

# How Microbes Make Milk

**Closing date:**  
**28th March 2026**

## Aim of the 38<sup>th</sup> MiSAC Annual Competition

To develop an understanding among teenagers of the role of microbes in enabling cows to produce milk throughout the year.

## Background

Does the competition title puzzle you? Surely cows are most likely to be responsible for making the milk that you drink? Imagine the scene: fields of pasture with herds of cows grazing on grass or in cowsheds eating fodder from troughs. Where do microbes such as bacteria, fungi and protozoa fit into this picture?

The problem is that cows are unable to make the enzymes necessary for initial digestion of the plant materials they eat to provide the nutrients needed for their energy, growth and milk production. However, some microbes can, and these live naturally in the cows' stomach. Plant digestion is a very slow process for which cows have evolved a four-chambered stomach to deal with their food efficiently. The first and largest stomach chamber is the rumen. It contains various microbes that break down the resistant cellulose in plant cell walls in the anaerobic conditions of the gut to make simpler soluble nutrients which the cow can use. The acid conditions in the last stomach chamber kill the microbes which have passed from the rumen and these are also digested by the cow's enzymes, providing additional nutrients to support milk production.

After calving, cows require a high level of nutrition to maintain milk production but, in autumn and winter, fields of grass cannot meet this need. Farmers therefore make a supplementary feed called silage by mowing and shredding green foliage crops and storing them in anaerobic conditions in bales of strong plastic or in covered heaps. Microbes which occur naturally on the crops ferment the sugars released by the shredding process, producing lactic and acetic acids. The resulting low pH of the silage protects it from spoilage by growth of other microbes and so preserves it as a valuable winter feed. Some farmers use commercially-available additives (either microbial or chemical) to improve the silage quality further.

Farmers also grow leguminous forage crops such as alfalfa, clovers and vetches to feed cows in winter months. These are especially rich in protein thanks to another microbe that grows in small swellings (nodules) on the roots of the legumes and establishes a symbiotic relationship with them. The legumes make carbohydrates by photosynthesis and the microbes metabolise these to provide energy for converting ('fixing') nitrogen from the air into simple nitrogenous compounds which the legume uses for protein synthesis. These nutritionally-enriched crops also help dairy cows 'make milk' throughout the year.

## Object of the competition

You are required to design an illustrated, web-page report for teenagers to raise their awareness of the roles of microbes in the production of milk by cows throughout the year. Include in your design references to the following:

- Describe how gut microbes help cows obtain nourishment from their food.
- Explain the role of microbes in producing nutritious silage for cows in winter.
- How do leguminous plants improve the quality of nutrients dairy cows require?

For all activities you mention, give the type of microbe involved (bacteria, fungi or protozoa) and their scientific names (see *Three top tips* below).

## 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 four students.

## Three top tips

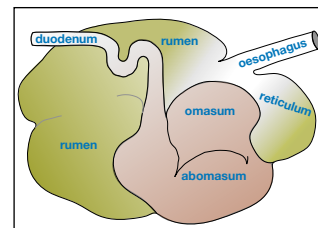
- Use your own words because plagiarism (cheating) will be penalised.
- The scientific name of a microbe begins with the genus starting with an upper-case letter, followed by the species starting with a lower-case letter, eg, *Escherichia coli*. This can be abbreviated to *E. coli* after its first use. Note that the name is written in an *italic* font if printed or underlined if it is hand-written.
- For data and other material used to illustrate your entry, provide information about their sources.

## How to produce an effective web page

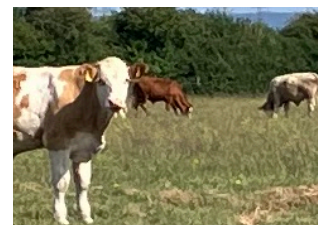
- Make an immediate impact by presenting a web-page report that is attractive, lively, well-designed and often amusing, as well as being informative.
- Use photographs, diagrams, drawings, plus data and sources of further information.
- If you use a variety of colours, choose shades that are clearly distinguishable from each other and from the background.
- Produce an entry that will entertain the intended audience - teenagers.

