

## **Review of NCEA Level 1 Standard 90188, 2002- 2005. New Zealand Qualifications Authority.**

### **Executive Summary:**

In 2004, a panel consisting of members of the New Zealand Microbiological Society (special interest group in Education) reviewed a booklet that was commercially available to support NCEA level 1 Science. In particular, the workbook series contained actual NZQA questions with detailed answers. Within these answers and questions the panel found an alarming amount of misconceptions and errors of fact. The publisher was contacted and he stated that the issue was a fault with NZQA (New Zealand Qualifications Authority) examiners as they (the publishers) work from their model answers.

Three main themes of misconceptions and errors were evident:

- Incorrect bacterial structure
- Incorrect fungal structure and terminology
- Incorrect assumptions regarding virus structure and replication.

An analysis was then done on the assessment schedules from NZQA that related to the questions assessing Achievement Standard 90188 from the external examinations from 2002 to 2005 and found that the same three misconceptions were evident. However, it is clear that the authors of the publications mentioned above had more errors than what was evident in the NZQA material.

Previous research has been done relating to the knowledge of science teachers in the NZ Secondary school system as it applies to basic microbiology facts and it is clear that the average teacher would not have enough knowledge to detect these errors in these publications and in the NZQA assessment schedules. A detailed report was submitted to the publisher and many of the errors were corrected. When the 2005 examination report was released, some of the same errors were further perpetuated.

**More importantly, the errors in the marking schedule have disadvantaged students being assessed against Achievement Standard 90188.**

The main points of error appear to be when attempting to relate general knowledge to a particular context. If the NZQA intends to retain this line of assessment, the NZ Microbiology Society requests that these questions or content are reviewed by one of its members to minimize these errors that then become perpetuated in the NZ Secondary school system. The current system obviously does not prevent errors from entering the examination system.

### **Reviewers:**

Christine Dunnington Fenton M.Sc, Western Institute of Technology at Taranaki;

Steve Flint PhD, Fonterra Research Institute;

Robin Simmonds PhD, Dip Tchg, Otago University;

Edward Smolinski, Fonterra Clandeboye;

Lynn McIntyre PhD, Massey University;

Michael Fenton M.Sc, Dip Tchg; Inglewood High School

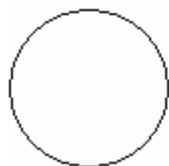
## Assessment Report

**2002**

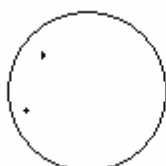
NCEA Level 1 Science (90188), 2002

### Comments on Specific Questions

- (b) Alana and Tama used agar plates to investigate the growth of micro-organisms. Plates A, B, C and D were uncovered for 20 minutes before being covered and put in incubators set at four different temperatures. The results after three days are shown below.



A



B



C



D

- (i) Name the type of organism that makes up the colony labelled in Plate C.  
(ii) Explain what the results of this investigation show about the growth of micro-organisms

**SOURCE: NZQA Examination 90188, 2002**

### NZQA Assessment schedule 2002

(b) Candidates often did not explain their observations. The relationship between temperature and growth was often missed. It was important to identify a trend and to refer to rate of growth.

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
The higher the temperature the more growth	The higher the temperature the more the growth : higher temperatures faster growth/reproduction.	explanation of why growth/ reproduction is faster at higher temp/optimum temp)

### **NZMS COMMENT:**

The most common way that this type of question is interpreted (by teacher resources and by the above NZQA comment) is that the "more" colonies on an agar plate, then the "more" bacteria that were present on the initial object sampled, or that the temperature of incubation has increased the rate of growth. These types of questions are misleading because increasing the temperature may NOT increase growth – microbes have specific optimum temperatures at which their growth is increased, and it varies greatly. This question could have worked better if ONE inoculum type (not multiple organisms by air exposure) were used. Only then could the student interpret that the most optimum temperature would be the one with the most growth/colonies. The arrow indicating the "smooth" type of colony has been interpreted by many resources as a "bacterium" as opposed to the filamentous type of microbe (fungi). This also is erroneous as many species of bacteria could look filamentous like this on an agar plate and many fungi would be just starting to be

