Food Science 12

Guide

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NOUVELLE-ÉCOSSE

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Food Science 12

Prepared by the Department of Education and Early Childhood Development

This is the most recent version of the current curriculum materials as used by teachers in Nova Scotia.

Food Science 12
Implementation Draft: August 2003

Foreword

Food Science 12 includes the following modules: food constituents, preservation factors, food quality and commodities, and food packaging.

This guide is intended to provide teachers with the overview of the outcomes framework for the course. It also includes some suggestions to assist teachers in designing learning experiences and assessment tasks.

The Department of Education wishes to acknowledge the contribution of the Department of Food Science and Technology, Dalhousie University, Halifax, Nova Scotia.

Contents

Introduction

Background

The Department of Education has made a commitment to providing a broad-based, quality education for students in the public education system and to expanding the range of programming to better meet the needs of all students. The Department is working in collaboration with school boards and other partners in education, business, the community, and government to develop several new courses.

These new courses provide increased opportunities for senior high school students to earn the credits they require to attain a high school graduation diploma, to diversify their program, and to prepare for varied post-secondary destinations. These courses are designed to appeal to a wide variety of high school students; to assist students in making connections among school, the community, and the workplace; and to allow them to explore a range of career options.

These courses are characterized by the following features:

- a strong applied focus with an emphasis on integrating, applying, and reinforcing the knowledge, skills, and attitudes developed in other courses
- a strong connection to the essential graduation learnings—aesthetic expression, citizenship, communication, personal development, problem solving, and technological competence
- a strong focus on refining career-planning skills with a "futures" orientation which invites students to explore a range of pathways from school
- a strong connection to labour market opportunities with a focus on enhancing students' employability skills—academic skills, social and teamwork skills, technological skills, and personal management skills, such as responsibility, adaptability, and positive attitudes
- a strong connection to the community and workplace with a focus on using real-world community and workplace problems and situations as practical contexts for the application of knowledge and skills and for further learning
- a strong focus on hands-on learning experiences, including experiences with a range of technologies

Aim

The aim of science education in the Atlantic provinces is to develop scientific literacy.

Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyse, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

Rationale

The science curriculum, as defined in the *Foundation for the Atlantic Canada Science Curriculum*, is aimed at enabling students to become scientifically literate.

Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities, to become life long learners, and to maintain a sense of wonder about the world around them. To develop scientific literacy students require diverse learning experiences which provide opportunity to explore, analyse, evaluate, synthesise, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their future.

The Nature of Food Science 12

Food Science 12 (Course Code: 11026) satisfies the second science requirement for high school graduation. Food Science 12 is an academic course. It is important to note that the course has been designed to engage and meet the needs of a wide range of learners.

Food Science 12 comprises four modules:

Food Constituents

This module investigates the constituents of food, the physical and chemical properties of the constituents, and applies the knowledge of food science through a project. Lab work is essential in this module, as it is throughout the course.

Preservation Factors

In this module, deteriorative factors and their controls are investigated. Preservation is examined. High temperature (cooking, blanching, pasteurization, sterilization) and low temperature preservation (chilling, freezing, cold storage) are investigated.

Food Quality and Commodities

Subjective and objective quality measurements, sampling, and analysis are examined to evaluate assurance, measurement, and control. Commodities are investigated through laboratory experiments. Production of the commodities with emphasis on quality retention and production techniques is discussed.

Food Packaging

This module looks at food ingredients, labels, and packaging. The key to food product development and design is the use of sensory analysis. Systematic product development is examined and analysed.

Program Design and Components

Learning and Teaching Science

What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include

- creating a classroom environment to support the learning and teaching of science
- designing effective learning experiences that help students achieve designated outcomes
- stimulating and managing classroom discourse in support of student learning
- learning about and then using students' motivations, interests, abilities, and learning styles to improve learning and teaching
- assessing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions
- selecting teaching strategies from a wide repertoire

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment that reflects a constructive, active view of the learning process. Learning occurs through actively constructing one's own meaning and assimilating new information to develop a new understanding.

The development of scientific literacy in students is a function of the kinds of tasks they engage in, the discourse in which they participate, and the settings in which these activities occur. Students' disposition towards science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to all of these facets of curriculum.

