

# TSG-4059-2

## General Science 1





## INTRODUCTION

The course entitled *General Science 1* is aimed at enabling adult learners to function effectively in situations from the *Research* and *Expertise* families that focus on the needs of the human body in terms of matter and energy and on the interactions between the nervous system and the external world.

In this course, adult learners will study scientific issues and seek answers or solutions to a variety of problems. They will acquire scientific knowledge about *The Living World*, which will help them understand and explain the factors at play in different situations involving the digestive and nervous systems. By combining knowledge of the digestive system with knowledge of the properties of and changes in matter, which they will acquire in their study of *The Material World*, they will come to better understand how the human body breaks down and transforms food into nutrients it can assimilate. By combining knowledge of the nervous system with knowledge of the waves associated with the auditory and visual receptors, which they will also acquire in their study of *The Material World*, they will come to understand the role of the networks in the human body that exchange information with the external world.

By the end of this course, in situations concerning the human body's needs in terms of matter and energy and the interactions of the nervous system with the external world, adult learners will be able to:

- ✓ model the physical and chemical changes that take place so that the digestive system can transform food, referring to the characteristics and properties of matter
- ✓ model a characteristic of waves involved in the functioning of the nervous system
- ✓ analyze an aspect of the digestive system or the interaction of the nervous system with the external world
- ✓ discuss an issue dealing with the human body's needs in terms of matter and energy
- ✓ discuss an issue dealing with the interactions of sensory receptors with the external world
- ✓ plan, with assistance, a simple experiment that deals with waves and the properties of or changes in matter
- ✓ follow, with assistance, an experimental procedure that deals with waves and the properties of or changes in matter
- ✓ write a report of an experiment that deals with waves and the properties of or changes in matter by following a basic framework

## SUBJECT-SPECIFIC COMPETENCIES

The following table lists, for each competency, the key features studied in the course. The manifestations of the key features are presented in Appendix 4.

<b>Competency 1</b> <b>Seeks answers or solutions to scientific or technological problems</b>	<b>Competency 2</b> <b>Makes the most of his/her knowledge of science and technology</b>	<b>Competency 3</b> <b>Communicates in the languages used in science and technology</b>
<ul style="list-style-type: none"> <li>▪ Defines a problem</li> <li>▪ Develops a plan of action</li> <li>▪ Carries out the plan of action</li> <li>▪ Analyzes his/her results</li> </ul>	<ul style="list-style-type: none"> <li>▪ Puts applications or scientific and technological issues in context</li> <li>▪ Analyzes an application or an aspect of the issue from a scientific point of view</li> <li>▪ Forms an opinion about the issue</li> </ul>	<ul style="list-style-type: none"> <li>▪ Interprets scientific and technological messages</li> <li>▪ Produces scientific and technological messages</li> </ul>

## PROCESSES

The investigative processes enable adult learners to examine issues, solve problems and study applications. The following are the steps in an investigative process:

- Define the problem
- Formulate a hypothesis
- Test the hypothesis
- Draw conclusions and communicate

The most appropriate methods for this course are the experimental method, modelling, documentary research and the observation method from a scientific point of view. It is during hypothesis testing that these methods become distinguishable. Section 3.5 and Appendices 1 to 3 present these investigative processes with their respective characteristics.

## CROSS-CURRICULAR COMPETENCIES

The cross-curricular competencies supplement the subject-specific competencies. The development of one contributes to the development of the others. Course TSG-4059-2 allows for all the cross-curricular competencies to be put into practice. Some of them, indicated in grey shading in the table below, are especially targeted in the sample learning situation that will be presented in the last part of the course.

Cross-Curricular Competencies			
Intellectual	Communication-Related	Personal and Social	Methodological
Uses information	Communicates appropriately	Achieves his/her potential	Adopts effective work methods
Solves problems		Cooperates with others	Uses information and communications technologies
Exercises critical judgment			
Uses creativity			

## SUBJECT-SPECIFIC CONTENT

### A) KNOWLEDGE

The compulsory concepts and techniques are presented in the tables in the following two sections.