CD Fenton

NZMS report to NZQA – NCEA standard 90188, 2002 -2005

visible after 3 days of incubation, along with the fact that many fungi (yeast) could exhibit smooth colony morphology. Also, without knowing the temperature of incubation, or the type of agar being used, deducing the type of organism in colony C would be very difficult without making wrong assumptions such as those above. By the statement in the assessment schedule this would have disadvantaged students.

This question appears to be based on a poor understanding of an amalgam of knowledge from Level 1 study guides with no basis whatsoever in having actually cultured different microorganisms or sampling the environment. Since sampling the environment and culturing unknown and potentially pathogenic organisms is discouraged by the Ministry of Education's own Safety Guidelines to schools, perhaps this sort of question is no longer appropriate. An alternative is to use an authentic resource, perhaps from a lab that routinely cultures environmental samples.

(c) Read the following instructions for the storage of yeast.

Yeast is a live micro-organism, so proper storage of yeast used in bread-making is important. The enzymes in stored yeast are in an inactive state. **If the packet of yeast is unopened, it can be stored at room temperature for up to one year. After opening, yeast should be stored in an airtight container in a refrigerator or freezer.** It must be used within four months of opening.

Discuss the biological reasons for the different storage conditions needed before and after the yeast has been opened.

**SOURCE: NZQA Examination 90188, 2002**

**NZQA Assessment schedule 2002**

*(c) Many candidates failed to recognise that yeast is a micro-organism, despite this being stated in the resource; they instead saw it as a food source for bacteria. Many candidates had the yeast 'rotting' and being dangerous to the consumer's health due to bacterial contamination, which was not relevant to this question. Many also did not recognise that yeast is a fungus. Many candidates used the general term 'air' instead of specifying 'oxygen', while others incorrectly stated that the yeast reacted with oxygen. Another common error was for candidates to state that refrigeration stops growth rather than slowing it.*

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
Unopened – yeast in suspended animated state (yeast needs warmth/moisture to grow/reproduce)	Unopened – yeast can be stored anywhere because it is free of moisture/oxygen and therefore remains inactive OR Opened – yeast in contact with oxygen and moisture start growing.	In fridge slows this process. Unopened – yeast in suspended animated state : Opened – yeast in contact with oxygen and moisture start growing. In fridge slows this process.

**NZMS COMMENT:**

The wrong assumption here is that the yeast used to make bread is aerobic (requires oxygen). It is in fact anaerobic so will grow without the presence of oxygen (fermentation is anaerobic process). If a student was to correctly note that the yeast will grow independently of "oxygen", and that the only requirement for "activity" is for moisture (more likely in an opened container) it is not clear if marks would be given. In the "merit" and "excellence" segments, it is implied that both are required (moisture **and** oxygen). By the statement in the assessment schedule this would have disadvantaged students.

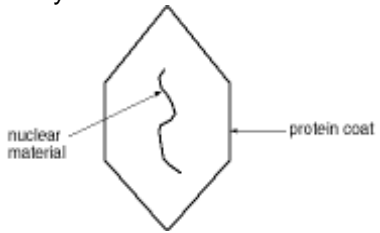
- 
- |   |
|---|
| (d) Viruses are known as obligate parasites. This means that they can ONLY live as parasites, causing diseases in plants and animals.<br><br>(i) Draw and label a diagram to show the structure of a virus.<br><br>(ii) Discuss the reasons why viruses must always be parasites. Your answer should consider the structure and way of life of viruses. |
|---|

**SOURCE: NZQA Examination 90188, 2002**

**NZQA Assessment schedule 2002**

*(d) (i) Candidates generally performed well on this question, although many missed the protein coat label. More care needed to be taken with lines from labels to diagrams.*

