quickly, so many generations can be produced in a short period of time.
D. Genetic information is passed from the original infecting virus to all the new virus particles produced in a host.

5. A virus gains entry to a host cell via a specific interaction between its own surface (or envelope) proteins, and proteins on the surface of the host cell. This means the surface proteins (shown in blue in the diagram below) play a crucial part in how infectious the virus is. A virus with the wrong kind of surface protein will not be able to infect a host's cells.



DEXi / CC0

The surface proteins are also important in determining whether a host is immune or not. A host's immune system recognises a virus it has encountered before by the virus's surface proteins.

When a virus enters a cell, it hijacks the cell's own machinery to create more copies of its own DNA. All DNA copying processes are prone to errors, and this means that a proportion of the new virus particles have mutations (changes) in their DNA and in their surface proteins. These mutations may be small or significant.

One class of antiviral drugs, used to treat viral diseases, works by increasing the rate of mutation during the copying process. This leads to a higher proportion of mutated viruses.

Which of the following statements is **incorrect**?

A. A high rate of mutation increases the probability that previously infected hosts may not be immune if they are re-exposed to the virus.
B. A high rate of mutation increases the infectiousness and lethality of all virus copies.
C. A high rate of mutation increases the probability that the virus could migrate to a different host species.
D. A high rate of mutation makes it harder to create an effective vaccine against the virus.

6.

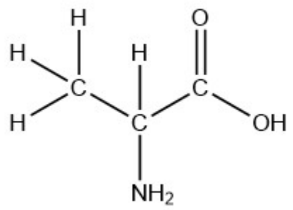
Proteins are an important class of molecules in living organisms. They perform a wide range of jobs including signalling, transport, forming structures, and speeding up chemical reactions. Each of the thousands of types of protein in an organism has a specific structure and does a specific job.

Despite the huge variety in protein molecules, they are all constructed in the same way. Each one is a very long chain-like molecule made of many smaller molecules joined end-to-end, rather like beads than can clip together into a chain. The smaller molecules (the 'beads') are known as amino acids.

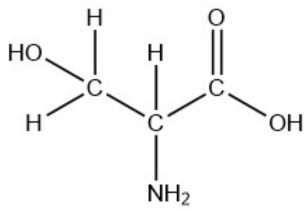
There are twenty natural amino acids. All proteins are made from different sequences of these twenty.

In the diagrams below, each atom is represented by its chemical symbol (e.g. C = a carbon atom) and the straight lines between atoms represent the chemical bonds that hold them together. Sometimes for convenience, the straight line is omitted and the two bonded atom symbols are written next to one another. For instance, OH means a hydrogen atom bonded to an oxygen atom.

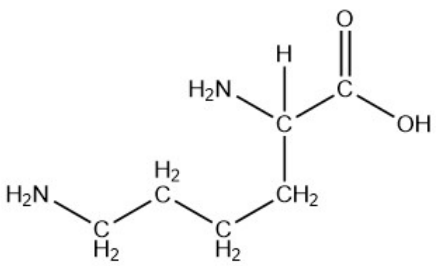
All amino acids have the same basic structure. To illustrate this, four complete amino acid molecules are shown below. Note that when a molecule's structure is drawn like this, the arrangement of the atoms on the page is not important – the only thing that matters is which atom is joined to which.



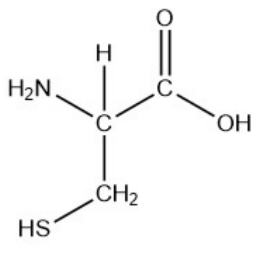
alanine



serine



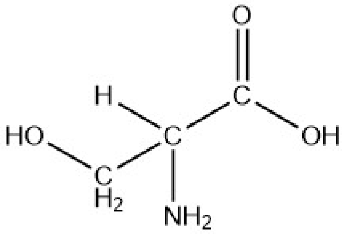
lysine



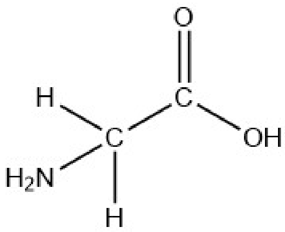
cysteine

Figure 1: four amino acids

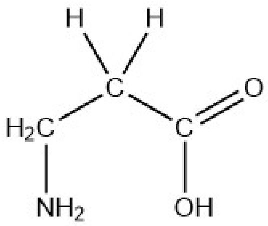
Four molecules are depicted below, labelled A, B, C and D. Which of the four molecules is NOT an amino acid?