#### 1. Concepts

❖ The Living World	
<p><b>General concept: Digestive system</b></p> <p>Human beings rely on a regular intake of food garnered from other organisms. This intake is necessary and makes it possible to build and repair tissues and produce heat and energy in different forms (e.g. mechanical, thermal).</p> <p>The mechanical and chemical transformation of food takes place in the digestive system. Ingestion, digestion, absorption and elimination are the four steps in the processing of food.</p> <p>The digestive glands are responsible for the chemical decomposition of food. The salivary glands produce saliva, which has several functions (e.g. humidification, partial digestion of carbohydrates, antibacterial functions). Gastric secretions (e.g. hydrochloric acid, mucus, pepsin) help digest proteins. The small intestine and its ancillary structures (the pancreas and the liver) secrete a variety of juices to begin the digestion of fats. Bile salts play an important role in the digestion of fats. The small intestine also plays a major role in the digestion of carbohydrates, proteins and fats and in the absorption of nutrients. The absorption of water and electrolytes is one of the essential functions of the large intestine. The final segment of the large intestine, the rectum, stores fecal matter for elimination.</p>	
Compulsory concepts	KNOWLEDGE TO BE ACQUIRED
Types of foods: water, proteins, carbohydrates, fats, vitamins, minerals	<ul style="list-style-type: none"> <li>• Describes the main biological functions of the different types of food (water, proteins, carbohydrates, fats, vitamins, minerals)</li> <li>• Associates types of food with their main sources (e.g. proteins with meat and meat substitutes)</li> </ul>
Energy value of different foods	<ul style="list-style-type: none"> <li>• Determines the energy and nutritional value of different foods</li> </ul>
Transformation of food: mechanical, chemical	<ul style="list-style-type: none"> <li>• Associates the organs in the digestive system with the type of transformation they perform (e.g. mechanical action of teeth, chemical action of glands)</li> </ul>
Digestive tract: mouth, esophagus, stomach, small intestine, large intestine, anus	<ul style="list-style-type: none"> <li>• Names the main parts of the digestive tract</li> <li>• Explains the role of the digestive tract (decomposition of food, absorption of nutrients and water, elimination of waste)</li> </ul>
Digestive glands: salivary glands, gastric glands, pancreas, liver, intestinal glands	<ul style="list-style-type: none"> <li>• Describes the role of the secretions of the main digestive glands (saliva digests starches, bile breaks down fats, gastric juices digest proteins)</li> </ul>

## ❖ The Living World (cont.)

### General concept: Nervous system

The nervous system regulates internal bodily functions and human behaviour, enabling human beings to enter into relationships with the external world and adapt to it.

Complex behaviours are made possible by the central nervous system, which coordinates motor control through the peripheral nervous system. The nervous system collects vast amounts of information using different sensory receptors in the sensory organs that ensure vision, hearing, smell, taste and touch. This information is then integrated into the sensory zones located in the central nervous system. Sensory saturation can result from situations in the workplace and hinder the functioning of an organ.

Compulsory concepts	KNOWLEDGE TO BE ACQUIRED
Central nervous system: brain, spinal cord	<ul style="list-style-type: none"> <li>• Identifies the parts of the central nervous system (brain, spinal cord)</li> <li>• Explains the role of the central nervous system (managing complex behaviours and processing sensory information and related responses)</li> </ul>
Peripheral nervous system: nerves	<ul style="list-style-type: none"> <li>• Explains the role of the peripheral nervous system (transporting nerve impulses from the senses to the brain and from the brain to the muscles and the glands)</li> <li>• Associates nerves with the transmission of nerve impulses</li> </ul>
Sensory receptors:	
– eye	<ul style="list-style-type: none"> <li>• Identifies the main parts of the eye involved in vision (iris, cornea, crystalline lens, retina)</li> <li>• Describes the function of the main parts of the eye</li> </ul>
– ear	<ul style="list-style-type: none"> <li>• Identifies the main parts of the ear involved in hearing (auditory canal, eardrum, ossicles, cochlea)</li> <li>• Describes the function of the main parts of the ear involved in hearing</li> </ul>
– skin	<ul style="list-style-type: none"> <li>• Describes the function of the skin's sensory receptors (transforming feelings of pressure, temperature and pain into nerve impulses)</li> </ul>
– tongue	<ul style="list-style-type: none"> <li>• Describes the function of the taste buds on the tongue (transforming flavour [sweet, salty, sour, bitter, umami] into nerve impulses)</li> </ul>
– nose	<ul style="list-style-type: none"> <li>• Describes the function of the olfactory bulb</li> </ul>

