General Certificate of Secondary Education

GCSE Additional Applied Science - 4505

Assignment 1, Option 3:

The work of a microbiologist in the food industry

Controlled Assessment

Teachers' Notes

Version 1.0

Exemplar Work

Assignment 1, Option 3: The work of a microbiologist in the food industry

This assignment relates to Unit 1 Section 3.3.5 – The use of science in food production.

Introduction

In this option for Assignment 1, candidates should research and write a report on the work of a microbiologist who is using scientific techniques to monitor the growth of bacteria in food samples. They should then do a practical investigation using some of the techniques that a microbiologist might do in the process of their work and write a report on their findings.

Candidates should be allowed to demonstrate their research skills by collecting information from a range of sources and referencing them. Internet research is permissible, but candidates should be reminded to record all sources used. When using sources of information they should be reminded of the rules concerning plagiarism and that plagiarised work will receive no credit.

It is hoped that candidates may be able to collect first-hand information by visiting scientific organisations where microbiologists work, or that visits by a practitioner may be made to the centre.

Candidates should also be given the opportunity to practice the techniques they will use before undertaking the practical investigation. They must be made aware of the importance of following standard procedures.

During the practical investigation, candidates may work on their own or in groups to obtain their data.
However, each candidate must:

- record and process the data individually
- identify the data they collected.

Area of investigation

This work should be done during the teaching of Unit 1, Section 3.3.5 – The use of science in food production.

Approach to the investigation

Candidates need to do research to find an organisation involved in food production, and then write a report on the work that the microbiologist undertakes and the qualifications and practical skills he or she needs to do their work. They should be encouraged to decide for themselves on the organisation to study. A good introduction to the research task might be to hold an initial classroom discussion into the role of microbiologists in food production.

The second part of the assignment is a practical investigation, which should be researched and set by the teacher. A task should be set that uses practical techniques that a microbiologist would use – such as doing serial dilutions to determine the level of bacteria in foods. The task should be put into a context relating clearly to the work of microbiologists in the food industry.

Teachers should prepare procedures for candidates to follow in order to do the practical investigation. One copy of the procedures supplied to candidates should be included in the work sent for moderation. Candidates should study the procedures they will be doing and use them to devise a hypothesis that the procedure will test.

An example scenario is given below. Teachers are free to use this, adapt it to suit their candidates' needs or to create their own scenario.

Fresh milk is heat treated to 132 ^{o}C for one minute before it is sold to customers. This is known as ultra-heat treatment.

A milk manufacturer is trying to find ways to cut their production costs and has suggested that temperatures lower than 132 ^{o}C might achieve the same results.

You are a microbiologist investigating the effect of temperature on the levels of bacteria in milk samples. You will report your findings to the milk manufacturer.

The teacher would need to prepare the following standard procedures for candidates to follow:

- heating milk samples to different temperatures
- serial dilution
- plating techniques
- counting colonies of bacteria in milk samples.

Candidates should be provided with all the equipment and materials they would need in order to do the investigation. They could be given a sample of milk which contains more bacteria than fresh milk (this could be UHT milk 'doctored' with live yoghurt or old pasteurised milk) – this could represent fresh milk before heat treatment. Each candidate (or group of candidates) could heat the sample to a different temperature before allowing the milk to cool and performing serial dilution and plating techniques to make accurate bacteria counts. Each group could also have one UHT milk sample that would form the control as this would already be heat treated to 132°C. Class data for the number of colonies of bacteria at the different temperatures of milk could be collated.

Once given the scenario and procedures, candidates should make a hypothesis that the procedures are going to test, and clearly state this hypothesis in their write-up.

Once candidates have done the investigation, they should prepare a report, analysing their data and making conclusions from the results in the same way as the scientist in the scenario would have to do.

Working safely in the laboratory

It is the responsibility of the centre to be aware of any health and safety implications of the investigation and ensure that a risk assessment is done. Teachers should remind candidates about safe working practices when doing laboratory procedures.

Stage 1 – Planning

The teacher should lead a discussion with the candidates to introduce the assignment, during which the research methods and practical techniques to be used should be discussed. The discussion should include how to develop a hypothesis and the role of experimentation and gathering evidence in testing hypotheses.

