Purpose: To examine the mercury content in fish and determine the safe amount of fish which can be eaten on a daily basis without adverse effects on the human body.

Materials: Graph paper, pen, this handout, colouring materials.

Fact #1: PPB means parts per billion. A measure of 126 PPB means that in 1 billion grams (1000 tonnes) of a substance (fish in this case) there would be 126 grams (about 1/8th of a kilogram) of mercury present. To put it a different way, a box of fish measuring 10 m x 10 m x 10 m would contain about a quarter pound of mercury.

Data: Fish (levels of mercury in PPB)

<table>
<thead>
<tr>
<th>Fish</th>
<th>Mercury (PPB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cod</td>
<td>111</td>
</tr>
<tr>
<td>Crab</td>
<td>65</td>
</tr>
<tr>
<td>Salmon</td>
<td>22</td>
</tr>
<tr>
<td>Trout</td>
<td>71</td>
</tr>
<tr>
<td>Halibut</td>
<td>241</td>
</tr>
<tr>
<td>Tuna</td>
<td>126</td>
</tr>
<tr>
<td>Oyster</td>
<td>12</td>
</tr>
<tr>
<td>Lobster</td>
<td>93</td>
</tr>
<tr>
<td>Mackerel</td>
<td>50</td>
</tr>
<tr>
<td>Shrimp</td>
<td>9</td>
</tr>
</tbody>
</table>

US Food and Drug administration: Mercury levels in commercial fish and shellfish. Averages given.

Activity 1: Organize the data above from the least concentration of mercury to the greatest concentration. Include the name of the organism and the concentration.

Activity 2: Draw a bar graph of the data on the following page. Organize it from the least value to the greatest value. Label the vertical axis “Mercury Concentration (PPB)” and the horizontal axis “Type of Fish.” Leave enough room to write the fish’s name at the bottom of the graph. Title the graph “Average Concentration of Mercury Found in Fish.” Use the whole sheet of graph paper; be sure to colour the graph when done.

Fact #2: Mercury can be ingested in many forms, but we tend to get it from eating fish in the form of methyl mercury. Methyl mercury is easily absorbed into the body through the digestive tract. The body assimilates about 90% of the mercury ingested this way.

Fact #3: The US FDA (Food and Drug Administration) has stated that a safe level of methyl mercury is 0.3 µg/kg per day. This means that for every kg of your body weight you can ingest 0.3 µg of mercury. A µg is a microgram, and it takes 1,000,000 µg to equal one gram. So in other words, a safe amount to ingest every day is only 0.0000003 grams of methyl mercury per kg of body tissue. That is a really tiny amount.

Activity 3: Let’s assume for the moment that you weigh about 45 kilograms (~ 100 lbs). That means that you can ingest 0.3 x 45 = 13.5 µg of mercury per day. To determine the maximum amount of how much fish you can eat per day and still be safe, take the number 13.5, multiply it by 1000, then divide it by the PPB level of mercury in fish. So for tuna then,

\[
13.5 \times 1000 \div 126 = 107.1 \text{ grams}
\]
Determine the amount of fish you can consume each day for a 100 lb person. You do not have to show your work. However, you do have to fill the table in completely. Tuna has been done for you.

<table>
<thead>
<tr>
<th>Name of fish</th>
<th>Level of mercury (PPB)</th>
<th>Safe amount a 100 lb person can eat (g)</th>
<th>Name of fish</th>
<th>Level of mercury (PPB)</th>
<th>Safe amount a 100 lb person can eat (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuna</td>
<td>126</td>
<td>107.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fact #4:** The result for tuna, 107.1 grams, is the number of grams of tuna you are allowed to eat each day without risking mercury poisoning. That is a little more than half a small can of tuna. The thing to remember is that we also get mercury from other sources, so really you should have less than this to be safe.

**Activity 4:** We will examine tuna a little bit further by making this personal. Follow the numbers below.

Step 1: What is your weight in pounds: ________

Step 2: Divide that amount by 100: __________

Step 3: Multiply it by 107.1: __________________

**Answer:** Write your answer from step 3 here: ________ grams. This tells you the number of grams of tuna you can eat on a daily basis without risking mercury poisoning. Once again, this assumes that you aren’t ingesting mercury from some other source, or that the average mercury levels in the fish haven’t changed because of an increase in pollution from mercury.

**Activity 5:** Imagine a baby weighing 16 lbs. How much tuna could they eat every day and be safe? Follow the steps above.

**Answer:** ________

**Think:** If a can of tuna contains 170 grams of fish, then it means the baby can have no more than 10% of that can a day – **which is about a tablespoon**. If someone has fish only once a week, they can ingest more than the values here, which are based on daily consumption.

**Fact #5:** Mercury increase in the body as it is consumed. However, mercury levels also decrease over time. Mercury is removed primarily through urination, but small amounts leave through solid wastes, sweating, and even through breathing. However, it takes a very long time to rid the body of these toxins. While they are present, they can do a great deal of damage to both the kidneys and the nervous system.
Mercury (chemical symbol, 'Hg') is a naturally occurring metal in soil, rocks, and water bodies. It can also be released into the environment as a result of human activities including coal-fired power generation, metal mining, and waste incineration. Mercury can exist in three different chemical forms: elemental (Hg or Hg\(^{2+}\)), inorganic (combined with elements such as sulfur, chlorine, or oxygen), and organic (combined with carbon or hydrogen).

