# 10A Respiration and Temperature

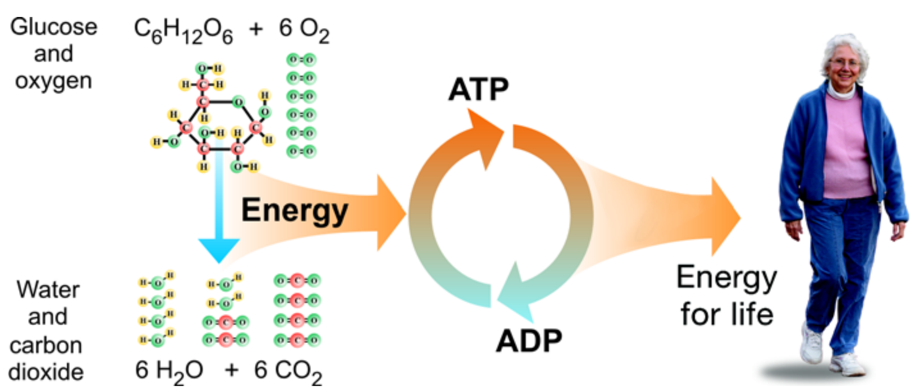
*Why are living organisms dependent on temperature?*

Earth gets hot in summer and cold in winter, but not early so much as other places in the Solar System. The average temperature on Venus is 460°C (860°F), hot enough to melt lead! At the opposite extreme is icy Neptune with a temperature of -200°C (-328°F). Earth life wound not survive on Venus or Neptune because of the extreme temperatures. This investigation will look at how the chemical processes of life are affected by temperature.

*Materials*

- Probe System with temperature probe and heater
- 25 mm test tube
- 2 hole stopper with 7mm glass tube inserted (premade)
- Balance (0.1 g)
- 5-10 g rapid rise yeast
- 5-10 g sugar
- stopwatch
- cm ruler
- weighing papers
- permanent marker

## Part 1: Cellular respiration




Living organisms eat food to get energy and matter from their environment. At the microscopic level, the process of extracting energy from food is called cellular respiration. The actual chemical reactions proceed in many steps but the overall reaction is to convert sugar and oxygen into carbon dioxide, water, and energy. The energy is stored in a rechargeable molecular "battery" called adenosine triphosphate (ATP).

In this experiment we are going to investigate how the reactions of cellular respiration are affected by temperature. The results will tell us a great deal about why Earth is so well suited for life.

## Part 2: Questions to think about

**a.** What is the maximum temperature at which living things can survive?

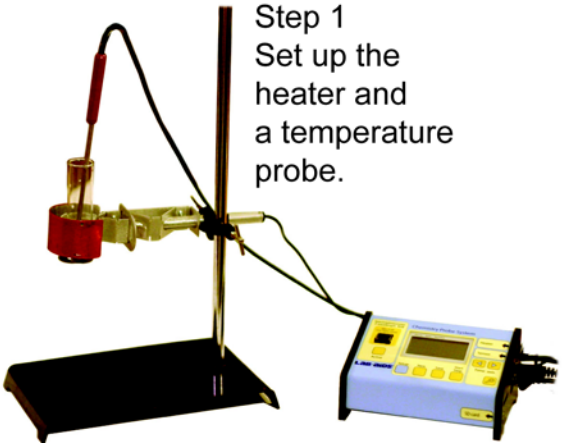
**b.** What is the minimum temperature at which living things can survive?