## ❖ The Material World

### General concept: Properties of matter

The human organism is made up of a wide variety of substances. Whether they are in the body's cells or in bodily fluids, or whether they are natural or synthetic, they have their own characteristic properties. Because of the role they play and their concentration in the body, some substances (water, oxygen, carbon dioxide, certain nutrients, mineral salts and various waste products) are major factors in a person's health.

Tables listing the characteristic physical and chemical properties of matter can help us identify substances and understand their roles and uses and the risks they pose for the human body.

Substances in the body are mostly mixtures, many of them solutions. Many vital systems depend on the ability of water and fats to dissolve different substances.

Compulsory concepts	KNOWLEDGE TO BE ACQUIRED
Characteristic physical properties: – density  – solubility  Characteristic chemical properties: reaction to indicators  Properties of solutions: concentration	<ul style="list-style-type: none"> <li>• Explains the concept of density</li> <li>• Determines the density of different substances</li> <li>• Defines the concept of solubility</li> <li>• Describes the effect of temperature variations on a substance's solubility</li> <li>• Recognizes a substance by its characteristic chemical properties (e.g. starch turns blue in the presence of an iodine solution, acidic solutions turn bromothymol blue yellow)</li> <li>• Describes the effect of variations in the quantity of solute or solvent on a solution's concentration</li> <li>• Defines the concept of the concentration of a solution</li> <li>• Determines the concentration of an aqueous solution (g/L or percentage)</li> <li>• Recognizes the solute in an aqueous solution</li> <li>• Recognizes the solvent in an aqueous solution (e.g. tears, saliva, urine)</li> </ul>



## ❖ The Material World (cont.)

### General concept: Changes in matter

Human beings exchange substances with their environment, constantly transforming matter and energy. We survive because these changes provide energy in an accessible form and matter to repair and produce tissues and to maintain our mineral reserves.

Depending on the average agitation energy of its molecules, a substance can take the form of a liquid, a solid or a gas.

Observing the behaviour of matter during these changes is the starting point for building a particle model of matter.

Preparing solutions through dissolution and changing the concentration of solutions by means of dilution are common operations in everyday life. In chemical changes, the molecules are altered. The products of these changes differ from the reagents: they are characterized by different properties. The mass and number of atoms of each element remain the same, which is the underlying principle of simple balanced chemical equations (oxidation, synthesis and decomposition reactions). Certain indicators are used to make it easier to recognize the formation of a new substance.

Compulsory concepts	KNOWLEDGE TO BE ACQUIRED
Particle model	<ul style="list-style-type: none"> <li>• Defines the particle model as a way of representing the behaviour of matter</li> <li>• Compares the arrangement of particles in a substance in its solid, liquid and gaseous states</li> </ul>
Physical changes:	
– dissolution	<ul style="list-style-type: none"> <li>• Explains dissolution using the particle model</li> </ul>
– dilution	<ul style="list-style-type: none"> <li>• Explains dilution in terms of concentration and volume</li> <li>• Applies the mathematical relationship that exists between the volumes and concentrations of an aqueous solution before and after dilution (<math>C_1V_1 = C_2V_2</math>)</li> </ul>
Chemical changes:	
– decomposition and synthesis	<ul style="list-style-type: none"> <li>• Names chemical changes that occur in the human body (e.g. respiration, digestion)</li> <li>• Recognizes a decomposition or synthesis reaction represented by means of the particle model</li> <li>• Associates known chemical reactions with decomposition or synthesis reactions (e.g. protein formation, digestion)</li> </ul>
– oxidation	<ul style="list-style-type: none"> <li>• Associates known chemical reactions with oxidation reactions (e.g. cellular respiration, combustion)</li> </ul>