Learning experiences in science education should vary and should include opportunities for group and individual work, discussion among students as well as between teacher and students, and hands-on/minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations and the evaluation of the evidence accumulated provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he/she is familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging in science. These activities provide students with opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important in their own right, and they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equitable opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of, and make adaptations to accommodate, the diverse range of learners in their classes. To adapt instructional strategies, assessment practices, and learning resources to the needs of all learners, teachers must create opportunities that will permit students to address their various learning styles.

As well, teachers must not only remain aware of and avoid gender and cultural biases in their teaching, they must also actively address cultural and gender stereotyping (e.g., about who is interested in and who can succeed in science and mathematics). Research supports the position that when science curriculum is made personally meaningful and socially and culturally relevant, it is more engaging for groups traditionally under-represented in science and indeed, for all students.

While this curriculum guide presents specific outcomes for each module, it must be acknowledged that students will progress at different rates.

Teachers should provide materials and strategies that accommodate student diversity, and should validate students when they achieve the outcomes to the best of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equitable opportunities to experience success as they work toward achieving designated outcomes. Teachers should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provide access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

The Role of Technologies

Vision for the Integration of Information Technologies

The Nova Scotia Department of Education has articulated five components to the learning outcomes framework for the integration of IT within curriculum programs:

Basic Operations and Concepts

- concepts and skills associated with the safe, efficient operation of a range of information technologies

Productivity Tools and Software

- the efficient selection and use of IT to perform tasks such as
  - the exploration of ideas
  - data collection
  - data manipulation, including the discovery of patterns and relationships
  - problem solving
  - the representation of learning

Communications Technology

- the use of specific, interactive technologies which support collaboration and sharing through communication

Research, Problem Solving, and Decision Making

- the organization, reasoning, and evaluation by which students rationalize their use of IT

Social, Ethical, and Human Issues

- that understanding associated with the use of IT which encourages in students a commitment to pursue personal and social good, particularly to build and improve their learning environments and to foster stronger relationships with their peers and others who support their learning

Integrating Information and Communication Technologies within Food Science 12

As information technologies shift the ways in which society accesses, communicates, and transfers information and ideas, they inevitably change the ways in which students learn.

Students must be prepared to deal with an information and communications environment characterized by continuous, rapid change, an exponential growth of information, and expanding opportunities to interact and interconnect with others in a global context.

Because technologies are constantly and rapidly evolving, it is important that teachers make careful decisions about applications, always in relation to the extent to which technology applications help students to achieve the curriculum outcomes.

Technology can support learning for the following specific purposes.

Inquiry

Theory Building: Students can develop ideas, plan projects, track the results of growth in their understanding, develop dynamic, detailed outlines, and develop models to test their understanding, using software and hardware for modelling, simulation, representation, integration, and planning.

Data Access: Students can search for and access documents, multimedia events, simulations, and conversations through hypertext/hypermedia software; digital, CD-Rom, and Internet libraries, and databases.

Data Collection: Students can create, obtain, and organize information in a range of forms, using sensing, scanning, image and sound recording and editing technology, databases, spreadsheets, survey software, and Internet search software.

Data Analysis: Students can organize, transform, analyse, and synthesize information and ideas using spreadsheets, simulation, statistical analysis or graphing software, and image processing technology.

Communication

Media Communication: Students can create, edit, and publish, present, or post documents, presentations, multi-media events, Web pages, simulations, models, and interactive learning programs, using word processing, publishing, presentation, Web page development, and hypertext software.

Interaction/collaboration: Students can share information, ideas, interests, concerns, and questions with others through e-mail; Internet audio, video, and print conferences; information servers; Internet news groups and listservs; and student-created hypertext environments.

Teaching and Learning: Students can acquire, refine, and communicate ideas, information, and skills using tutoring systems and software, instructional simulations, drill and practice software, and telementoring systems.

Construction

Students can explore ideas and create simulations, models, and products using sensor and control systems, robotics, computer-aided design, artificial intelligence, mathematical and scientific modelling, and graphing and charting software.

Expression

Students can shape the creative expression of their ideas, feelings, insights, and understandings using graphic software, music making, composing, editing and synthesizing technology; interactive video and hyper media, animation software; multimedia composing technology; sound and light control systems and software; and video and audio recording and editing technology.

Writing in Science

Learning experiences should provide opportunities for students to use writing and other forms of representation as ways to consolidate and communicate their understanding. Students should be encouraged to use writing to speculate, theorize, summarize, discover connections, describe processes, express understandings, raise questions, and make sense of new information using their own language as a step to the language of science. Science logs are useful for such expressive and reflective writing. Purposeful note making is an intrinsic part of learning in science, helping students better record, organize, and understand information from a variety of sources. The process of creating webs, maps, charts, tables, graphs, drawing, and diagrams to represent data and results helps students learn and also provides them with useful study tools.