Candidates should be given the opportunity to have hands-on experience of the techniques to be used during the delivery of Unit 1.

Stage 2 – Completing the assignment

For the research part of the assignment candidates may work individually or in groups under limited supervision.

When undertaking the practical investigation in the assignment candidates may work individually or in groups under normal laboratory supervision.

Each candidate must contribute to the collection of data.

Stage 3 – Data processing, analysis and final report writing

This part of the assignment may be done under informal supervision during normal class time. Candidates must work on their own to write up their research findings, analyse their data and present their conclusions as a final report. The report may be handwritten or data processed.

We expect that this stage of the assignment will take a number of normal lessons. Candidates' work (including that done on removable media) must be collected by the teacher at the end of each lesson and returned at the beginning of the next.

Candidates should **not** be allowed to work on the final report between lessons.

In their final report candidates should:

- give information about the organisation in which the microbiologist works
- give an account of the work that the nutritionist does in this organisation, including the qualifications and practical skills they need to do their job
- list the range of sources they have used to find this information
- make a hypothesis for the investigation
- demonstrate that they have followed the standard procedures correctly
- present their observations and numerical data appropriately
- identify patterns within their data and do calculations
- make conclusions based on their analysis of the data/evidence that a microbiologist might be expected to make.

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Exemplar material

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This assignment relates to Unit 1 Section 3.3.5 – The use of science in food production.

Area of Investigation

Microbiologists work in a wide variety of organisations that are involved in food production. The type of work a microbiologist will need to do depends on the type of organisation they are working for. They need particular qualifications and skills to be able to do their work, and use many different practical techniques.

Task

1. You will need to do research to find out about the work of a microbiologist in the food industry.
2. You will also need to do a practical task that uses some of the techniques that a microbiologist would use to help them in their work. Before you do the task you will need to decide on a hypothesis that the task could be used to test.
3. You will then need to write a report of what you found in your research, and analyse the results of your practical task.

You will be given the opportunity to:

- collect information from a range of sources, including the internet, and reference them
- do a practical task using a standard procedure and equipment that will be provided for you.

You will be expected to:

- research and select appropriate information to use in your report
- practice the technique that you will use during your practical task, using the equipment provided
- understand and comment on the importance of using standard procedures.

You will have to decide on things such as:

- what information should go in your report
- what your hypothesis is
- how you will structure your report
- the limitations of your research and of the data you obtained from the practical task.

In your final report you should:

- give information on the purpose of the type of organisation in which the microbiologist works
- give an account of the work the microbiologist does
- describe the qualifications the microbiologist needs to do their work
- explain how the microbiologist uses their practical skills and scientific knowledge to do their work
- explain how the microbiologist would use the techniques you have used in your practical task
- state the hypothesis that you will be testing in the practical task
- record the data and observations you made in an appropriate form
- analyse the data and write scientific conclusions that the microbiologist would give, based on the evidence you have obtained in your investigation.

Assignment 1 The work of microbiologists in the food industry

Aim

In this assignment I am going to do some research to find out about the work of microbiologists in the food industry. I am then going to do an experiment where I follow a method that would be used by a microbiologist and write a report.

Research

The Food Standards Agency

1A.1a
1A.2a
1A.3a

A lot of microbiologists work for the Food Standards Agency. The Food Standards Agency is an independent Government department set up by an Act of Parliament in 2000. The aim of the FSA (as stated on their website) is "to protect the public's health and consumer interests in relation to food." The microbiologists who work for the FSA study the microorganisms that cause food poisoning and food spoilage (going off). Food poisoning sometimes kills people, especially in developing countries, but they also cost most countries, including the UK, a lot of money in medical care and lost days at work. Food spoilage also costs a lot of money and advances in food science means that much less food is wasted as foods can last longer if stored correctly. All these are reasons why the experiments done by food microbiologists are important to society – the results they get from their experiments may help to save lives, save money and waste less food.

