Lab 9. Population Growth: What Factors Limit the Size of a Population of Yeast?

Introduction

All populations of living things change in size over time. The human population is no different. A population is a group of individuals that belong to the same species and live in the same region at the same time. In 1800, the total number of people on Earth was about 1 billion. Now the world population is 7 billion. This observation has caused many scientists to ask questions such as “What caused this dramatic increase in the human population?” and “How long will the human population continue to grow?”

Human population growth has been a “hot topic” of discussion in the popular media and among ecologists (scientists who study how organisms interact with each other and the environment). To better understand human population growth on Earth, it is necessary to study population dynamics, or the changing size, density, and range of a population. Population dynamics is an area of life science that focuses on these changes. Scientists studying *population dynamics* investigate how different factors in living organisms and the environment shape those changes. However, humans are not the only living things studied through population dynamics. Factors related to all living organisms can include what they eat and drink, the amount of space they need, and how they interact with other organisms. Many of these factors are considered *biotic factors*, because they involve living things in an ecosystem. Factors related to the environment can include how much space is available and the weather and climate patterns in a particular area. Many of these factors are considered *abiotic factors*, because they involve nonliving pieces of an ecosystem.

By investigating these biotic and abiotic factors, scientists determine important relationships that help populations grow or reduce the number of organisms in an area. Scientists study the population dynamics of many different organisms to help us understand more about what affects human populations. Also, scientists study how human populations change other populations of organisms. Knowing about these relationships helps scientists and policy makers make decisions about how to manage natural resources and organisms in many different types of ecosystems.

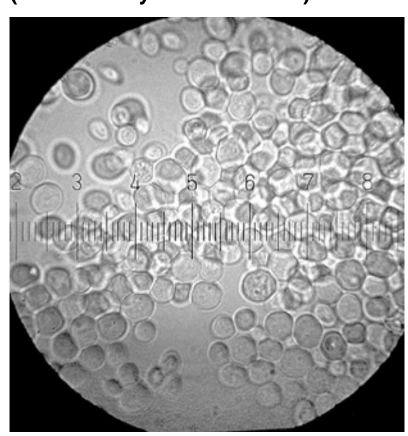
Your Task

Design an investigation on how the size of a population of yeast changes over time in response to different factors such as *amount of food*, *amount of space*, and *the initial size of the population*. Yeasts are single-celled organisms in the Fungi kingdom. One species of yeast called *Saccharomyces cerevisiae* (Figure L9.1) has been used in baking and alcoholic beverages for thousands of years. Scientists have also used it to gather information about how cells function because it reproduces quickly. In fact, *S. cerevisiae* and many other species of yeast can produce a new generation every two hours. Therefore, a population of yeast could potentially increase in size very quickly if something did not prevent the size of the population from growing over time.

The guiding question of this investigation is, **What factors limit the size of a population of yeast?**

FIGURE L9.1

Microscopic image of yeast (*Saccharomyces cerevisiae*)



Materials

You may use any of the following materials during your investigation:

Consumables	Equipment
• Yeast culture • Sugar solution • Iodine solution • Distilled water	• Graduated pipette (1 ml) • Test tubes • Test tube rack • Simple compound light microscope • Microscope slides • Cover slips • Calculator • Sanitized indirectly vented chemical-splash goggles • Chemical-resistant apron • Gloves

Safety Precautions

Follow all normal lab safety rules. In addition, take the following safety precautions:

1. If you have any allergies to yeast, be sure to discuss this with your teacher immediately!
2. Put on sanitized indirectly vented chemical-splash goggles and laboratory apron and gloves before starting the lab activity.
3. Handle all glassware with care to avoid breakage. Sharp glass edges can cut skin!
4. Review the important information on chemicals on the safety data sheet, and use caution when handling chemicals.
5. Follow all safety rules that apply when working with electrical equipment, and use only GFCI-protected electrical receptacles.
6. Wash hands with soap and water after completing the lab activity.