Learning experiences in science should also provide abundant opportunities for students to communicate their findings and understandings to others, both formally and informally, using a variety of forms for a range of purposes and audiences. Such experiences should encourage students to use effective ways of recording and conveying information and ideas and to use the vocabulary of science in expressing their understandings. It is through opportunities to talk and write about the concepts they need to learn that students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in, and demonstration of, the strategies they need to develop and apply in reading, viewing, interpreting, and using a range of science texts for various purposes. It will be equally important for students to have demonstrations of the strategies they need to develop and apply in selecting, constructing, and using various forms for communicating in science.

Assessment and Evaluation

The terms **assessment** and **evaluation** are often used interchangeably, but they refer to quite different processes. Science curriculum documents developed in the Atlantic region use these terms for the processes described below.

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analysing, reflecting upon, and summarizing assessment information, and making judgments or decisions based upon the information gathered.

The assessment process provides the data, and the evaluation process brings meaning to the data. Together, these processes improve teaching and learning. If we are to encourage enjoyment in learning for students now and throughout their lives, we must develop strategies to involve students in assessment and evaluation at all levels. When students are aware of the outcomes for which they are responsible and of the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate their learning.

The Atlantic Canada science curriculum reflects the three major processes of science learning: inquiry, problem solving, and decision making. When a teacher assesses student progress, it is helpful to know some activities/skills/actions that are associated with each process of science learning. Student learning may be described in terms of ability to perform these tasks.

Inquiry

- define questions related to a topic
- refine descriptors/factors to provide focus for practical and theoretical research
- select an appropriate way to find information
- make direct observations
- perform experiments, record and interpret data, and draw conclusions
- design an experiment that tests relationships and variables
- write lab reports that meet a variety of needs and place emphasis on recorded data
- recognize that both quality of both the process and the product are important

Problem Solving

- clearly define a problem
- produce a range of potential solutions for the problem
- appreciate that several solutions should be considered
- plan and design a product or device intended to solve a problem
- construct a variety of acceptable prototypes; pilot test, evaluate, and refine them to meet a need
- present the refined process/product/device and support why it is “preferred”
- recognize that quality of the process and the product is important

Decision Making

- gather information from a variety of sources
- evaluate the validity of the information source
- evaluate which information is relevant
- identify the different perspectives that influence a decision
- present information to reflect different perspectives
- use information to support a given perspective
- recommend a decision and provide supporting evidence
- communicate a decision and provide a “best” solution

Effective Assessment and Evaluation Practices

Effective assessment improves the quality of learning and teaching. It can help students to become more reflective and to have control of their own learning, and it can help teachers to monitor and focus their instructional programs.

Assessment and evaluation of student learning should accommodate the complexity of learning and reflect the complexity of the curriculum. Evaluation should be based on the full range of learning outcomes towards which students have been working during the reporting period, be proportionate to the learning experiences related to each outcome, and focus on patterns of achievement as well as specific achievement.

In reflecting on the effectiveness of their assessment program, teachers should consider the extent to which their practices

- are fair in terms of the student’s background or circumstances
- are integrated with learning
- provide opportunities for authentic learning
- focus on what students can do rather than on what they cannot do
- provide students with relevant, supportive feedback that helps them to shape their learning
- describe students’ progress toward learning outcomes
- help them to make decisions about revising, supporting, or extending learning experiences
- support learning risk taking
- provide specific information about the processes and strategies students are using
- provide students with diverse and multiple opportunities to demonstrate their achievement

- accommodate multiple responses and a range of tasks and resources
- provide evidence of achievement in which students can take pride
- acknowledge attitudes and values as significant learning outcomes
- encourage students to reflect on their learning and to articulate personal learning plans
- help them to make decisions about teaching strategies, learning experiences and environments, student grouping, and resources
- include students in developing, interpreting, and reporting on assessment

Involving Students in the Assessment Process

When students are aware of the outcomes they are responsible for and the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate they know, are able to do, and value.

It is important that students participate actively in the assessment and evaluation of their learning, developing their own criteria and learning to judge a range of qualities in their work. Students should have access to models in the form of scoring criteria, rubrics, and work samples.