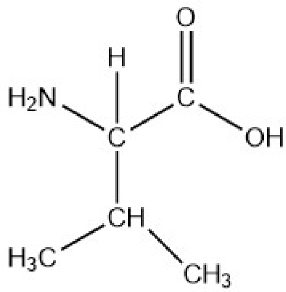
A



B



C



D

A. Molecule A
B. Molecule B
C. Molecule C
D. Molecule D

7. DNA uses a code based on four molecules (known as ‘bases’) which we can represent with letters: A, C, T and G. The bases are arranged in groups of three (called ‘codons’). Each codon represents one of the 20 amino acids.

For example, the following table shows which amino acid is encoded by each of the following codons:

Codon	Amino acid
CGT	Alanine
TTT	Lysine
AGG	Arginine
GGA	Glycine

A very short protein consisting of alanine-glycine-arginine-alanine would therefore be encoded by CGTGGAAGGCGT.

If, instead of 20 different amino acids, proteins were composed of only 12 different amino acids, what is the smallest possible codon size that could be used in DNA to encode them all?

A. 1
B. 2
C. 3
D. 4

8.

One of the symptoms of COVID-19, along with many other diseases, is a fever. When a person has a fever, it means their internal body temperature is higher than the normal healthy range.

Internal body temperature is regulated by various feedback systems to maintain homeostasis (a steady state) in the body. The effect of the feedback systems is to prevent body temperature from rising too high or falling too low.

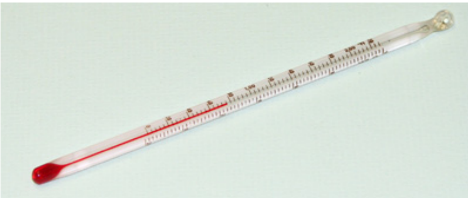
Which types of feedback systems are most common to maintain homeostasis in the human body?

A. Positive feedback systems
B. Negative feedback systems
C. Both positive and negative feedback systems are common
D. Both positive and negative feedback systems are rare

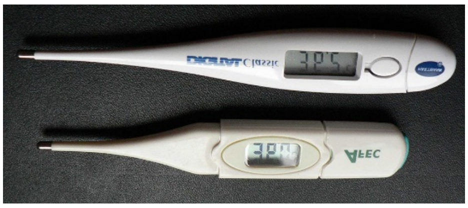
9.

Fever is a symptom of COVID-19, so one method for detecting people who might be infected with coronavirus is to check their temperature.

One way a health worker could check your temperature is to put a contact thermometer under your tongue. This would either be a traditional liquid thermometer or an electronic thermometer. When the same thermometer needs to be used on many people, it must be sterilised between patients.



https://www.sciencelabsupplies.com/Lab-Thermometer-6-Red-Alcohol-10-to-110-C.html



Biol / Public Domain

To avoid physical contact, your temperature could instead be checked using a **non-contact thermometer** or thermal imaging. In this type of device, the heat released by your body is detected from a distance and either reported as a temperature or shown as a heat image.

Mos.ru / CC BY (https://creativecommons.org/licenses/by/4.0)

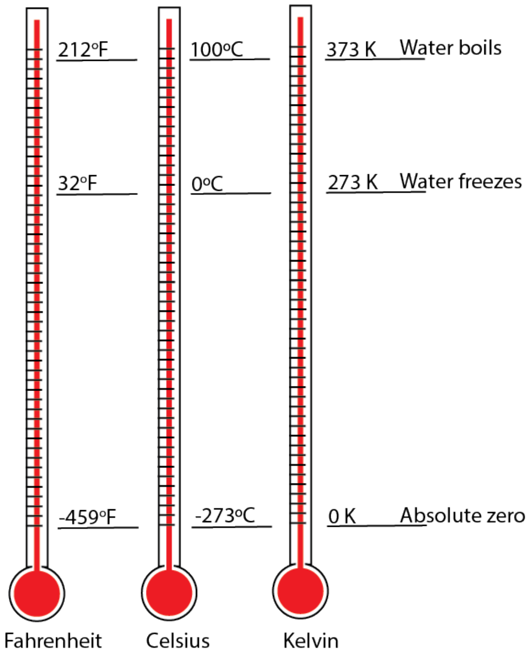
In each sentence below, circle the type of **heat transfer** that each type of thermometer relies on.