**c.** What is the average temperature of your body in °C and °F?

**d.** What is the average temperature of Earth's surface in °C and °F?

**e.** What are the approximate high and low temperatures in areas where people live (in °C and °F)?

## Part 3: Setting up.



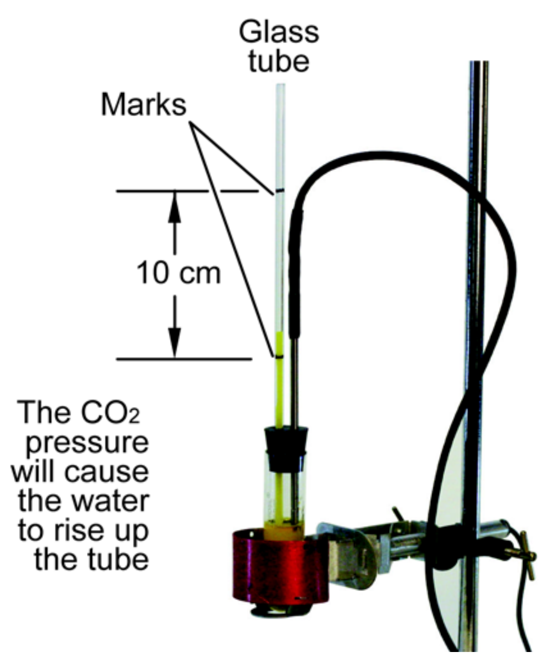
Step 1
Set up the heater and a temperature probe.


Measure out 1 g or sugar and 1 g of yeast

1. Set up the Probe System with a temperature probe and the heater.
2. Bring 30 mL of water in a test tube to the temperature you are assigned by your teacher.
3. While the water is heating up, measure out 1 gram of sugar and 1 gram of yeast.
4. Record the temperature of water in the table below.
5. Take the test tube out of the heater and add the sugar. Stir well and put the test tube back in the heater.
6. Take the stopper with the glass tube and make two marks 10 cm apart with the permanent marker. The lowest mark needs to be at least 5 cm from the stopper. The tube should be about 1 cm from the bottom of the test .tube.
7. Insert the temperature probe in the other hole so it sticks down at least 1 cm into the water.

## Part 4: How the experiment works

When you add the yeast to the sugar water, the microscopic yeast will start to live and grow. This means the yeast will eat the sugar and produce carbon dioxide gas. IF the stopper is snug in the test tube, the $CO_2$ gas will make the pressure in the test tube go up. In turn this will force water up the glass tube.

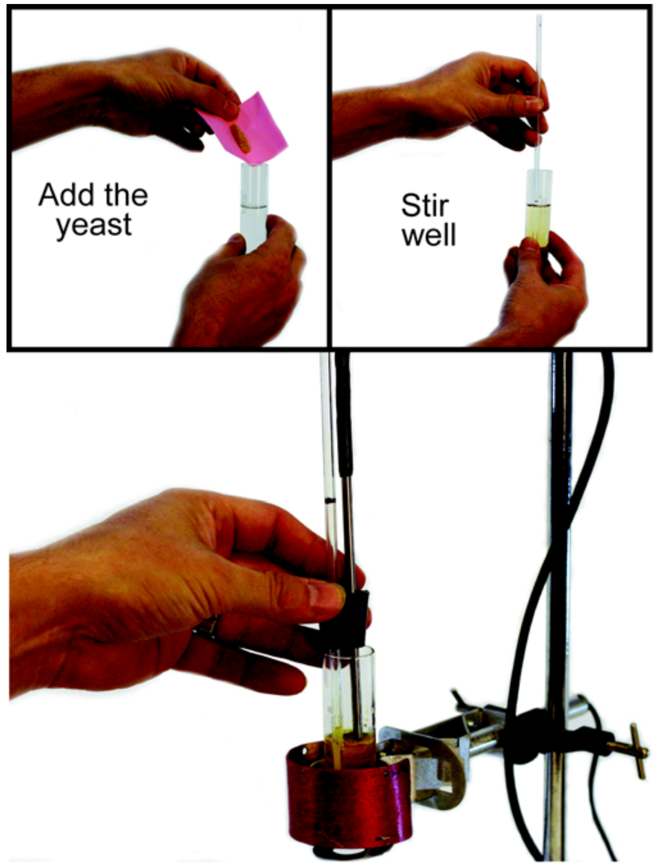



The RATE of chemical reactions withing the yeast directly affects how fast the water rises up the tube. By measuring how long it takes for the water to rise 10 cm, you can measure the rate of cellular respiration of the yeast. Of course, as the yeast grow and multiply, this reaction rate will change. Therefore, it is VERY IMPORTANT to be ready to make measurements AS SOON as you add the yeast to the test tube. Practice what you are going to do before adding the yeast.

One last important step! When the water has reached the higher mark, quickly loosen the stopper in the test tube and release the pressure. Otherwise the yeast mixture will overflow the top of the tube and make a mess!