## ❖ The Material World (cont.)

### General concept: Waves

The human organism is equipped with different structures that enable it to receive information from its environment. Two external stimuli picked up by sensory organs will be examined: sound (mechanical) waves and visible light (electromagnetic) waves.

Sound waves are longitudinal mechanical waves that are produced by a vibrating elastic body and propagate in a medium that is periodically compressed and rarefied. The exploration of transverse mechanical waves in a spring or in water can help adult learners understand wave motion.

Although they are very different, light waves in some respects behave similarly to sound waves and mechanical waves in general. Like other waves, light waves are characterized by their frequency, wavelength, amplitude and velocity of propagation. However, light waves propagate in a vacuum and in transparent media.

Certain objects in our natural and built environments exhibit the properties of light. The reflection and refraction of light are studied qualitatively using plane mirrors and converging and diverging lenses.

Compulsory concepts	KNOWLEDGE TO BE ACQUIRED
Frequency	<ul style="list-style-type: none"> <li>• Defines the frequency of a wave as the number of cycles per second (Hz)</li> <li>• Associates the frequency of a sound wave with the pitch of the sound (e.g. a low-frequency wave produces a low-pitched sound)</li> </ul>
Wavelength	<ul style="list-style-type: none"> <li>• Defines “wavelength” as the distance between two identical points on a wave at a given time</li> <li>• Describes the relationship between wavelength and energy (e.g. high-energy x-rays have a short wavelength)</li> </ul>
Amplitude	<ul style="list-style-type: none"> <li>• Defines the amplitude of a sound wave as the loudness of the sound</li> </ul>
dB (decibel) scale	<ul style="list-style-type: none"> <li>• Locates on the decibel scale levels dangerous to the human ear based on duration or frequency of exposure</li> </ul>
Electromagnetic spectrum	<ul style="list-style-type: none"> <li>• Locates different areas on the electromagnetic spectrum (e.g. radio waves, infrared, visible light, ultraviolet, x-rays, <math>\gamma</math>-rays)</li> </ul>
Deviation of light waves	<ul style="list-style-type: none"> <li>• Describes how light waves are deviated by a plane reflective surface</li> <li>• Determines the angle of reflection of a light ray on the surface of a plane mirror</li> <li>• Describes how light waves are deviated when they pass through the surface of a translucent substance</li> </ul>
Focal point of a lens	<ul style="list-style-type: none"> <li>• Determines the focal point of concave and convex lenses</li> <li>• Describes the relationship between the focal point of a lens and the degree to which light rays are deviated in various situations (e.g. accommodation of the crystalline lens, choice of corrective lenses)</li> </ul>

## 2. Techniques

The techniques presented here are grouped in two categories. Many of these techniques require the use of instruments and tools or chemicals. Safety and the use of safety equipment in the laboratory must be a constant concern for all those using such techniques.

In the Laboratory or Workshop	
Techniques	KNOWLEDGE TO BE ACQUIRED
<p><b>Experimentation</b></p> <ul style="list-style-type: none"> <li>- Safely using materials and equipment</li>   <li>- Using observational instruments</li>   <li>- Preparing solutions</li> </ul> <p><b>Measurement</b></p> <ul style="list-style-type: none"> <li>- Using measuring instruments</li> </ul>	<ul style="list-style-type: none"> <li>• Uses laboratory materials and equipment safely (e.g. allows hotplate to cool, uses beaker tongs, uses a universal holder attachment)</li> <li>• Handles chemicals safely (e.g. uses a spatula and a pipette filler)</li>   <li>• Uses observational instruments appropriately (e.g. magnifying glass, binoculars, microscope, light ray box, spectroscope)</li> <li>• Prepares an aqueous solution of a specific concentration given a solid solute</li> <li>• Prepares an aqueous solution of a specific concentration given a concentrated aqueous solution</li>   <li>• Uses measuring instruments appropriately (e.g. ruler, thermometer, graduated cylinder, balance, volumetric flask, sound meter)</li> </ul>