*(ii) This question was well done by able candidates but few recognised that a virus is non-living, ie unable to carry out MRS GREN. A common error was for candidates to state that the entire virus was inserted into cells. Answers to this question showed that there is generally a poor understanding of the use of the cell's mechanisms/processes in virus replication. Very few candidates understood the process once the viral nucleic acid entered the living host cell.*

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
Correct diagram with labels for protein coat and nuclear material, (diagram below). Viruses have no nucleus / cannot respire independently / do not carry out MRS GREN functions 	Therefore viruses require a host cell (to carry out reproduction)	Viruses must take over a host cell using the host cell's processes to reproduce

**NZMS COMMENT:**

A very major fundamental error presented here is often perpetuated throughout supporting resource material and we have seen this error over consecutive years of assessment. This relates to the misconception that ALL viruses replicate similar to a

bacteriophage. The NZQA statement relating to *"common error was for candidates to state that the entire virus was inserted into cells"* is extremely worrisome to the NZMS. In fact, MOST viruses replicate in this way. The following statements that: *"Answers to this question showed that there is generally a poor understanding of the use of the cell's mechanisms/processes in virus replication. Very few candidates understood the process once the viral nucleic acid entered the living host cell"* actually highlight that this examiner had a poor understanding of virus replication. This misconception of viral replication and the incorrect links that all viruses replicate in a similar way to bacteriophage also has perpetuated many errors in the supporting resources. They include expected diagrams of viruses (label of protein coat and nuclear material) being actual bacteriophage (viruses that infect bacteria: not animals or plants to which the question relates). Because the question is relating to plants and animal diseases, a student could correctly relate that the entire virus is inserted into the host cell, but be marked incorrect. By the statement in the assessment schedule this would have disadvantaged students.

---

## Assessment Report

**2003**

NCEA Level 1 Science (90188), 2003

### Comments on Specific Questions

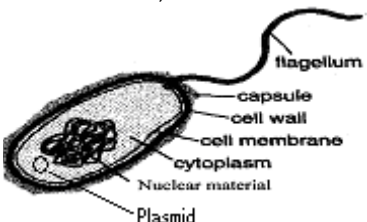
#### QUESTION TWO: WINTER COLDS AND FLU

Faguele went to the doctor with a sore throat. A sample from his throat was cultured on nutrient agar to see if bacteria caused the problem.

- Draw and label a diagram of a bacterial cell.
- Explain why agar plates are usually placed in an incubator when culturing bacteria.
- Discuss how the life processes of bacteria differ from those of viruses.

SOURCE: NZQA Examination 90188, 2003

### NZQA Assessment schedule 2003

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
<p>Nuclear material includes genetic material, chromosome, DNA etc</p>  <p>Diagram must correctly show <b>nuclear material</b> plus <b>two other cell parts</b>.</p>		

#### NZMS COMMENT:

The heading of this question is inappropriate as it gives the impression that "Faguele" is suffering from colds or flu – which are illnesses caused by viruses. The entire question however is relating to **bacteria**. Also, due to the contextual basis of this question, with "Faguele" having a sore throat, the sample that would have been grown from his throat would have been a bacterium that was coccoid (round) in shape, not a bacillus (rod shaped) as in the NZQA answer. It is also extremely unlikely that it would have a flagella, but it **may** have a capsule. Published resources that support this standard often mimic this "ideal" bacterium, with the flagella, the rod shape, and the cytoplasm but this often is entirely incorrect due to the contextual source of the culture. The correct answer for this question would have been a simple circle shaped bacterium, with DNA (circular, NOT linear) showing cytoplasm, cell membrane and cell wall. By the statement in the assessment schedule this would have disadvantaged students.