## Part 5: The experiment

1. Make sure you have everything set: temperature probe is at the right height in the stopper, water is at temperature, sugar is mixed, stop watch is ready and your marks are on the glass tube.
2. Remove the test tube and carefully stir in the yeast.
3. Press NEW on the Probe System to restart the system clock
4. At 3 minutes, put the stopper in the test tube and measure how long it takes the water to get from the first mark to the second mark (10 cm higher).
5. Release the pressure by lifting the stopper and resting it on the edge of the test tube.
6. Repeat the procedure using 0.5 g of sugar
7. Repeat using 2 g of sugar.




Lift the stopper to release the pressure and keep the tube from overflowing

## Part 6: Analyzing the data

**Table 1: Temperature of water**

| Time (minutes) | Time to rise 10 cm (seconds) |
|---|---|
| 0 | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

## Part 7: Thinking about what you observed

**a.** Each group will repeat the experiment for several different temperatures. Collect the data from the class and make a graph. The graph shold have temperature on the x-axis. The rise time should be on the y-axis since this is a measure of the reaction rate.

**b.** What does the graph look like? IS it a line? Is it a curve? Does it have a hump?

**c.** At what temperature does the reaction go fastest?

**d.** What does this experiment tell you about the temperature range that yeast find most suitable for life?

## Part 8: Investigating other aspects of the environment

There are other chemical variables that affect the ability of living organisms to thrive and grow. One of the most important is pH and another is the presence of environmental factors such as salt and other compounds

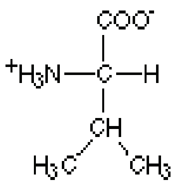
**a.** design an experiment to test the impact of pH on respiration. Carry the experiment out and state your conclusion.

**b.** design an experiment to test the effect of salt concentration on respiration in yeast. Carry the experiment out and state your conclusion.

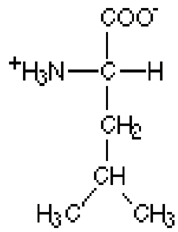
For each of the experiments, you should

1. Create a data table and record data that you can use to evaluate your research question.
2. Analyze the data, using appropriate techniques such as graphing and error analysis.
3. Write down a formal hypothesis for your experiment
4. Write down a brief procedure for your experiment.
5. Write down a paragraph for a conclusion.

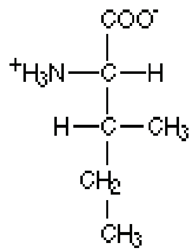
## Amino acids with hydrophobic side groups



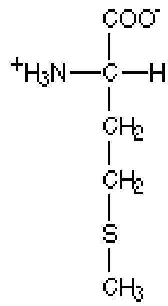
Valine
(val)



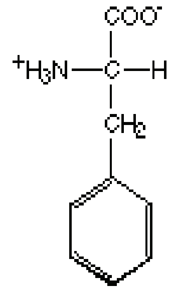
Leucine
(leu)



Isoleucine
(ile)

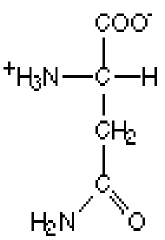


Methionine
(met)

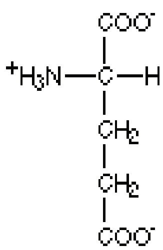


Phenylalanine
(phe)

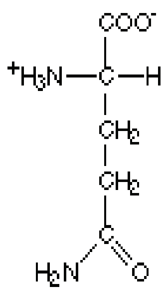
## Amino acids with hydrophilic side groups



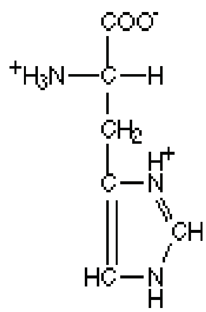
Asparagine
(asn)



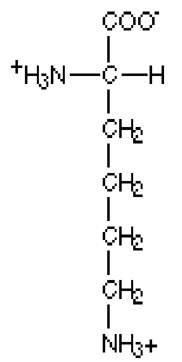
Glutamic acid
(glu)



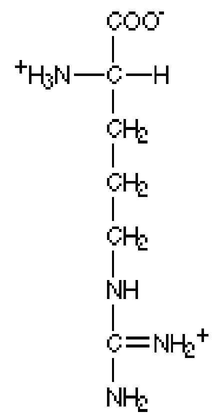
Glutamine
(gln)