A contact thermometer relies on conduction/convection/radiation.

A non-contact thermometer relies on conduction/convection/radiation.

10. The three most common scales used to measure temperature are the Fahrenheit scale (used mostly in north America), the Celsius scale (used in most other countries) and the Kelvin scale (used in science, particularly physics and chemistry).

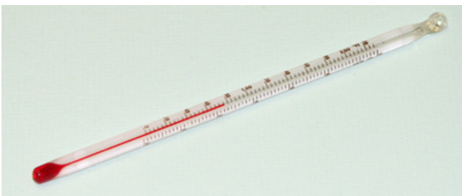
The following diagram shows how the three temperature scales are related.



Which of the following statements is **correct**?

A. (Temperature in Kelvin) = (Temperature in Celsius – 273)
B. There is a nonlinear relationship between the Celsius and Fahrenheit scales.
C. 1°F measures a smaller change in temperature than 1°C.
D. 50.0°C is equivalent to 74°F.

11. In an old-fashioned liquid thermometer, liquid rises from a bulb up a narrow tube with a graduated scale printed on it. The liquid is usually alcohol with food colouring in it.



https://www.sciencelabsupplies.com/Lab-Thermometer-6-Red-Alcohol-10-to-110-C.html

As the temperature rises, the column of liquid rises higher up the tube. A person can read the temperature from the thermometer by comparing the top of the liquid column to the graduated scale.

Which of the following most accurately describes the principle by which a liquid thermometer works?

A. As the alcohol heats up, the molecules vibrate more vigorously, which causes the substance's density to decrease.
B. As the alcohol heats up, its density increases, which causes its volume to increase.
C. As the alcohol heats up, its mass increases proportionally with its volume.
D. As the alcohol heats up, the molecules expand, which causes the alcohol's volume to increase.

12.	In order to be sure that a thermometer is accurately recording temperature, thermometers should be calibrated. This usually involves using the thermometer to measure a material whose temperature is already accurately known; for instance, boiling water. Below is a method for calibrating a thermometer. ***How to calibrate a thermometer.*** *Step 1: Boil tap water and pour into a suitable container (such a mug or beaker)* *Step 2: Place your thermometer into the container* *Step 3: Wait for 2 minutes* *Step 4: Check that the temperature is between 99°C and 101°C* *Step 5: If the temperature isn't correct, adjust your thermometer to the correct temperature while it is still in the water. If you can't manually adjust your thermometer, arrange for professional re-calibration or get a replacement.* Which of the following is the **most significant reason** why this is not a reliable method for calibrating a thermometer? A. Thermometers can’t be adjusted. B. You’re only checking one temperature. C. You need some independent way to measure the boiling temperature of water. D. Heat transfer will occur from the water to the mug.

13.

All objects emit infrared radiation, and the warmer they are, the more infrared radiation they emit.

Infrared or laser thermometers use this principle to measure an object's temperature by detecting how much infrared radiation it is emitting.

The pictures below show the same scene. The first picture was taken with a camera that detects visible light only.

The second picture was taken with an infrared camera, which detects the infrared radiation being emitted by the objects. The colours in the second picture have been artificially added to give a visual representation of temperature. The coloured bar to the right of the second picture shows the correlation between colour and temperature (temperature is measured in Fahrenheit).

Temperature (^{o}F)

NASA/IPAC/Public domain

Which of the following inferences could NOT be made from the second picture?

A. The black plastic bag is mostly transparent to infrared radiation.
B. The man's glasses transmit visible light but not infrared radiation.
C. Hair is an insulating material.
D. The man's chest is cooler than his face.

