MiSAC
MICROBIOLOGY IN SCHOOLS ADVISORY COMMITTEE

Promoting microbiology in schools and colleges since 1969

2023 Competition

for KS3 & KS4

S1/2 and S3/4 in Scotland

For the attention of the Head of Biology

Microbes and the Water Cycle

Aim of the 35th MiSAC Annual Competition

To develop an understanding among teenagers of the key roles of microbes in the water cycle.

Closing date: 3rd April 2023

Sewage treatment works and reservoir.
Image: Thames Water

Aeration lane in a sewage treatment works.
Image: Thames Water

Clean drinking water from kitchen tap.
Image: BrianAJackson - iStock photo images

Background

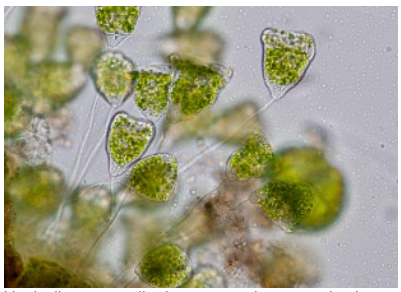
Water is a precious resource and we have to recycle it. In nature, water from seas, lakes and rivers evaporates into the air where it forms clouds. Water is released, eg, as rain or snow, as it falls back to earth. It refills surface waterways and reservoirs or soaks into underground stores (aquifers) from which supplies are taken for domestic, agricultural and industrial use. For example, Thames Water supplies over 10 million people, with around 80% of this water being taken from the river Thames, and the rest from aquifers. Before water can be supplied to homes and businesses, it must be treated and tested to ensure that it is safe to use. Treatment includes chlorination to remove bacteria, viruses and parasites that can cause disease.

After use, *wastewater* is contaminated with various pollutants. If it flows into natural water courses, it would harm the environment. Nitrates and phosphates used in agriculture, and high levels of organic material, can cause blooms of algae and plankton in ponds, lakes and reservoirs, a process known as *eutrophication*. Some algae produce toxins which can affect aquatic & farm animals and birds. When these blooms die, other microbes cause their decay which reduces the amount of dissolved oxygen, killing fish and other wildlife.

The problem of polluted wastewater is solved by harnessing microbes to decompose the organic matter in the pollution. The wastewater is piped into *sewage works* for treatment. Solid particles are allowed to sink by gravity, forming a sludge which is collected for later treatment. The water above the settled-out sludge flows into large open tanks, through which air is pumped - the *aeration lanes*. Oxygen encourages naturally-occuring bacteria and protozoa to respire and degrade the polluting material. The increasing mass of new bacterial cells and other microbes clump together (*flocculate*) to form a blanket of *floc* which sinks down, adding to the sludge. The cleaner water above moves on through filter beds of stones and sand which become coated with a microbial layer or *biofilm*. This continues to remove particles from the water and break down remaining dissolved pollutants. The final effluent is then allowed to flow back into rivers and streams.

Sludge collected during the treatment of sewage is often pumped into lagoons and dried for use as agricultural fertilizer. In large sewage works, sludge is transferred to closed tanks where, in the absence of oxygen, a type of naturally-occurring bacterium flourishes in the organic waste and produces biogas. Its methane component is used to generate electricity for use on-site.

Future advances in treating wastewater are likely to expand the use of biofilm reactors and the development of microbial fuel cells which are more efficient, use less energy and produce smaller quantities of waste sludge for disposal.



Vorticella sp., a stalked protozoan, in an aeration lane. The green colour is ingested algae.
Image: Sinhyu - iStock photo images

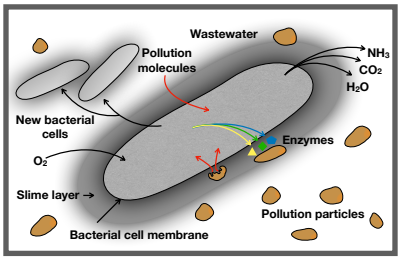


Diagram of a bacterium in wastewater.
Image: John Schollar MiSAC

Thames Water

Sponsor of the 2023 competition

Object of the competition

You are required to produce an illustrated, web-page report explaining to teenagers the importance of microbial activities in the water cycle and processes involved in reusing water supplies.

- ***Briefly*** *outline* the main features of the natural water cycle.
- How do the activities of microbes involved in the cycling of water have a helpful *or* harmful effect?
- Give the identity of these microbes (ie, protozoa, bacteria, algae, etc) and where they are found in different stages of the water cycle and associated water treatments. Where possible, give their scientific names (see **Important**).

Format of entries

- Your entry must be produced on paper as hard copy on one A3 sheet (or two A4 sheets secured side by side with adhesive tape) *using only one side of the paper.*
- You may produce your entry either by hand or computer.
- The entry may be submitted by an individual or a group of not more than 4 students.