## Assessment Report

CD Fenton

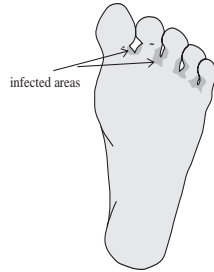
NZMS report to NZQA – NCEA standard 90188, 2002 -2005

**2004**

NCEA Level 1 Science (90188), 2004

**Comments on Specific Questions**

**QUESTION ONE: ATHLETE'S FOOT**



**What is athlete's foot?**

Athlete's foot is a skin disease causing an itchy rash on the bottom and sides of the feet and between the toes. Athlete's foot is caused by a fungus.

Feet provide a warm, dark, and humid environment, which encourages fungal growth using aerobic respiration.

- (a) What does '**aerobic**' mean in aerobic respiration?
- (b) Describe how the athlete's foot fungus feeds (obtains nutrients). A **labelled** diagram may assist your answer.
- (c) Discuss how the biology of fungi allows the athlete's foot fungus to be transmitted from one person to another.

**SOURCE: NZQA Examination 90188, 2004**

**NZQA Assessment schedule 2004**

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
Biology must be described. Lots spores / sporangia outside body / spores light / (spores) easily dispersed / able to survive outside body / damp areas / specific transmission from foot to foot / damp foot. <b>1 idea needed</b>	Biology explained. Lots spores / sporangia outside body / spores light / (spores) easily dispersed / able to survive outside body / damp areas / specific transmission from foot to foot / damp foot. <b>2 ideas (must mention spores)</b>	Biology discussed. Lots spores / sporangia outside body / spores light / (spores) easily dispersed / able to survive outside body / damp areas / specific transmission from foot to foot / damp foot. <b>3 ideas (must mention spores)</b>

**NZMS COMMENT:**

Another common misconception amongst supporting published documents is that all fungi have sporangia. In the context that this question is set athletes' foot fungus produce micro-conidia. It is not clear from the marking criteria/model answer if a student would lose marks from this question if they represented the reproductive structures correctly (as microconidia) instead of sporangia or mushroom "like" structures. The generalized use of the term "sporangia" is misleading as it applies to a particular type of fungi and it certainly does not apply to athletes foot.

**QUESTION TWO: GLANDULAR FEVER**

Glandular fever is caused by a viral infection.

- (a) Describe the process of virus reproduction. A **labelled** diagram may assist your answer.
- (b) Explain why it is not possible to culture a virus on a nutrient agar plate in a school laboratory.

**SOURCE: NZQA Examination 90188, 2004**

**NZQA Assessment schedule 2004**

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
Virus reproduction described. DNA / RNA / genetic material injected into host cell: nucleus / cell / (cell) more virus made : virus released from cell. <b>NOT virus reproducing itself</b>		
Virus needs living host to reproduce / nutrient agar does not contain living cells / material / host.	Virus does not reproduce without living host. : Nutrient agar does not contain living cells/material/host.	

**NZMS COMMENT:**

Again, because this question is specific in that the question has the contextual basis of "glandular fever" then asks the student to describe the process of viral reproduction, the model answer is wrong. Glandular fever is in fact caused by Epstein-Barr virus which is an enveloped icosahedral virus. The envelope on the Epstein-Barr virus fuses with the cell and the **whole virion enters the cell** (it does not inject its nuclear material as mentioned in the marking criteria). The virus is not released by cell lysis, but they bud from the nuclear membrane and exit via the endoplasmic reticulum.

If part (b) of this question is relating to glandular fever, then the answer is correct (except for the reference regarding plants). Glandular fever virus CAN NOT be grown on nutrient agar. However, if the question is relating to viruses in general then the answer is incorrect. "*Nutrient agar does not contain living cells*" is correct but misleading. The viruses that reproduce in the cells of bacteria (bacteriophage) are grown in nutrient agar that contains the bacterial host cells. The virus is then put onto the agar plate and it utilizes the bacterial cells held in the agar medium (nourished by the nutrients in the nutrient agar plate). Mammalian viruses and plant cells are grown in tissue culture but many viruses are ROUTINELY grown in Nutrient agar (with live bacterial host cells). By the statement in the assessment schedule this could have disadvantaged students.