14.	In settings such as laboratories, hospitals and the food industry, it often necessary for equipment or items to be sterilised. Sterilisation involves treating the object in some way that will kill or inactivate any bacteria or viruses that are present. One method is flame sterilisation. This involves exposing the item to the high temperature of a flame for a short period of time. In a laboratory, an easy way of flame sterilising items such as tweezers is to dip them in a fuel (e.g. ethanol) and then place them in a Bunsen burner. Below is the chemical equation for the combustion of ethanol (C_2H_5OH). Balance the equation in its simplest possible form. __ C_2H_5OH + __ O_2 → __ CO_2 + __ H_2O
15.	Equipment can also be sterilised by using nuclear radiation, which is produced by nuclear reactions. Nuclear reactions are different to chemical reactions. Which of the following is an **incorrect** statement about nuclear reactions and chemical reactions? A. Nuclear reactions and chemical reactions both involve energy transformations. B. In both nuclear and chemical reactions you can end up with more particles than you started with. C. Chemical reactions can turn one element into another. D. Nuclear reactions convert mass to energy. E. Chemical reactions obey the law of conservation of mass.
16.	Isotopes are a common feature of nuclear reactions. Which of the following statements is **true** for isotopes? A. Isotopes of the same element have different numbers of electrons. B. Isotopes of the same element have different chemical properties. C. Isotopes of the same element have the same atomic number. D. Isotopes of the same element have the same mass number.
17.	Cobalt-60 (Co-60) is a radioactive isotope that undergoes two types of nuclear reaction: beta decay and gamma decay. Gamma decay produces gamma rays (or gamma radiation). Gamma rays are a high-energy form of light that can break apart DNA molecules. This means gamma radiation can kill bacteria and inactivate viruses (including coronavirus). Medical companies and hospitals can therefore use samples of Co-60 to produce gamma radiation to sterilise medical equipment. The half-life of a radioactive isotope is the time it takes for 50% of the isotope atoms present to decay. Co-60 has a half-life of approximately 5 years. If a medical company started with a 100g sample of Co-60, how long would it be before they only had 12.5g of Co-60 left? A. 5 years B. 15 years C. 20 years D. 40 years
18.	Gamma rays are a form of electromagnetic radiation. The can be thought of as a high-energy light wave. Which of the following statements about light waves is **incorrect**? A. The colour or type of light is determined by its wavelength. B. The frequency of a light wave is directly proportional to its energy. C. The amplitude of a light wave is related to the intensity of the light. D. As the energy of a light wave decreases, its wavelength decreases.

19.	To produce the isotope Co-60, scientists first take the stable isotope Co-59 and fire neutrons at it. This causes a nuclear reaction in which Co-59 atoms absorb a neutron and are transformed into Co-60: $$^{59}_{27}Co + n^0 \rightarrow ^{60}_{27}Co$$ Co-60 is unstable. The atoms naturally undergo **beta decay**, followed by **gamma decay**. When any atom undergoes **beta decay**, a neutron in the nucleus splits into a proton and an electron. The electron is ejected from the atom, and the new proton remains in the nucleus. The product of the beta decay of Co-60 is Ni-60. What isotope would need to undergo beta-decay to produce Co-59? A. Ni-59 B. Co-60 C. Fe-59 D. Fe-60 E. Ni-60
20.	The infectiousness of a disease is due in large part to how easy it is for the infectious particles (i.e. virus particles, bacterial cells etc.) to pass from an infected person to a non-infected person. When humans breathe normally, they exhale vapour in the form of tiny droplets of liquid. These droplets can be classified by size into **aerosol droplets** (<5µm in diameter) and **larger droplets** (>5µm in diameter). Coughing or sneezing increases the number of droplets a person exhales. *Note: 1µm = 1 micrometre = 1 x 10^{-6} m* **Aerosol droplets** are light enough that natural turbulence in the surrounding air keeps them suspended for a long time. Larger droplets fall and settle on surfaces over periods of 5 seconds to 20 minutes, depending on their size. Both aerosol and larger droplets breathed out by a person infected with a respiratory virus such as influenza and coronavirus contain virus particles. Calculate the volume in cubic micrometres (µm^3) of a respiratory droplet with a diameter of 5 µm. Assume the droplet is spherical. *Note: the volume of a sphere is calculated as* $V = \frac{4}{3}\pi r^3$ A. 65 µm^3 B. 79 µm^3 C. 314 µm^3 D. 523 µm^3
21.	A droplet has a volume of 8.3 µm^3 (cubic micrometres). Convert this volume to cubic nanometres (nm^3). Note: 1µm = 1000 nm A. 8.3 x 10^{-9} nm^3 B. 0.0083 nm^3 C. 1000 nm^3 D. 8300 nm^3 E. 8.3 x 10^{9} nm^3