1C.3b

1B.2a

1A.1b
1A.2b

I am going to take on the role of a microbiologist working for the FSA. I am going to do some experiments that a food microbiologist would do to test the freshness of milk. I will follow three standard operating procedures that would be used regularly by a food microbiologist. I will do some serial dilutions, plate up some agar plates containing the samples being tested and then count some colonies to make a comparison between the samples tested.

The work of a microbiologist working in the food industry

1B.1a
1B.2a
1B.3b

A food microbiologist may be involved in developing new food products, designing a process to produce foods and package materials, determine shelf life and microbiological and chemical testing. They may be involved in using "good" bacteria to produce foods such as cheese, yoghurt, bread, beer and wine, but they are mainly responsible for identifying what microorganisms are in foods and finding out the quantity of microorganisms in foods. Examples of microorganisms that cause food poisoning are Campylobacter and Salmonella. Microbiologists can identify these bacteria in food samples and find out what the levels of these and other microorganisms are in foods.

1C.3b

How a microbiologist would use the investigation

A microbiologist working in the food industry would carry out tests like these to ensure food or drink is fit for people to eat or drink without becoming ill. They would be able to tell how old the food or drink was and whether or not it had been kept correctly in a fridge. They would know the answers to these questions by comparing certain foods and seeing how many bacteria fresh food should have and then comparing foods where they don't know whether they are fresh or not, or if someone has stored them correctly if they need keeping in the fridge.

Scientific knowledge on bacteria in food and drink

1B.1b
1B.2b

Bacteria are everywhere, including the foods we eat. These bacteria multiply over time so that the older food is the more bacteria are present. This is why some foods/drinks have sell-by dates on them. When they are fresh they are safe because the numbers of bacteria are not high. But after food has been left or stored for some time, the bacteria numbers get bigger. Some foods need keeping in the fridge because they go off quick (not fit to eat because too many bacteria and other microbes like fungi growing on them) so keeping them in the fridge at a low temperature slows down the growth and reproduction because the enzymes in the bacteria work much slower at these temperatures. The microbiologist could tell how old food/drink was or whether it had not been kept in a fridge by doing a similar experiment to mine and comparing numbers of bacteria to those in samples of known ages.

Qualifications and skills

1C.1a
1C.2a
1C.3a

A food microbiologist is required to have a bachelor's degree in food microbiology or a food science degree. Most microbiologists who work for the Food Standard's Agency have a post graduate degree such as a Master's degree or a Doctorate degree (PHD). In order to get onto a food microbiology degree course it is essential to have A levels in Science, and must have GCSE Maths and English at grade C.

The skills required by a microbiologist in an investigation like the one I am going to do include the following:

1C.1b
1C.2b

- Use of precision instruments such as high-tech microscopes and cutting-edge lab technologies often using computers (we will not be doing this)
- Skills of observation to identify microbes, their characteristics and behavior and count colonies
- Skills to be able to draw accurate conclusions from results
- Be able to follow rigorous health and safety laboratory practices to ensure a sterile work environment and prevent contamination of the environment or the experiment
- Be able to communicate the results of their work effectively by being good at writing and speaking in order to present concise and clear reports to others
- General skills in time management, working in small teams under deadline pressure, working independently with minimal supervision and being able to interact with people

Bibliography

1D.1a

1D.2a

Resource used	What I used it for
http://www.ehow.com/about_7897768_role-food-microbiologist.html#ixzz1FTgyTAMk	Information about what microbiologists do
http://www.ehow.co.uk/info_7749987_microbiologist-qualifications.html	Qualifications needed to be a microbiologist
http://www.ehow.co.uk/list_6364103_skills-do-need-microbiologist_.html#ixzz1FXaolPe2	Skills needed to be a microbiologist
www.food.gov.uk	Information about the Food Standards Agency

www.eatsafe.gov.uk	Microorganisms in food and food hygiene
HGS A-level Biology	What is microbiology
Nelson Thornes GCSE Additional Applied Science text book Lawrie Ryan	Microorganisms that cause disease
Hodder and Stoughton GCSE Applied Science text book	Microorganisms that cause disease

Limitations of the investigation

1D.2b

It was a shame that we could only do 2 different milk samples. I do not actually know exactly how old this old milk was. If I was going to do this again I would use milk samples from a whole range of different ages e.g. I would use milk that was fresh and also milk that I knew was 2 days old, 4 days old, 6 days old and 8 days old. We would not have had time to do this but we could share this out amongst the class and do one sample of old milk each and put all the results together at the end. Also we could do further dilutions of each sample as the very old milk may have needed to be diluted more before we could clearly see and count the colonies.