---

**QUESTION THREE: CULTURING BACTERIA**

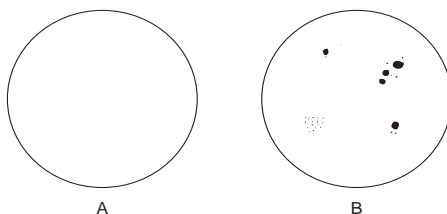
Two sterile nutrient agar plates have been inoculated with a sample of bacteria from a kitchen bench and then incubated at two different temperatures for six days.

**Results:**

- (a) The plates were incubated at 25°C and 55°C. Complete the table below, using the correct letter, to show which one of the plates was incubated at each temperature.

Temperature (°C)	Plate
25°	
55°	

- (b) Discuss why the bacterial growth on the two nutrient agar plates is different at the different temperatures.



**SOURCE: NZQA Examination 90188, 2004**

**NZQA Assessment schedule 2004**

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
25° B/55° A		
Idea relating to increased temp and faster growth for <b>specific</b> plate could earn follow on.	Explanation that temperature affects the growth/reproduction of bacteria: specific example <b>Either:</b> 55° is too hot leading to no growth. <b>Or:</b> 25° better / optimum temp therefore fast growth	At approx room temp (25°) : colony growth / bacterial reproduction / larger numbers of bacteria / faster reproduction : but 55° is too hot for most bacteria, therefore no colonies present / enzymes disrupted at this temp / no reproduction /bacteria killed.

**NZMS COMMENT:**

Bacteria do reproduce at their most rapid rate nearest their optimum growth temperature (almost the warmest they can tolerate). For many bacteria that cause human illness (and animals) that happens to be between 30 and 40°C and it is NOT appropriate to say that bacteria reproduce most rapidly at this temperature as many would not. Many microbes in the world would tolerate 55°. Also, due to the length of incubation (6 days) there are many other reasons why the 55° plate has less growth on it. By the statement in the assessment schedule this would have disadvantaged students.

---

## Assessment Report

**2005**

NCEA Level 1 Science (90188), 2005

### Comments on Specific Questions

#### QUESTION THREE: GINGER BEER

Ginger beer is a non-alcoholic soft drink made by adding ginger, sugar, water, and the fungus yeast together in a sterile container. The container is then kept in a warm place for a few days. At the end of this time, the container is heated at high temperature before the ginger beer is bottled.

- (a) Name the conditions required to obtain maximum growth of the yeast fungus.
- (b) Explain why the container of ginger beer is heated to a high temperature before its contents are bottled.

The yeast undergoes **anaerobic** respiration in the container.

- (c) What does anaerobic mean?
- (d) Name TWO products of this reaction.

SOURCE: NZQA Examination 90188, 2004

### NZQA Assessment schedule 2005

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
a) Food / moisture / warmth / O <sub>2</sub> /ok pH. <b>Any 2 needed.</b>		
c) Without : oxygen (not air) /not much.		

#### NZMS COMMENT:

As mentioned before, (2002 examination), fermentation is an anaerobic process, and therefore **does not** require oxygen.

---

#### QUESTION FOUR: CAMPYLOBACTER

- (a) Draw a **labelled** diagram of a bacterium.

*Campylobacter* is a bacterium that causes food poisoning. It is often caught from eating chicken.

- (b) Discuss how the **storage temperature** and **cooking temperature** of chicken affect the life processes of the *campylobacter* bacterium.