## B) CULTURAL REFERENCES

Cultural references make learning situations more meaningful. The following table presents some of the references related to this course.

Cultural References				
Technical objects, technological systems, processes and products	<ul style="list-style-type: none"> <li>– Food preparation and conservation</li> <li>– Enzymes</li> <li>– Nutraceuticals (preventive and curative products), vitamins, medication</li> <li>– Fertilizers and insecticides</li> <li>– Microphone, speaker, telephone, television, camera, CD-ROM player, etc.</li> <li>– Musical instrument</li> <li>– Hearing aid</li> <li>– Contact lenses, eyeglasses, binoculars, microscope</li> <li>– Telecommunications satellite</li> <li>– Magnetic resonance imaging</li> <li>– X-rays, ultrasound</li> <li>– Software enabling people with handicaps to communicate using Morse code</li> <li>– Virtual reality headset</li> <li>– Breathalyzer</li> <li>– Energy drink</li> </ul>			
Area	Scientists	Community Resources	Applications	Events
<b>The Living World</b>	Giovanni Alfonso Borelli Ivan Petrovitch Pavlov Allvar Gullstrand Edgar Douglas Adrian Georg von Békésy Lazzaro Spallanzani René Antoine Ferchault de Réaumur	<i>Canada Food Guide</i> Public Health Agency of Canada Ministère de la Santé et des Services sociaux Regional public health departments World Health Organization	Organic food basket Staple foods in different cultures (wheat, rice, manioc, potatoes, corn, fish) Imported foods Meals: different customs Diet for weight loss	Health fairs Gourmet festivals Food recall notices issued by the MAPAQ (Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec)
<b>The Material World</b>	Heinrich Rudolf Hertz Wilhelm Conrad Röntgen Guglielmo Marconi Louis and Antoine Lumière Alexander Graham Bell	Schools and faculties of engineering Food Research and Development Centre	History of efforts to measure the speed of light Public address systems Fibre optics	First telephone call

## FAMILIES OF LEARNING SITUATIONS

The learning situations in this course, derived from the *Research* and *Expertise* families, are related to the human body's needs in terms of matter and energy and the interactions between the nervous system and the external world. These situations involve general concepts related to The Living World and The Material World. The following paragraphs contain examples of tasks that could be assigned to adult learners in learning situations involving different combinations of general concepts.

In a situation involving general concepts applicable to the digestive system and certain properties of matter, adult learners could learn about the importance of the role and concentration of certain substances in the body. They could also conduct experiments to identify substances using tables listing the physical and chemical properties of matter. A study of the concept of changes in matter could also encourage adult learners to examine the quantity and quality of the foods they should eat. They could analyze technologies that are comparable to the digestive system or seek to understand the use of certain substances and their risks for the human body.

In a situation involving waves and the nervous system, adult learners could solve a soundproofing problem. They could experiment with the production of waves in a spring or in water to help them understand wave motion. Experimenting with variations in certain parameters of sound waves (frequency, wavelength, dB scale) could help them understand how the brain "hears" through the ear. They could also compare the decibel levels in different places and their impact on ear health.

In a situation involving general concepts related to the digestive system and chemical changes, adult learners could study the role of different foods in building and repairing tissues. They could also model a physical or chemical principle related to nutrition. In the laboratory, certain indicators such as colour change and heat production could pique their curiosity and lead to a qualitative study of chemical changes such as decomposition, synthesis and oxidation. They could then compare these changes with those that occur in food during the digestive process. In a more complex situation, they could analyze their own body's needs in terms of matter and energy, given their eating habits and level of activity.