22.	A respiratory droplet has a volume of 2000 µm^3 (2 x 10^{-15} m^3). Calculate the gravitational force in Newtons on this droplet. Notes: • Assume the droplet has the same density as water (1000 kg/m^3). • $F = ma$, where m is measured in kg and a is measured in m/s^2 • Acceleration due to gravity (g) = 10 m/s^2 A. 2 x 10^{-17} N B. 2 x 10^{-14} N C. 2 x 10^{-11} N D. 2 x 10^{7} N
23.	A larger respiratory droplet breathed out by an infected patient is falling straight downwards at a constant velocity. As it falls, it experiences: A. A constant downward force of gravity along with a smaller constant upward force from the air resistance. B. A constant downward force of gravity along with a steadily decreasing upwards force from the air. C. A constant downward force of gravity only. D. A net (total) force of zero.
Information	The following six true/false questions refer to a diagram from an article published in the April 2020 volume of the journal *Nature Medicine*. This diagram is reproduced with permission on the following page. The diagram refers to a study looking at the number of virus particles in patients infected with different diseases. In the study, patients infected with either influenza, rhinovirus or coronavirus were tested, and the viral load (the number of virus particles present) was measured in each of the samples they gave. The diagram shows a series of graphs depicting the data collected in the study. Each dot on the graph represents one sample taken from a participant. Samples were taken from four locations: • a nasal swab (swab of the nose) • a throat swab • collection of larger droplets from 30 minutes of breathing, and • collection of aerosol droplets from 30 minutes of breathing. In the breathing tests, patients were randomly assigned either to wear or not to wear a mask. This was to test whether wearing a mask affected the number of virus particles being breathed out by the patients. The **P-values** shown in the diagram are a statistical measure. They show how confident we can be that the intervention (in this case wearing a mask) is responsible for any difference seen in the data. • P-value < 0.05: the difference is significant and likely to be the result of the intervention • P-value > 0.05: the difference could be the result of chance and cannot be relied upon. For a set of data, both the conclusion and the P-value can be affected by the sample size. Large sample sizes are more reliable.