SOURCE: NZQA Examination 90188, 2004

**NZQA Assessment schedule 2005**

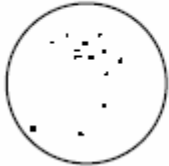
<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
<p>a) Diagram with any 3 <b>correct</b> labels.</p>  <p><b>Max 1 error.</b></p>		

**NZMS COMMENT:**

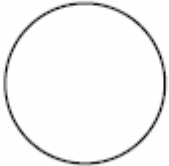
Again, due to the contextual basis of this question – using a named bacterium *Campylobacter* – the image in the assessment schedule is incorrect. A *Campylobacter* is a slender, spirally curved rod (the bacterium depicted here is ovoid not rod like). They can have flagella at both end of the cell and the flagellum is often 2 or 3 times as long as the length of the cell. They DO NOT have a “protective gel coat” as depicted in the NZQA marking criteria. A common mistake in supporting published material is that ALL bacterium have a “capsule” or “protective coat”. Although the question is not actually asking the student to draw a *Campylobacter* bacterium, the supporting publications using these as model answers are depicting this bacterium with incorrect features, modeling this answer.

The following agar plates were inoculated from 3 areas in a kitchen. The plates were then covered and stored for 3 days in the same place from where the sample was collected.


**Plate A**



**Plate B**



**Plate C**



**Plate A Plate B Plate C**

Area 1 – kitchen bench recently washed with disinfectant, Area 2 – pantry shelf  
 Area 3 – fridge shelf

(c) Match up the agar plates to the areas they were collected from.  
 Give a reason for each of your answers.

The plates were then incubated at a temperature of 28°C for a further 3 days.

(d) In the circles below, draw what the plates would look like **after** the period of incubation.

**SOURCE: NZQA Examination 90188, 2004**

**NZQA Assessment schedule 2005**

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
(d) Coverage of plate C > coverage A > coverage of plate B. <b>All have more than original plates.</b>		

**NZMS COMMENT:**

This question is making the assumption that after longer incubation, that there would be more coverage of plate. In fact, the individual colonies may just be larger, but coverage would be no different after another 3 days incubation at that temperature unless contaminants or fungi take over all growth. It is difficult to tell from the marking criteria what the examiner is expecting (hence teachers and writers of the supporting resources will have to interpret what is required). It would not be possible to judge which plate came from the fridge, or from the pantry. IF, the question is suggesting that one plate is incubated in the fridge, "stored in the same place from where the sample was taken" and so the other two plates are at room temperature, then you would expect growth on the other two plates (although less on the plate just disinfected). After the next 3 days of incubation, the plate from the fridge, and the plate from the pantry could look very similar.

**QUESTION FIVE: VIRUSES**

Viruses come in many different shapes, but they all have the same main parts in common.

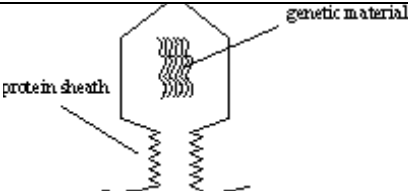
(a) Draw a **labelled** diagram of a virus.

All living things have several common characteristics.

(b) Discuss whether a **virus is alive or not**. You should compare the virus's characteristics to those common to all living things.

**SOURCE: NZQA Examination 90188, 2004**

**NZQA Assessment schedule 2005**

<i>Achievement</i>	<i>Merit</i>	<i>Excellence</i>
 <p><b>Diagram with 2 correct labels:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Genetic material / nucleic acid / DNA or RNA. (<b>Not</b> chromosome).</li> <li><input type="checkbox"/> Protein sheath / coat.</li> </ul>		

**NZMS COMMENT:**

As mentioned before, most viruses information assessed, and in the supporting resource material relates to the replication cycle of a bacteriophage (a virus that infects bacteria) and looks similar to this depicted virus. The problem comes when relating that information (morphology, mode of replication, exit/entry from host cell) to animal or human illnesses which have **entirely different morphology**, and replication modes. As a generic question relating to “viruses come in many different shapes ...” this answer is appropriate as long as the markers were not directed to accept only the morphology of the bacteriophage shown.