centre de développement pédagogique
*pour la formation générale en science et technologie*

# COOPERATIVE ASSIGNMENT

## « The heart and circulatory system »

Team guide

Name: _____
Name: _____
Name: _____
Name: _____

**TEACHER'S GUIDE**

**WORKING DOCUMENT**

February 2007

## Problem

During physical education and biology classes in your school, we notice an increase in obesity, breathlessness under effort and an increase in blood pressure as well as problems with diabetes and constipation. This portrait is replicated across Quebec society in youths of your age. Quebecois and Canadian children are progressively gaining extra kilos and becoming obese. The proportion of obese children has tripled in the last 20 years. The effect is premature wear in the structures of the circulatory system, resulting in cardiovascular illness as soon as early adulthood.

*Why are we seeing an increase in these health problems? How can we remedy this?*

## Mandate:

The mandate of your team, comprised of four specialists including a cardiologist, a nutritionist, a physical trainer and an engineer, is to improve the general health of your school!

The **cardiologist** has the responsibility for explaining the composition and functions of the parts of the heart and the different blood vessels by schematics and drawings.

The **nutritionist** has the responsibility for informing his or her colleagues about the best diet and the effects of certain substances on the quality of the circulatory system. You must present a balanced diet.

The **physical trainer** has the responsibility for informing his or her colleagues about the best exercises and pace to improve and/or maintain the circulatory system's health. You must present a detailed plan to get back in shape!

The **engineer** has the responsibility for informing his or her teammates as to the physical characteristics of the components and structures of the circulatory system. He/she must identify the peculiarities and constraints of the heart as a pump as well as those of the blood vessels. He/she must show the function and direction of flow in the circulatory system with the help of the prototype. The group of engineers will therefore have to detail or perfect the valves to complete the prototype pump.

### *The team must:*

1. Explain the workings of the heart and circulatory system. Support its explanation with a visual aid (pump-valve).

2. Present the causes and effects related to health problems as laid out in the original problem.

3. Propose viable solutions to improve the health of youths in your school both in terms of nutrition and physical condition.

**4.** Prepare an oral presentation, maximum ten minutes, supported by the visual aids of your choice.

**Instructions:**
- Form a four person team;

- Determine the role each person will play within the team;

- Give your team a name;

- The specialists within the same discipline must meet for one period, in order to discuss the notions related to their field of expertise;

- Each specialist will come back to their respective teams with the fruits of their labour, share the learned information and prepare their presentation as it relates to the original problem;

- The allotted time to answer the problem and prepare the presentation will be _____ hours.

- You must retain all your notes regarding your discussions and your team's work.

## Information gathering

**Specialists' team meeting**

- The specialists will have one period in which to gather information and prepare their report.
- Individually, each specialist appropriates the available information and completes his file.
- As a team, they discuss and agree upon the pertinent information to consign to each of their files, and then transmit this information to the teammates from their original team.
- You must retain all your notes regarding your studies or discussions.

**Multidisciplinary team meeting**

- With the help of the documents gathered in the specialists' meeting, the team discusses the information and prepares the assessment (pages 4 to 7) in the team guide.
- By the end of the second period, the team must have outlined the problem and come up with solutions.
- During the 3rd and 4th periods, the team prepares its prototype (pump-valve) and the oral presentation.

Each team will turn in the team guide outlining the problem as well as each specialist's files.

## *Global presentation of the problem*

***(Within its context)***

***The degree of structure of the activity (direction and openness) is up to the discretion of the teacher. The suggested guide questions may be modified, replaced or removed. The worlds and compulsory concepts are indicated for each question.***

**What are the principal components of the circulatory system, their characteristics and their function? For each component, identify its internal structure, as well as the function(s) of each of these.**

**Living World**
**Compulsory concepts**: Muscle,
Types of blood vessels,
Circulatory system,
Tissues, organs and systems

**Identify the relationship between the circulatory system and health problems.**

**What is the impact or importance of diet in putting the circulatory system back in working order, in improving it or even in maintaining its health?**

**Living World**
**Compulsory concepts**: Nutrition
-Types of foods
-Energy value of different foods

**What is the effect or importance of physical activity in putting the circulatory system back in working order, in improving it or even in maintaining its health?**

**Living World**
**Compulsory concepts**: Relationships
-Types of muscles
-Types of joint movements

***Explanation of the scientific principles (workings of the system under study)***

**Identify the capacity for compression of liquids, gases and solids.**
**Material World**
Compulsory concepts: Compressible and incompressible fluids
Pressure,
Pressure/volume relationship

**Determine the behaviour of liquids under pressure**
**Material World**
Compulsory concepts: Compressible and incompressible fluids
Pressure,
Pressure/volume relationship

**Describe the action of a compressed liquid on the walls of a container and then the equivalent within our circulatory system.**
**Material World**
Compulsory concepts: Pressure,
Pressure/volume relationship

**What role does the elasticity of blood vessels play in blood circulation?**
**Living World**
Compulsory concepts: Types of blood vessels
**Material World**
Compulsory concepts: Pressure and volume