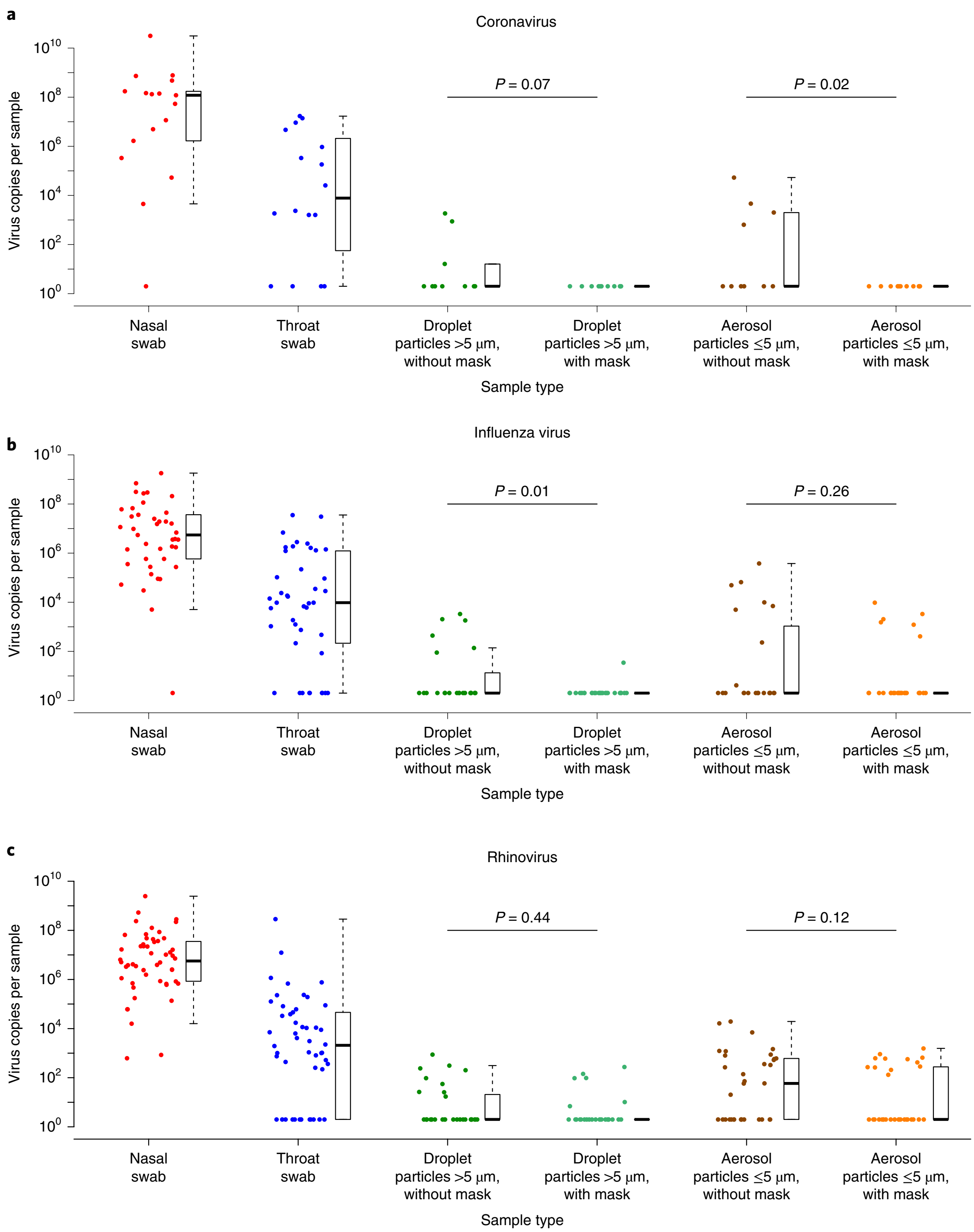


Fig. 1 | Efficacy of surgical face masks in reducing respiratory virus shedding in respiratory droplets and aerosols of symptomatic individuals with coronavirus, influenza virus or rhinovirus infection. a–**c**, Virus copies per sample collected in nasal swab (red), throat swab (blue) and respiratory droplets collected for 30min while not wearing (dark green) or wearing (light green) a surgical face mask, and aerosols collected for 30min while not wearing (brown) or wearing (orange) a face mask, collected from individuals with acute respiratory symptoms who were positive for coronavirus (**a**), influenza virus (**b**) and rhinovirus (**c**), as determined by RT–PCR in any samples. *P* values for mask intervention as predictor of $\log_{10}$ virus copies per sample in an unadjusted univariate Tobit regression model which allowed for censoring at the lower limit of detection of the RT–PCR assay are shown, with significant differences in bold. For nasal swabs and throat swabs, all infected individuals were included (coronavirus, n=17; influenza virus, n=43; rhinovirus, n=54). For respiratory droplets and aerosols, numbers of infected individuals who provided exhaled breath samples while not wearing or wearing a surgical face mask, respectively were: coronavirus (n=10 and 11), influenza virus (n=23 and 28) and rhinovirus (n=36 and 32). A subset of participants provided exhaled breath samples for both mask interventions (coronavirus, n=4; influenza virus, n=8; rhinovirus, n=14). The box plots indicate the median with the interquartile range (lower and upper hinge) and ±1.5×interquartile range from the first and third quartile (lower and upper whiskers).