The Practical Task

Hypothesis

I am going to test the hypothesis that a sample of old milk has more bacteria in it than a sample of fresh milk.

Equipment

2.1
2.2

8 test tubes
Nutrient agar liquid
Fresh milk sample
Old milk sample
$1cm^3$ syringe
$1cm^3$ pipette
Bunsen burner
Heatproof mat
8 agar plates
Glass rod
Measuring cylinder
Disinfectant spray
Cotton wool
Antibacterial hand wash

Method – serial dilution

1. I followed aseptic technique to ensure that I didn't get any contamination. I did this by working next to a Bunsen burner, keeping all my equipment on the heatproof mat. I had already cleaned my bench with disinfectant spray and washed my hands with antibacterial hand wash.
2. I measured out 9cm^3 of nutrient agar using the measuring cylinder into each of 4 test tubes labelled test tubes 1, 2, 3 and 4 (indicating 'fresh' on each)

3.3a Independent

3. 1cm^3 sample of the fresh milk was measured using the syringe and added to test tube 1 and then I mixed up the contents with a glass rod.
4. I then measured out 1cm^3 of the mixture in test tube 1 and added it to test tube 2 and mixed the contents.
5. I then measured out 1cm^3 of the mixture in test tube 2 and added it to test tube 3 and mixed the contents.
6. I then measured out 1cm^3 of the mixture in test tube 3 and added it to test tube 4 and mixed the contents.
7. I repeated this whole procedure with old milk – calling them test tubes 1, 2, 3 and 4 (indicating 'old').

Method – plating up

1. I took 1cm^3 out of test tube 1 and added it to the first agar plate labelled 1 old. I repeated this taking 1cm^3 from the other 3 test tubes and adding them to plates 2, 3 and 4 (labelled old) in order.
2. I then repeated this with the 4 test tubes 1, 2, 3 and 4 with the old milk samples in, adding 1cm^3 to plates 1, 2, 3 and 4 (labelled old).

Method – counting bacterial colonies

1. I left all 8 plates in an incubator at 25^{o}C for 48 hours.
2. I took the plates out of the incubator and observed the bacterial growth on the plates.
3. If I could see individual colonies, I counted them.

Results

3.1b

3.2b

Samples	Test tube/Agar plate			
	1	2	3	4
Fresh milk	Too many colonies to count	Too many colonies to count	Individual colonies can be seen and counted (22)	Individual colonies can be seen and counted (2)
Old milk	Too many colonies to count	Too many colonies to count	Too many colonies to count	Individual colonies can be seen and counted (35)

Conclusion

I need to work out the numbers of bacteria in the original samples using the equation:

Number of bacteria (per cm^3) in original samples = number of colonies x dilution of sample

When I added $1cm^3$ of the milk sample to $9cm^3$ of nutrient agar I diluted the original sample ten times. So test tube/Plate 1 = diluted 10 times
Test tube/Plate 2 = diluted 100 times
Test tube/Plate 3 = diluted 1 000 times
Test tube/Plate 4 = diluted 10 000 times

So if I found 22 colonies on plate 3 then I need to work out the number in the original sample by multiplying 22 by 1000 = 22 000 bacteria in fresh milk sample. I can check this by doing plate 4 = 2 x 10000 = 20 000. These are both nearly the same.

In the old milk I can do the following calculation:
Number of bacteria in original sample = 35 x 10 000 = 350 000. 4.3a

These calculations show me that my hypothesis was correct – old milk has more bacteria in it than fresh milk. In my experiment there are 16 times more bacteria in the old milk than in the fresh milk (350 000/22 000). 4.3b