***Explanation of technological principles (pump-valve model)***

**Determine the chemical and physical characteristics of liquids, and particularly blood (composition), as well as their behaviour.**

**Living World**
Compulsory concepts: Functions of blood constituents

**Material World**
Compulsory concepts: Properties of solutions (concentration, solute, solvent)
Heterogeneous mixture

**Why is it necessary for blood vessels to be sealed?**
**Material World**
Compulsory concepts: Pressure and volume (flow)

**Identify the structures that prevent blood from flowing back into the heart and blood vessels. Which structure(s) allow the heart to perform efficiently; to move blood with a certain pressure in one direction?**

**Living World**
Compulsory concepts: Muscle
Types of blood vessels
Circulatory system
Tissues, organs and systems

**Material World**
Compulsory concepts: Pressure and volume

**Why must the blood flow only in one direction?**
**Living World**
Compulsory concepts: Muscle
Types of blood vessels
Circulatory system
Tissues, organs and systems

***Position-taking in relation to the original problem (opinion forming)***

**Which elements indicate deterioration in the state of health of the students in your school in particular, and in Quebecers in general?**
**Living World**
Compulsory concepts: Nutrition

**What are the causes of this deterioration?**
**Living World**
Compulsory concepts: Nutrition

**How is the state of health of the youth population in Quebec evolving?**

**Why is our state of health tending towards this direction?**

**What are the impacts of lifestyle (nutrition and physical activity) on the circulatory system?**

**Identify the most pertinent solutions to remedy the situation in terms of nutritional behaviour.**
**Living World**
Compulsory concepts: Nutrition

**Identify the most pertinent solutions to remedy the situation in terms of getting in shape.**
**Living World**
Compulsory concepts: Relationships – muscles

**What is the usefulness in maintaining or improving the health of the circulatory system?**
**Living World**
Compulsory concepts: Respiratory and circulatory function

**How would your approach, both nutritionally and in terms of getting in shape, be adapted to the needs of the students of your school?**

## Theoretical Capsules

### The heart and blood circulation (history)

The understanding of the circulatory system is relatively recent in the history of mankind. Hippocrates, in the 5th century BC, was the first to use observation as a tool for the understanding of the phenomenon of blood circulation. His interpretations are faulty, but his observations useful. The heart is connected to a tubular system and is the basis of life. The following centuries summarise different medicines (Greek, Roman and Arab). Arteries and veins both contain blood, which differs in composition. It is thought that the heart is a pump that exchanges air and blood. It is not until the 17th century (1616) that William Harvey confirms the unidirectional flow of blood, its cycle (heart – body – heart – lungs – heart – body) and the role of the heart and each type of blood vessel in its circulation. The XVII and XVIII centuries bring development and refinement in terms of the instrumentation used in observation and thus, the discovery of finer structures within the circulatory apparatus.

### Circulation (physico-chemical aspect)

Very few liquids exist in large quantity in nature. Other than water and petroleum, the majority of other liquids are manufactured. That is why most living organisms are generally composed of 65 to 95% water. Blood too, as well as all liquids found in living organisms, is mainly comprised of water. By studying the characteristics of water as a liquid, one more easily understands the constraints to which the circulatory system is subject.

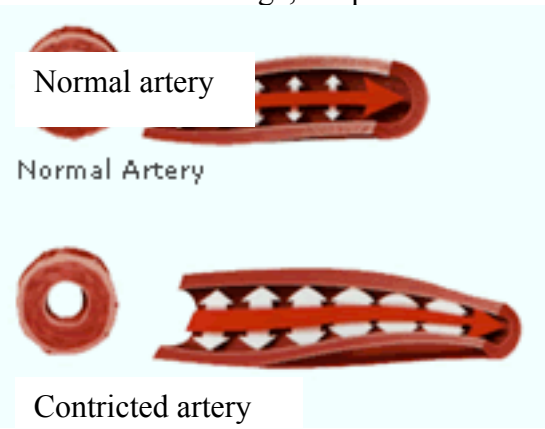
The viscosity of a liquid represents its degree of cohesiveness or the strength of its intermolecular connections. When blood is more viscous, it does not circulate as easily in the blood vessels and it is less reactive to pressure. Greater force is thus required and will therefore require additional effort from the heart. Structures within the heart exist which increase or diminish viscosity. In the circulatory system, certain chemical reactions can create an increase in pressure by a specific contraction of the blood vessels. This increased pressure is created in order to prioritise certain zones, for instance muscles during intense effort.

### Pressure/volume :

Fluids change volume very little even under heavy pressure. When pressured, fluid transmits the pressure on the walls opposite and adjacent to it. In blood circulation, pressure on the arteries corresponds to the pressure exerted by the heart to circulate blood. We therefore measure the force or push of the heart by the deformation of the arteries during a heartbeat. This corresponds to the pressure exerted by the cardiac muscle (ventricle). The instrument used to measure arterial pressure is called a "sphygmomanometer".