24.	A larger proportion of patients showed zero viral load in throat swabs than in nasal swabs. True/false.
25.	Rhinovirus has the biggest data set for assessing whether masks are effective at reducing viral shedding and shows the greatest effect. True/false.
26.	A person looking at this diagram can confidently conclude that requiring patients to wear masks while infected would reduce their infectiousness. True/false.
27.	On average, a sample of aerosol particles appears to have a higher viral load than the equivalent sample of larger droplets. True/false.
28.	There appears to be a large variation in contagiousness between the patients taking part in the study. True/false.
29.	When two data sets are compared, the P-value increases as the difference between the two data sets increases. True/false.
Information	One method of virus transmission is by touching a surface that has virus particles on it. The virus can be transferred to your hands, and then potentially to your eyes, nose or mouth. Cleaning your hands is therefore an easy but important method of reducing disease transmission. Both soap and alcohol inactivate viruses by breaking their outer capsule apart. The usual kind of alcohol used is ethanol (C_2H_5OH), which is the same alcohol found in beer, wine and spirits. In addition, methylated spirits, used as a fuel and for cleaning, is 99% ethanol. During the COVID-19 lockdown period, a number of Australian distilleries switched from making gin, vodka and other alcoholic spirits to making hand sanitiser. To make alcohol, distilleries use yeast to ferment glucose (which can come from any number of different sources; e.g. wheat, barley, corn, potatoes etc.). The products of this chemical reaction are ethanol and carbon dioxide. The balanced chemical equation for the fermentation of glucose is: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH+2CO_2$
30.	Different atoms have different masses. The ratio of the masses of hydrogen, carbon and oxygen atoms is shown below: hydrogen : carbon : oxygen 1 : 12 : 16 If 126g of glucose was fermented, what mass of ethanol would be produced? A. 32 g B. 46 g C. 64 g D. 92 g E. 126 g

Information	As the coronavirus pandemic developed, the World Health Organisation released the following guidelines for making hand sanitiser. **Recipe for 10L of hand sanitiser:** • 8333mL ethanol • 417mL of 3% hydrogen peroxide solution • 145mL glycerol • Sufficient water to make the solution up to 10L. Hydrogen peroxide is a highly reactive chemical that can destroy biological molecules. Its purpose in this formulation is to remove any bacterial contamination during production of the hand sanitiser. It does not contribute significantly to the anti-viral properties of the hand sanitiser, which are largely due to the high percentage of ethanol. A 3% solution means that in every 100mL of solution, 3mL is pure hydrogen peroxide (the rest being water).
31.	If it doesn't react with contaminating bacteria, the hydrogen peroxide in the hand sanitiser will slowly be converted to oxygen and water via the following reaction: $2H_2O_2 \rightarrow O_2 + 2H_2O$ Consider the chemical reactions below. Which one belongs to the same class of chemical reaction as the hydrogen peroxide reaction shown above? (Note: you may ignore redox reactions as a class of reaction.) A. $2HCl + Zn \rightarrow ZnCl_2 + H_2$ B. $2NaNO_2 \rightarrow Na_2O + NO + NO_2$ C. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ D. $4K + O_2 \rightarrow 2K_2O$
32.	If you were to make up hand sanitiser according to the WHO guidelines above, calculate the percentage of pure hydrogen peroxide (by volume) in the final product. A. 0.125% B. 0.250% C. 1.25% D. 3.0% E. 4.17%

Information	Epidemiologists are scientists who study the spread of disease. One of the measures that epidemiologists use to compare diseases is R_0: the 'basic reproduction number'.

The R_0 value can be thought of as the number of new infections that a single infected person can be expected to cause. Diseases with R_0 > 1 can cause outbreaks.

The table below (from the Wikipedia page on R_0 values) shows the R_0 values for a range of common diseases.