Methylmercury is an organic form of mercury and is very toxic at high exposure levels. Methylmercury is the most common form of mercury in fish and is present in some types of fish at concentrations that have the potential to impair human health. In humans, methylmercury is readily absorbed into the bloodstream and distributed throughout the body to locations including the brain and, in pregnant women, the developing fetus.

A wide range of adverse health effects have been observed in humans following methylmercury exposure, the severity largely depending on the magnitude of the dose and the duration of exposure. The predominant health affects in humans are associated with the impaired functions of the central and peripheral nervous systems. For example, elevated methylmercury exposure in a fetus or young child can cause a decrease in I.Q., delays in walking and talking, lack of coordination, blindness, and seizures. In adults, excessive methylmercury exposure can lead to personality changes, tremors, changes in vision, deafness, loss of muscle coordination and sensation, memory loss, intellectual impairment, and, in very extreme cases, even death.

The developing fetus is most sensitive to short-term (acute) methylmercury exposure. Fetal exposure to methylmercury may affect the developing nervous system at substantially lower doses than in adults. Epidemiological studies, including recent studies in fish-eating populations in the Seychelles and the Faroe Islands, have demonstrated that methylmercury exposure may have subtle impacts on fine motor function, attention span, verbal learning, and memory of children that were exposed to methylmercury in utero.

Traces of mercury have been measured in a wide variety of foods including dairy products, meats, poultry, eggs, pasta, fruits, and vegetables. However, the levels of mercury in these foods are very low relative to the levels found in fish and these foods only contribute a small amount of mercury to the diet. The most common source of human exposure to mercury is the consumption of certain types of fish. No type of common cooking method (for example, frying, poaching, grilling) reduces the total concentration of mercury in a fish. Mercury is bound to proteins in a fish's muscle and cannot be removed through cooking.

**Question and Answer Section – Part 1:** Use the *Activity* and *Fact* sections.

Note: the word “fish” will be taken to mean all boned fish, shell fish, and crustaceans.

1. Which fish had the lowest amount of mercury in it? _____________

2. Which had the greatest amount of mercury in it? _____________

3. Which has more mercury in it, Salmon or Trout? _____________
4. Which fish is your favourite? ____________ Least favourite? ____________

5. What does PPB mean? ________________________________________________

6. According to the FDA, a safe level of methyl mercury is _____ µg/kg per day. That translates to _____________ grams/kg per day.

7. How many grams (maximum allowable) can a 100 pound person eat per day of the following fish:
   a) Crab: __________
   b) Cod: __________
   c) Halibut: __________

8. Explain why you can eat more crab on a daily basis than halibut. ____________________________

9. Regarding activity 4: How many grams of tuna are you allowed to eat in a day, based upon your weight? __________ Think: How long should a 250 gram can of tuna last if you ate the maximum allowed amount every day? ____________________________

10. What is the main way that the body rids itself of methyl mercury? ______________________

Part 2: Refer to the Mercury in Fish document from Health Canada

1. The chemical symbol for mercury is ________.

2. Mercury finds its way into the environment through these 3 human activities:
   a) ______________________ b) ______________________ c) ______________________

3. The most common form of mercury in fish is ____________________.

4. Name three effects of methyl mercury on adults: ________________________________

5. Name three effects of methyl mercury on children: ________________________________

6. Which group is more likely to be affected by the presence of methyl mercury:
   a) adults  b) children  c) fetuses  ______________________

7. Does cooking help to reduce the amount of mercury in fish? ______________________
**Part 3: Bioaccumulation and biomagnification**

1. Refer to your glossary – define the following terms:
   a) bioaccumulation: ___________________________________________________________
      ______________________________________________________________________
   b) biomagnification: _________________________________________________________
      ______________________________________________________________________
   c) heavy metals: ______________________________________________________________________
      ______________________________________________________________________

**Fact #6:** Mercury in its pure form (as a metal) is not easily absorbed by multicellular organisms. However, mercury enters bacteria directly or indirectly through other mercury containing compounds. In the bacteria it becomes methylated and transforms into the toxic compound methyl mercury. Methyl mercury is very toxic. It both bioaccumulates and biomagnifies. As concentrations get higher the compound is much more likely to cause adverse health effects, and may lead directly to death or indirectly to death by affecting an organism’s ability to survive in its surroundings.

**Fact #7:** Methyl mercury is absorbed from the ecosystem through direct contact, or more likely through eating organisms with methyl mercury stored in it. Bacteria absorb mercury and convert it to methyl mercury. Tiny organisms called zooplankton then consume the bacteria (and other zooplankton). The methyl mercury contained inside the bacteria is digested and absorbed by the zooplankton. Mercury is stored in fatty tissues and is hard for the body to get rid of it. This is bioaccumulation as it builds up over time. Progressively larger organisms eat the smaller organisms and the levels of mercury increase up the food chain. This is biomagnification. Eventually the levels get so high that it starts to affect the nervous system. High order and top carnivores may experience illness related to mercury poisoning.

2. Write a paragraph about what you learned from this activity. Explain why you need to monitor the amount and kind of fish you eat. Important – include the following terms:
   - methyl mercury  - bioaccumulation  - biomagnification  - top carnivores