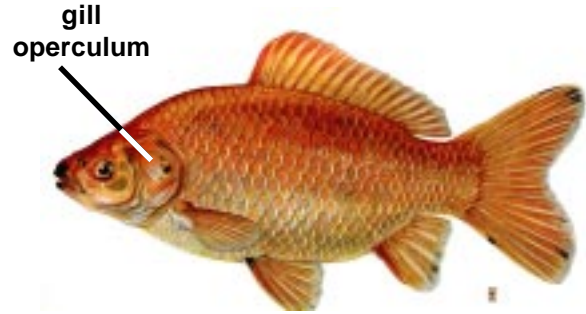


ENVIRONMENTAL TEMPERATURE AND METABOLIC RATE IN *Carassius auratus*

INTRODUCTION

Any change in the metabolic rate of *Carassius auratus* can be easily observed by counting the number of times the gill cover (or operculum) beats per minute. The operculum opens and closes as water (containing oxygen) passes over the gills. When the metabolic rate increases, the animal uses more oxygen and the operculum can be seen to open and close more frequently.



Carassius auratus

<http://www.dnr.cornell.edu/sarep/fish/Cyprinidae/goldfishpic.html>

LIST OF MATERIALS (for each team)

- | | |
|---|-----------------------------------|
| live <i>Carassius auratus</i> specimens | ice cubes |
| 500 mL beaker, jar or bowl | hot (or warm) water |
| thermometer | clock (or watch) with second hand |

PROCEDURES

1. Fill a 500 mL beaker (jar or bowl) with clean tap water, and measure its temperature in °C . This will be called the “starting temperature.” Record this temperature on your data chart.
2. Place one *Carassius auratus* specimen in the beaker and observe the specimen for 2 or 3 minutes as it acclimates to the new beaker environment. Locate the gill operculum and observe how it moves naturally.
3. Working with your team partner, count the number of times the gill operculum beats (moves in and out) for a period of exactly one minute. Record this on your data chart.
4. Repeat your gill cover beat measurement two more times with your specimen at the starting temperature. Record these data and calculate the average of all three room temperature measurements.
5. Next add one ice cube to the beaker and gently stir it around using your thermometer. (Be careful with the glass thermometer, and do not touch the *Carassius auratus* specimen with it). Remove the ice cube immediately when the water temperature reaches a point exactly 5°C lower than the starting temperature used above.
6. As before, count the number of gill cover beats for exactly one minute, for three trial runs. Record your data and calculate the average number of beats per minute.
7. The last series of trials will be conducted with a water temperature 5°C higher than the starting temperature. Slowly add warm water to your beaker, stirring gently, until the proper temperature is reached.
8. Count the number of gill cover beats for one minute, for three trials. Record and calculate.

DATA:

	Trial One	Trial Two	Trial Three	Average beats/min.
Starting Temp =				
Temp. -5°C =				
Temp. +5°C =				

ANALYSIS OF DATA

- a. Use a sheet of your own graph paper to plot “Temperature °C” on the x-axis, and “Average Operculum Beats/Min” on the y-axis. Use a linear scale with equal intervals.
- b. Summarize the meaning of your graph in a few sentences.
- c. Calculate *how many times greater* the operculum beat was at +5°C above the starting temperature, than it was at -5°C below the starting temperature (a 10°C difference). Show your work.
- d. Based on your calculation in item “c,” what would you predict the operculum rate would be at: (a) +15°C above the starting temperature; -15°C below the starting temperature?
- e. What happens to the metabolic rate of *Carassius auratus*: (a) when environmental temperature decreases, and (b) when environmental temperature increases?
- f. In general, based on your observations and calculations in this investigation, what is the relationship between environmental temperature and metabolic rate?