As lifelong learners, students assess their own progress, rather than relying on external measures, for example marks, to tell them how well they are doing. Students who are empowered to assess their own progress are more likely to perceive their learning as its own reward. Rather than asking What does the teacher want? students need to ask questions such as What have I learned? What can I do now that I couldn't do before? What do I need to learn next?

Effective assessment practices provide opportunities for students to

- reflect on their progress toward achievement of learning outcomes
- assess and evaluate their learning
- set goals for future learning

Diverse Learning Styles and Needs

Teachers should develop assessment practices which affirm and accommodate students' cultural and linguistic diversity. Teachers should consider patterns of social interaction, diverse learning styles, and the multiple ways oral, written, and visual language are used in different cultures for a range of purposes. Student performance takes place not only in a learning context, but in a social and cultural context as well.

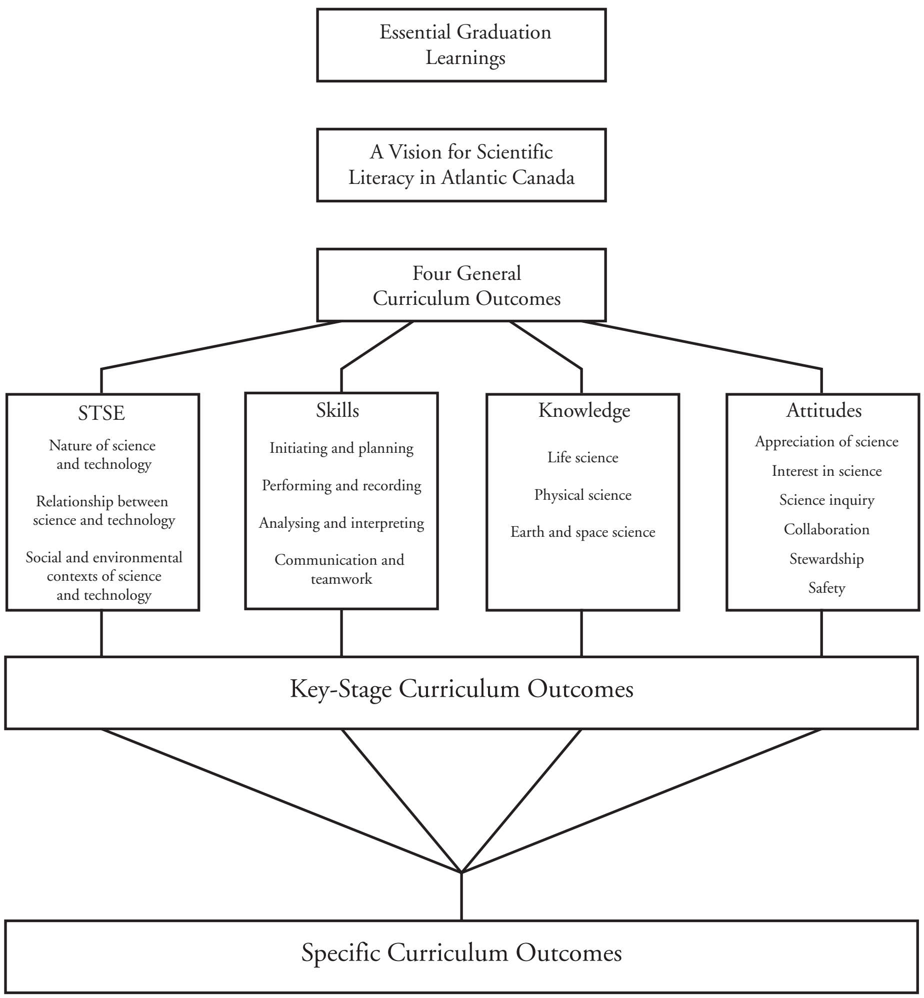
Assessment practices must be fair, equitable, and without bias, providing a range of opportunities for students to demonstrate their learning. Teachers should be flexible in evaluating the learning success of students and seek diverse ways for students to demonstrate their personal best. In inclusive classrooms, students with special needs have opportunities to demonstrate their learning in their own way, using media which accommodate their needs, and at their own pace.

Curriculum Outcomes Framework

Overview

The science curriculum is based on an outcomes framework that includes statements of essential graduation learnings, general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes. The general, key-stage, and specific curriculum outcomes reflect the pan-Canadian C*ommon Framework of Science Learning Outcomes K to 12*. The diagram below provides the blueprint of the outcomes framework.