Values of R_0 of well-known infectious diseases[1]

Disease	Transmission	R_0
Measles	Aerosol	12–18[2]
Chickenpox (varicella)	Aerosol	10–12[3]
Mumps	Respiratory droplets	10–12[4]
Polio	Fecal–oral route	5–7[citation needed]
Rubella	Respiratory droplets	5–7[citation needed]
Pertussis	Respiratory droplets	5.5[5]
Smallpox	Respiratory droplets	3.5–6[6]
HIV/AIDS	Body fluids	2–5[citation needed]
SARS	Respiratory droplets	0.19–1.08[7]
SARS-CoV-2/COVID-19	Respiratory droplets (Aerosol transmission under investigation)	2–6[8][9]
Common cold	Respiratory droplets	2–3[10]
Diphtheria	Saliva	1.7–4.3[11]
Influenza (1918 pandemic strain)	Respiratory droplets	1.4–2.8[12]
Ebola (2014 Ebola outbreak)	Body fluids	1.5–1.9[13]
Influenza (2009 pandemic strain)	Respiratory droplets	1.4–1.6[14]
Influenza (seasonal strains)	Respiratory droplets	0.9–2.1[15]
MERS	Respiratory droplets	0.3–0.8[16]

https://en.wikipedia.org/wiki/Basic_reproduction_number (accessed 26 July 2020).

R_0 is calculated like this:

$$R_0 = P \times r \times T$$

where:

P = the probability that when a contact event occurs, it will lead to a new infection

r = the rate of contact events between infectious people and non-infected people

T = the length of time the person is infectious (regardless of how they behave)

Important notes:

- The value of P ranges between 0 and 1. '1' would mean the disease is **always** passed on when an infected person meets a non-infected person, and 0 would mean it is **never** passed on.
- A 'contact event' is when an infected person is close to a non-infected person for a certain length of time. For the questions below, assume that a contact event for coronavirus is defined as being within 1.5m of a person for at least 15 minutes.
- The value of R_0 assumes that the entire population is susceptible (i.e. not immune) to the disease, and that **no control measures** (e.g. social distancing) have been taken.

33.	From the following list, circle the THREE factors that WOULD affect the value of P. Recall that P is the probability that when a contact event occurs, it will lead to a new infection. *This question is worth 2 marks.* A. How easily the virus particles are destroyed by temperature extremes outside the body B. The total length of time for which an infected person is infectious to others C. Normal cultural practices (e.g. hand shaking, gatherings etc.) D. Population density E. Ensuring infected people are quarantined (isolated) F. The average viral dose (number of viral particles) that must enter a susceptible person to cause them to become infected G. The number of virus particles shed or released by an infectious person H. Making a vaccine available I. Implementation of social distancing measures
34.	You will notice that in the table above, a range of R_0 values is listed for each disease. The R_0 for a disease can vary between city and rural areas, and from country to country. From the following list, select the THREE factors that WOULD contribute to R_0 varying between different geographical locations. *This question is worth 2 marks.* A. How easily the virus particles are destroyed by temperature extremes outside the body B. The total length of time for which an infected person is infectious to others C. Normal cultural practices (e.g. hand shaking, gatherings etc) D. Population density E. Ensuring infected people are quarantined (isolated) F. The average viral dose (number of viral particles) that must enter a susceptible person to cause them to become infected G. The number of virus particles shed or released by an infectious person H. Making a vaccine available I. Implementation of social distancing measures
35.	Once measures are taken to reduce the spread of a disease, epidemiologists can calculate R_{eff} (the **effective** reproduction number). If the measures work, the value of R_{eff} will be less than that of R_0. R_{eff} is the reproduction number when: • control measures have been taken to reduce the spread of the disease **and/or** • when part of the population is immune to the disease. The formula for R_{eff} is similar to that for R_0, but with an extra factor: $$R_{eff} = P \times r \times T \times x$$ where x is the fraction of the population that is susceptible to the disease. *Recall: 'susceptible' means 'not immune'.* Four control measures are listed below. Each measure affects one of the factors in the equation for R_{eff}.

Circle one word or letter in each cell of the table to create accurate sentences that describe how each control measure affects one of the factors.

This question is worth 4 marks.

i.	Wearing face masks would:	Increase/decrease	P / r / T / x
ii.	Staying 1.5m apart from other people in public would:	Increase/decrease	P / r / T / x
iii.	Isolation/quarantine of people with symptoms would:	Increase/decrease	P / r / T / x
iv.	Making a vaccine available would:	Increase/decrease	P / r / T / x