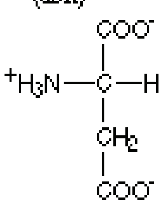
Histidine
(his)



Lysine
(lys)

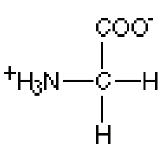


Arginine
(arg)

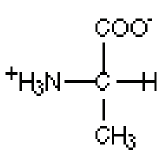


Aspartic acid
(asp)

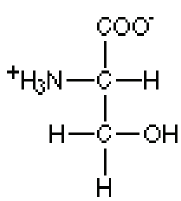
## Amino acids that are in between



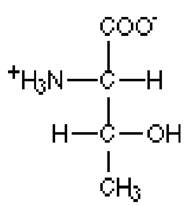
Glycine
(gly)



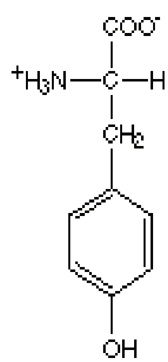
Alanine
(ala)



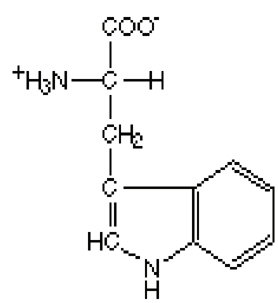
Serine
(ser)



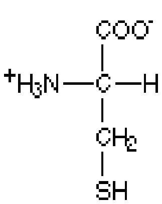
Threonine
(thr)



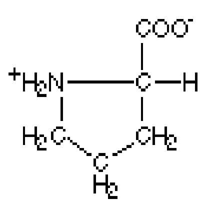
Tyrosine
(tyr)



Tryptophan
(trp)



Cysteine
(cys)



Proline
(pro)

# 17C DNA and Proteins

*How does DNA carry genetic information?*

DNA is a complex molecule that carries the gentic code for all living organisms on Earth. How does DNA actually work? Scientists still do not understand all the details, but one of the ways DNA works is to store the "blueprints" for all the proteins a living organism needs. This investigation will show you how to "read" DNA to build a protein.

*Materials*

- Molecular modeling kit

## Part 1: Amino acids are the building blocks of proteins

Proteins are large and very complex molecules. Like most complex things, a single large protein molecule is built up from smaller parts. In this case the "parts" are smaller molecules called amino acids. A protein molecule is made of many, often hundreds, of amino acids joined together like links in a long, curled up chain. You might think that proteins in plants and animals are different, and they are. However, the proteins in living things on earth, including all plants and animals, are made of the same 20 amino acids! This is an extraordinary fact, and no coincidence. It is proof that all living things on our planet are related. You can eat plants, and get nourishment from them, because the proteins in plants use the same amino acids your body needs to build the proteins it needs for itself.

Build the amino acid molecule(s) you are assigned by the instructor.

## Part 2: The DNA code

Each amino acid is coded for by a three letter sequence of bases in a DNA molecule. These "codons" specify the order in which the amino acids are assembled to make a completed protein. Note that each of the amino acids has several different codons. To tell where a protein sequence begins or ends the codons TAA, TAG, and TGA stand for START/STOP

**Table 1: DNA codons for amino acids**

| Amino acid | DNA | Amino acid | DNA codons |
|---|---|---|---|
| phenylalanine | TTT, TTC | histidine | CAT, CAC |
| leucine | TTA, TTG, CTT, CTC, CTA, CTG | glutamine | CAA, CAG |
| isoleucine | ATT, ATC, ATA | asparagine | AAT, AAC |
| methionine | ATG | lysine | AAA, AAG |
| valine | GTT, GTC, GTA, GTG | aspartic acid | GAT, GAC |
| serine | TCT, TCC, TCA, TCG, AGT, AGC | glutamic acid | GAA, GAG |
| proline | CCT, CCC, CCA, CCG | cysteine | TGT, TGC |
| threonine | ACT, ACC, ACA, ACG | tryptophan | TGG |
| alanine | GCT, GCC, GCA, GCG | argenine | CGT, CGC, CGA, CGG, AGA, AGG |
| tyrosine | TAT, TAC | glycine | GGT, GGC, GGA, GGG |