Outcomes Framework



Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the essential graduation learnings will prepare students to continue to learn throughout their lives. These learnings describe expectations not in terms of individual school subjects but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries and to be ready to meet the shifting and ongoing opportunities, responsibilities, and demands of life after graduation. Provinces may add additional essential graduation learnings as appropriate. The essential graduation learnings are

Aesthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Communication

Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s) as well as mathematical and scientific concepts and symbols to think, learn, and communicate effectively.

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving

Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, mathematical, and scientific concepts.

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

Teachers should consult *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the essential graduation learnings, vision for scientific literacy, general curriculum outcomes, and key-stage curriculum outcomes.

General Curriculum Outcomes

The general curriculum outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

Science, Technology, Society, and the Environment

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

Attitudes

Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Key-Stage Curriculum Outcomes

Key-stage curriculum outcomes are statements that identify what students are expected to know, be able to do, and value by the end of grades 3, 6, 9, and 12 as a result of their cumulative learning experiences in science. The key-stage curriculum outcomes are from the *Common Framework for Science Learning Outcomes K to12*.

Specific Curriculum Outcomes

Specific curriculum outcomes for Food Science 12 are statements identifying what students are expected to know and be able to do as a result of their learning experiences in this course. They provide the framework for instructional design and assessment and are intended to help teachers design learning experiences and assessment tasks. Specific curriculum outcomes represent a framework for assisting students to achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately the essential graduation learnings.

Specific curriculum outcomes are organized in modules. Each module is organized by topic. Food Science 12 modules and topics follow.

Food Constituents

- Food Constituents
- Carbohydrates
- Lipids
- Proteins
- Water and Other Constituents in Food

Preservation Factors

- Food Microbiology and Food Safety: Fermentation Microbiology
- Food Microbiology and Food Safety: Preservation Microbiology
- Food Microbiology and Food Safety: Food Safety Microbiology
- Evolution of Food Preservation
- Cooling
- Heating
- Fermentation
- Drying Processing Techniques

Food Quality and Commodities

- Food Commodities
- Food Quality
- Product Development—Schemes and Stages

Food Packaging

- Food Packaging and Food Labels
- New Food Product

The following pages outline Food Science 12 specific curriculum outcomes grouped by modules and topics.

Food Constituents

Students will be expected to

Food Constituents

- identify and describe science- and technology-based careers related to food science
- analyse a food package ingredient listing

Carbohydrates

- explain and describe the function/properties of other starches, including carbohydrates and cellulose, pectins, and gums

Lipids

- identify and describe the properties and functions of lipids

Proteins

- describe the structure of proteins found in various foods, including essential amino acids

Water and Other Constituents in Food

- summarize the functions of water in food preparation and food development
- explain the functions and basic properties of emulsifiers, organic acids, vitamins, enzymes, antioxidants, colour, and flavour
- design an experiment, identify specific variables, and perform it

Preservation Factors

Students will be expected to

Food Microbiology and Food Safety: Fermentation Microbiology

- explain how the metabolism of microorganisms introduce new desirable flavours, ingredients, and physical properties to the foods

Food Microbiology and Food Safety: Preservation Microbiology

- explain food spoilage in terms of the growth of microorganisms (appearance of off-flavours, off-odours, slime, visible growth)
- describe the role that processing and food additives play in eliminating, inhibiting, or delaying the growth of spoilage microorganisms

Food Microbiology and Food Safety: Food Safety Microbiology

- explain simple measures that can be taken to keep foods safe
- explain how viruses, bacteria, moulds, and parasites can cause disease

Evolution of Food Preservation

- explain practical methods of food preservation

Cooling

- explain the use of chilling and cold storage of fresh foods in terms of preservation

Heating

- identify and give examples of the different types of high temperature cooking

Fermentation

- describe the fermentation process and make a fermented product

Drying Processing Techniques

- explain what water activity is, why it is important, and how it can be controlled

Food Quality and Commodities

Students will be expected to

Food Commodities

- analyse the properties of specific food commodities
- select and use different resources and materials to collect information about their commodity
- devise and conduct an experiment on their commodity

Food Quality

- identify psychological factors used to market and develop food products
- collect and compare sensory data

Product Development—Schemes and Stages

- explain how well a product is designed to meet consumer wishes

Food Packaging

Students will be expected to

Food Packaging and Food Labels

- explain the functions and considerations for food packaging
- identify and explain the information required for labels on food products made in Canada

New Food Product

- design, develop, make, and present a food product identifying and anticipating major variables that may impact on the final quality of the product

Attitude Outcomes

It is expected that the Atlantic Canada science program will foster certain attitudes in students throughout their school years. The STSE, skills, and knowledge outcomes contribute to the development of attitudes, and opportunities for fostering these attitudes are highlighted in the Elaborations—Strategies for Learning and Teaching sections of each unit.