In the learning situation described below, the main tasks help adult learners develop the second and third competencies. This situation therefore belongs to the *Expertise* family.

## BROAD AREAS OF LEARNING

Learning situations will have more meaning for adult learners if they are related to the broad areas of learning. All of the broad areas of learning are readily applicable to the learning situations for course TSG-4059-2. The example below reflects the educational aim of the broad area of learning *Health and Well-Being*.

<b>Broad Areas of Learning</b>
Health and Well-Being
Career Planning and Entrepreneurship
Environmental Awareness and Consumer Rights and Responsibilities
Media Literacy
Citizenship and Community Life

## EXAMPLE OF A LEARNING SITUATION

### NEARSIGHTEDNESS IS BECOMING AN EPIDEMIC

The World Health Organization has sounded the alarm: more and more young people are suffering from nearsightedness, and this trend is particularly worrisome in North America. The overuse of screens would seem to be the cause. A diagnosis of nearsightedness usually entails a prescription for corrective lenses—unless a person opts for laser eye surgery.

What is nearsightedness? Why are screens thought to cause the condition? How can this problem be corrected with eyeglasses? What does laser eye surgery do?

Your search for information will allow you to:

- draw a diagram of the main parts of the eye and describe their functions
- describe the path of nerve impulses from the eye to the brain
- explain the causes of nearsightedness
- compare nearsightedness with other vision problems
- experimentally reproduce the optical conditions for nearsightedness and other vision problems
- describe how laser surgery can correct nearsightedness

### END-OF-COURSE OUTCOMES

Learning situations are administered on the premise that the adult learner will become familiar with investigative processes, particularly the experimental method, modelling and the observation of scientific phenomena. The learning situations also enable adult learners to apply their problem-solving skills and knowledge, and to produce messages.

When adult learners are engaged in the process of solving a well-defined problem related to the needs of the human body in terms of matter and energy or to the interactions between the nervous system and the external world, they develop a representation of the problem after reading and interpreting scientific messages. They are guided in establishing a plan of action based on one of the suggested hypotheses and use what they know about waves and about the properties of and changes in matter. They complete or select an experimental procedure. They have access to help when implementing a plan of action involving laboratory activities in which they prepare an aqueous solution, devise a setup to study a wave-related phenomenon or use a measuring instrument. They carry out the steps as planned, make changes as needed and use the appropriate techniques. Following a basic framework, they write a report in which they suggest an answer that takes their results into account and explain, if necessary, any changes to be made to their plan of action based on the information given in the problem.

When studying an issue that involves satisfying the human body's needs in terms of matter and energy or the interactions of the human body with the external world, adult learners formulate questions related to the contextual elements presented. Using concepts, laws, theories or models, they identify and explain the wave-related phenomena or the properties of or changes in matter involved. They suggest a solution or take a stand on an aspect of the issue as it relates to the digestive system or the nervous system, using their scientific and technological knowledge to explain their position.

#### EVALUATION CRITERIA FOR SUBJECT-SPECIFIC COMPETENCIES

Evaluation Criteria for Competency 1	Evaluation Criteria for Competency 2	Evaluation Criteria for Competency 3
<ul style="list-style-type: none"> <li>▪ Appropriate representation of the situation</li> <li>▪ Development of a suitable plan of action</li> <li>▪ Appropriate implementation of the plan of action</li> <li>▪ Development of relevant explanations, solutions or conclusions</li> </ul>	<ul style="list-style-type: none"> <li>▪ Appropriate interpretation of the issue</li> <li>▪ Relevant use of scientific and technological knowledge</li> <li>▪ Appropriate formulation of explanations or solutions</li> </ul>	<ul style="list-style-type: none"> <li>▪ Accurate interpretation of scientific and technological messages</li> <li>▪ Appropriate production or transmission of scientific and technological messages</li> </ul>

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