Investigation Proposal Required? ☐ Yes ☐ No

Getting Started

Brainstorm with your group one possible factor that you think will limit the size of the yeast population. While designing your investigation, consider this variable while writing your hypotheses (e.g., population size is limited by the amount of food available, space available, and other factors). Be sure to include a control condition in your investigation, which will include environmental conditions that you will not change across different treatment conditions. A control condition usually represents the "normal" environment for the organism you are studying. You will need to track the size of a population of yeast for the next 72 hours.

Listed below are some important tips for working with yeast.

Setting up a population of yeast:

1. Use a graduated pipette to transfer 1 ml of the yeast from the class culture to a standard test tube. Measure carefully. In this case, more is not better.
2. Add two drops of iodine to yeast in the test tube. Be sure to drop the iodine into the culture, not on the side of the test tube. (The iodine will help you to see the cells under the microscope.)
3. Add water to the test tube (this can range from 1 ml to 5 ml depending on how much space you want to give the yeast population).
4. Add sugar solution to the test tube (this can range from 1 ml to 3 ml depending on how much food you want to give the yeast population).

Counting the number of yeast in your test tube:

Because yeast cells tend to settle out of solution, you will need to stir the yeast in your test tube so that the cells are evenly distributed. This must be done gently to avoid foaming the culture.

1. Use the 1 ml pipette to transfer 0.1 ml (a single drop) from the test tube to the graduated microscope slide.
2. Carefully lower a cover slip onto the drop to make a wet mount slide. Observe the slide under low power and identify the yeast cells.
3. Count the number of yeast cells in three different fields of view under high power. Select those fields of view from different areas of the slide.
4. Add the total number of cells you counted in all three squares and find the average number of cells per field of view.

To answer the guiding question, you must first determine what type of data you need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you need to collect*, think about the following question:

- What type of measurements or observations will you need to record during your investigation?

To determine *how you will collect your data*, think about the following questions:

- What will serve as a control (or comparison) condition?
- What types of treatment conditions will you need to set up and how will you do it?
- During the experiment, when will you collect data and how often will you collect it?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect and how will you organize it?

To determine *how you will analyze your data*, think about the following questions:

- How will you determine if there is a difference between the treatment conditions and the control condition?
- How will you calculate change over time?
- What type of graph could you create to help make sense of your data?

Connections to Crosscutting Concepts, the Nature of Science, and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

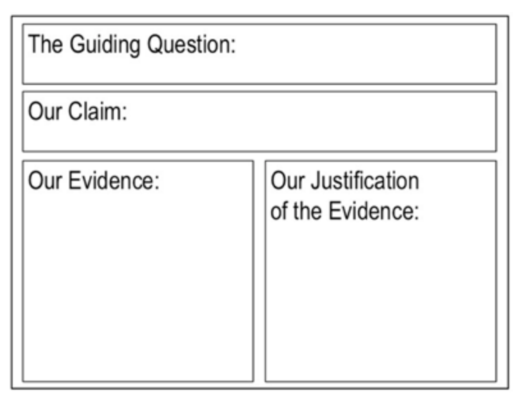
- how scientists try to identify patterns in nature to better understand it,
- how living things go through periods of stability followed by periods of change,
- the difference between observations and inferences in science, and
- the role of experiments in science

Initial Argument

Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a claim, evidence to support your claim, and a justification of the evidence. The claim is your group's answer to the guiding question. The evidence is an analysis and interpretation of your data. Finally, the justification of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L9.2.

FIGURE L9.2

Argument presentation on a whiteboard



Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their classmates. This is similar to how scientists present their arguments to other scientists at conferences. If you are responsible for critiquing your classmates' arguments, your goal is to look for mistakes so these mistakes can be fixed and they can make their argument better. The argumentation session is also a good time to think about ways you can make your initial argument better. Scientists must share and critique arguments like this to develop new ideas.

- To critique an argument, you might need more information than what is included on the whiteboard. You will therefore need to ask the presenter lots of questions. Here are some good questions to ask:
- What did your group do to collect the data? Why do you think that way is the best way to do it?
- What did your group do to analyze the data? Why did your group decide to analyze it that way?
- What other ways of analyzing and interpreting the data did your group talk about?
- What did your group do to make sure that these calculations are correct?
- Why did your group decide to present your evidence in that way?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those other ideas?
- How sure are you that your group's claim is accurate? What could you do to be more certain?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. The report must be typed and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!