Our blood vessels have the benefit of being elastic in relation to the constraints of pressure. As they stretch, they accumulate a potential for energy that, when released, will be retransmitted to the blood to ease its movement. This elasticity facilitates the heart's works by doing some of it itself. When the arteries become hardened or obstructed, elasticity is reduced and the heart must work harder and harder to circulate the blood. In addition, it requires energy to make this additional effort. This energy comes from the arteries… If these are in poor shape, a lack of oxygen, and eventually, the stoppage of the cardiac muscle, results. Relatively rapidly, necrosis

(death) of the non-irrigated cells and a permanent incapacity of that section of the heart occurs. If the section is too large, the person dies.




**Compressible and incompressible Fluid**:
Fluids have very little compressibility and it varies depending on the density. Weight acts on the fluid and compresses it slightly, pushing its molecules on top of one another. Only gases offer a large compressibility.

## The body and the circulatory system

**Blood circulation**
The transportation of blood (oxygen, nutrients, hormones, white blood cells, antibodies, etc.) ensured by an extended and precise network. Through the heart's impulsion, blood vessels, arteries and veins ensure the transportation of blood indispensable to our entire organism. Also play a role in thermoregulation.

**Arterial tension**
Corresponds to the force exerted by the blood on the walls of the arteries. Common usage dictates that it is often measured in centimetres or millimetres of mercury (mmHg). It is expressed by two measurements (hence the two numbers e.g. 120/60):

- The maximum pressure at the moment the heart contracts (systole)
- The minimum pressure at the moment the heart "releases" (diastole)

**Elasticity of blood vessels**
Property of blood vessels to dilate, then contract, to allow quicker and more efficient passage of blood. This elasticity helps the propulsion of blood. Thanks to this property, the heart doesn't work as hard to obtain greater efficiency.

**Pump:**
Machine that puts a fluid in motion by aspirating it, then propelling it, to circulate in a network.

## Causes of poor function in the circulatory system

Causes of these dysfunctions range from genetic heredity to poor lifestyle habits and include accidents (trauma causing different types of ruptures). Obviously, poor lifestyle habits aggravate hereditary genetic problems.

**The presentation may be made (or suggested) as a table (information organisation)**
**Here are two examples of tables.**

**What are the principal components of the circulatory system, their characteristics and their function?**

| | |
|---|---|
| Myocardium | |
| Stimulant | |
| Blood vessels | |
| Arteries | |
| Veins | |
| Auricles | |
| Ventricles | |
| Auricles | |
| Clot | |

**What are the characteristics of the principal problems related to poor lifestyle habits?**

| | |
|---|---|
| Cholesterol | |
| Arterial Hypertension | |
| Obesity | |
| Angina | |
| Arteriosclerosis | |

**It is possible to draw an organisational chart showing all links between organs and the circulatory system.**

**It is possible to pursue the exploration of the circulatory system by a short activity on blood vessels.**

Problem to resolve and hypotheses:
**Study on the pressure of fluids (blood) and elasticity of canals**

You have used a watering hose and noticed that it is possible to vary the force or pressure of the water. What happens when you reduce or increase the diameter of a hose? Does a flexible hose allow an increase

in pressure by compressing it? If we block the output of a flexible hose, then release it; is the rate of flow constant?
(The smaller the diameter, the greater the pressure; thus when blood vessels are narrowed or blocked, the harder the heart works, the greater the pressure becomes). (When the tap is opened, the rate of flow is greater for a few seconds as the hose regains its shape).
With a pump, reduction of the diameter of the hose (greater aspiration).

http://www.doctissimo.fr/html/dossiers/maladies_cardiovasculaires.htm

http://perso.orange.fr/doigt.rose/doigscien/ttt/erythrop.htm

http://www.cflri.ca/fra/dossier_recherche/index.php

http://www.cflri.ca/pdf/f/dr0101.pdf

http://www.cflri.ca/pdf/f/dr0103.pdf

http://www.cflri.ca/pdf/f/dr0107.pdf

http://www.quid.fr/2006/Medecine/Toucher/2

http://www.quid.fr/2006/Medecine/Sang_Et_Appareil_Circulatoire/3

http://maree-montante.nbed.nb.ca/rescol/le_système_circulatoire.htm

http://ww2.fmcoeur.ca/Page.asp?PageID=1978&ArticleID=5211&Src=heart&From=SubCategory

http://books.google.com/books?vid=OCLC14840047&id=eQEAAAAAQAAJ&pg=RA2-PA125&lpg=RA2-PA125&dq=Élasticité+des+vaisseaux+sanguins&hl=fr

http://www.cardiologie-francophone.com/articles/article%20definitif2.htm

http://www.ac-orleans-tours.fr/SVT/publis/coeur/foncoeur.html

http://www.cyber.uhp-nancy.fr/demos/CH-TTFS/chap2/sect-3-2.html

http://www.cslaval.qc.ca/cdp/previews/coeur_i.html

http://www.cslaval.qc.ca/cdp/previews/pistoleau.html