Important

Remember that part of the competition judging will be on the *scientific merit* of an entry. You must use, where possible, the scientific name of any microbe you mention, remembering that the first name (genus) begins with an upper-case letter and the second name (species) has a lower-case initial letter (eg, *Nitrosomonas eutropha*). If a microbe's species is not known, write *Nitrosomonas* sp. Use an italic font for the scientific name - or underline it if your entry is hand-written. Always use your own words because plagiarism will be penalised. For data and other material used to illustrate your entry, provide information of their sources.

Prizes

Schools:	1st £250	2nd £125	3rd £70
Students:	1st £100	2nd £50	3rd £25

A certificate will be awarded to each student submitting an entry of scientific merit. The results, winning entries and a report of the competition will be published on the MiSAC web site competition pages at www.misac.org.uk.

What makes a good web page?

Effective web pages rely on being not only informative but attractive, lively, well-designed and often amusing, in order to make an immediate visual impact. This can be achieved by using photographs, diagrams, drawings, plus data and sources of further information. Make the presentation of your entry entertaining for its intended audience - teenagers.

Web sites

- https://www.thameswater.co.uk/about-us/responsibility/education/the-water-cycle
- https://www.thameswater.co.uk/about-us/responsibility/education/the-water-treatment-process
- https://archiv.ipn.uni-kiel.de/eibe/UNIT17EN.PDF See Case Study B: *Providing clean water*.
- https://www.stwater.co.uk/content/dam/stw/my-severn-trent/documents/Sewage-treatment-poster.pdf
- https://ec.europa.eu/environment/marine/pdf/brochure_young_people.pdf
- https://owlcation.com/stem/Reading-a-Water-Cycle-Diagram
- https://sitn.hms.harvard.edu/flash/2019/waste-not-want-not-harnessing-power-microbes-wastewater-recycling/
- https://www.newscientist.com/article/mg23130840-100-bacteria-made-to-turn-sewage-into-clean-water-and-electricity/

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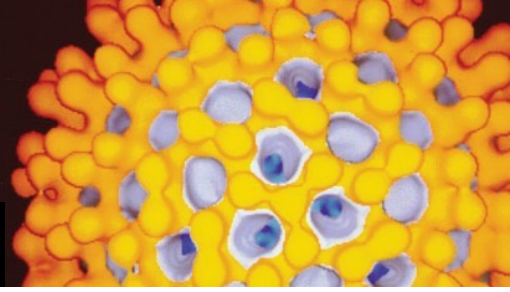

Rules

- Judging will be based on two entry groups: Key Stage 3 (S1/2) and Key Stage 4 (S3/4).
- Each entry must be submitted on paper, on **one A3 sheet** (or two A4 sheets taped together) using one side of the paper only, and may be produced either by hand or by computer.
- Entries may be created either by individuals or groups of no more than 4 students.
- A maximum of 10 entries per school in each entry group is permitted.
- Account will be taken of originality, presentation and effectiveness in communicating with the intended audience.
- Only entries that conform to the competition rules and show scientific merit will be considered; note the requirements and consider the suggestions given on the front page.
- Evidence of plagiarism, such as downloading text directly from web sites without modification and interpretation, will result in disqualification. (MiSAC recommends only reputable sites for research; see https://help.open.ac.uk/searching-online for tips on using the internet.)
- Each entry must be clearly labelled on the back with the name and address of the school, the teacher's name, the full name of each contributing student and the entry group, i.e. Key Stage 3 or S1/2 and Key Stage 4 or S3/4.
- Entries cannot be returned and may be used for promotional purposes by MiSAC.

Closing date: 3rd April 2023

Check list for teachers

Please tick before submitting entries

- Students' name/s on entry? [ ]
- School name on entry? [ ]
- School address on entry? [ ]
- Teacher's name on entry? [ ]
- Key stage on entry? [ ]
- Entry form completed? [ ]

Sponsor of the 2023 competition

Thames Water

Entry form * **Please use capital letters**

Name of teacher: .....

Tel no: .....

Email: .....

Name and address of school

.....

.....

.....

KS3, S1/2 entry group

Name(s) of student(s) **Please use capital letters**

1 .....
2 .....
3 .....
4 .....
5 .....
6 .....
7 .....
8 .....
9 .....
10 .....

KS4, S3/4 entry group

Name(s) of student(s) **Please use capital letters**

1 .....
2 .....
3 .....
4 .....
5 .....
6 .....
7 .....
8 .....
9 .....
10 .....

How did you learn of the competition? Please tick

[ ] **MiSAC web site** [ ] **Post to school** [ ] **Emailing** [ ] **Social media** [ ] **Other** .....

Don't forget to keep a copy of the rules and entry form!

** Personal data for use only by MiSAC in connection with the MiSAC Annual Competition*

Address for entries: MiSAC Competition, c/o NCBE, University of Reading, 2 Earley Gate, Whiteknights Road, Reading RG6 6AU