## Website articles

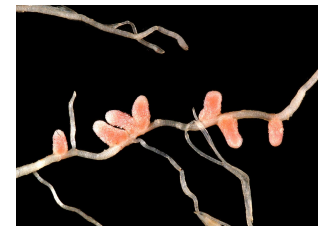
<https://en.wikipedia.org/wiki/Cud>  
<https://iowaagliteracy.wordpress.com/2018/08/29/why-do-they-do-that-cattle-chewing-cud/>  
<https://www.fda.gov/animal-veterinary/animal-health-literacy/how-cows-eat-grass>  
<https://www.misac.org.uk/article-downloads/4b-MiSACBriefing-21-2-20.pdf>  
<https://milnepublishing.geneseo.edu/botany/chapter/rhizobium/>  
[https://pubs.nmsu.edu/\\_a/A129/Nitrogen\\_Fixation\\_by\\_Legumes](https://pubs.nmsu.edu/_a/A129/Nitrogen_Fixation_by_Legumes)  
<https://www.mdpi.com/2077-0472/14/1/152> Beneficial Soil Microbiomes and Their Potential Role in Plant Growth and Soil Fertility  
<https://en.wikipedia.org/wiki/Silage>  
<https://www.shutterspeedireland.com/silage-production-in-the-uk-a-complete-guide-for-farmers>  
<https://businesswales.gov.wales/farmingconnect/news-and-events/technical-articles/silage-additives>  
[https://microbiologysociety.org/resource\\_library/knowledge-search/microbial-diversity-in-the-digestive-tract-of-herbivores.html](https://microbiologysociety.org/resource_library/knowledge-search/microbial-diversity-in-the-digestive-tract-of-herbivores.html)



Ruminant digestive system  
Image: MiSAC



Cattle grazing on pasture  
Image: J Schollar, MiSAC



Nodules growing on roots of Clover  
copyright: CC BY-SA 3.0 Ninjatacoshell



Bales of silage  
Image by M Whalley, MiSAC

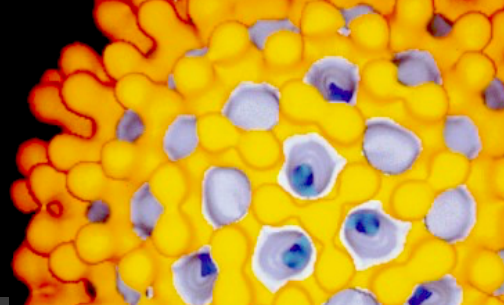
Competition sponsored by:



## Prizes

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

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 website competition pages at [www.misac.org.uk](http://www.misac.org.uk).



## 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 [www.open.ac.uk/webguide](http://www.open.ac.uk/webguide) 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.

## 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/Email on entry? [ ]
- Key stage on entry? [ ]
- Entry form completed? [ ]

## Sponsor of the 2026 competition



**Closing date: 28th March 2026**

## Entry Form

Please download the entry form from the competition page of the MiSAC web site:

[www.misac.org.uk/competition.html](http://www.misac.org.uk/competition.html)



The form will allow you to **type in** school contact details & students' names, particularly for group entries, and **then** print this out for submission with the competition entries.

**MiSAC 2026 Competition Entry Form**

School/College Name: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 Post code: \_\_\_\_\_  
 Telephone Number: \_\_\_\_\_  
 Name of teacher: \_\_\_\_\_  
 Teacher's email address: \_\_\_\_\_

**Check list for teachers:**  
 Please tick before submitting entries

Students' names on entry? ☐  
 School name on entry? ☐  
 School address on entry? ☐  
 Teacher's name/email on entry? ☐  
 Key stage on entry? ☐  
 Entry form completed? ☐  
 School: Fee paying ☐ or State funded ☐

**KS3, S1/2 Entry group**  
 Full name of student(s)

1			
2			
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**KS4, S3/4 Entry group**  
 Full name of student(s)

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How did you learn of the competition? Click in the relevant box(es).  
 MiSAC flyer email ☐ MiSAC website ☐ MiSAC printed flyer sent to school ☐ CLEAPSS Bulletin ☐ CLEAPSS E-alert ☐  
 SSERC Synapse ☐ Bictutor ☐ Social media ☐ Entered previous competition ☐  
 Other: (Please type in details) \_\_\_\_\_

**Personal data on this form is used by MiSAC only in connection with submitting student names for the Annual Competition**  
 Address for entries: MiSAC Competition, c/o NCBE, University of Reading, 2 Earley Gate, Whiteknights Road, Reading RG6 6AU

**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

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