Attitudes refer to generalized aspects of behaviour that teachers model for students by example and by selective approval. Attitudes are not acquired in the same way as skills and knowledge. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating a readiness for responsible application of what students learn.

Since attitudes are not acquired in the same way as skills and knowledge, outcome statements for attitudes are written as key-stage curriculum outcomes for the end of grades 3, 6, 9, and 12. These outcome statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the pan-Canadian *Common Framework of Science Learning Outcomes K to 12* for the end of grade 12.

Key-Stage Curriculum Outcomes: Attitudes

By the end of grade 12, students will be expected to

Appreciation of Science	Interest in Science	Scientific Inquiry
436 value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not 437 appreciate that the applications of science and technology can raise ethical dilemmas 438 value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds *Evident when students, for example,* • consider the social and cultural contexts in which a theory developed • use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on STSE issues • recognize the usefulness of being skilled in mathematics and problem solving • recognize how scientific problem solving and the development of new technologies are related • recognize the contribution of science and technology to the progress of civilizations • carefully research and openly discuss ethical dilemmas associated with the applications of science and technology • show support for the development of information technologies and science as they relate to human needs • recognize that western approaches to science are not the only ways of viewing the universe • consider the research of both men and women	439 show a continuing and more informed curiosity and interest in science and science-related issues 440 acquire, with interest and confidence, additional science knowledge and skills using a variety of resources and methods, including formal research 441 consider further studies and careers in science- and technology-related fields *Evident when students, for example,* • conduct research to answer their own questions • recognize that part-time jobs require science- and technology-related knowledge and skills • maintain interest in or pursue further studies in science • recognize the importance of making connections among various science disciplines • explore and use a variety of methods and resources to increase their own knowledge and skills • are interested in science and technology topics not directly related to their formal studies • explore where further science- and technology-related studies can be pursued • are critical and constructive when considering new theories and techniques • use scientific vocabulary and principles in everyday discussions • readily investigate STSE issues	442 confidently evaluate evidence and consider alternative perspectives, ideas, and explanations 443 use factual information and rational explanations when analysing and evaluating 444 value the processes for drawing conclusions *Evident when students, for example,* • insist on evidence before accepting a new idea or explanation • ask questions and conduct research to confirm and extend their understanding • criticize arguments based on the faulty, incomplete, or misleading use of numbers • recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen • expend the effort and time needed to make valid inferences • critically evaluate inferences and conclusions, cognizant of the many variables involved in experimentation • critically assess their opinions of the value of science and its applications • criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist • insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position taken can be judged • seek new models, explanations, and theories when confronted with discrepant events or evidence

Key-Stage Curriculum Outcomes: Attitudes *(continued)*

By the end of grade 12, students will be expected to

Collaboration	Stewardship	Safety in Science
445 work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas *Evident when students, for example,* • willingly work with any classmate or group of individuals regardless of their age, gender, or physical and cultural characteristics • assume a variety of roles within a group, as required • accept responsibility for any task that helps the group complete an activity • give the same attention and energy to the group's product as they would to a personal assignment • are attentive when others speak • are capable of suspending personal views when evaluating suggestions made by a group • seek the points of view of others and consider diverse perspectives • accept constructive criticism when sharing their ideas or points of view • criticize the ideas of their peers without criticizing the persons • evaluate the ideas of others objectively • encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision making • contribute to peaceful conflict resolution encourage the use of a variety of communication strategies during group work • share the responsibility for errors made or difficulties encountered by the group	446 have a sense of personal and shared responsibility for maintaining a sustainable environment 447 project the personal, social, and environmental consequences of proposed action 448 want to take action for maintaining a sustainable environment *Evident when students, for example,* • willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation • assume part of the collective responsibility for the impact of humans on the environment • participate in civic activities related to the preservation and judicious use of the environment and its resources • encourage their peers or members of their community to participate in a project related to sustainability • consider all perspectives when addressing issues, weighing scientific, technological, and ecological factors • participate in social and political systems that influence environmental policy in their community • examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans • willingly promote actions that are not injurious to the environment • make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations • are critical-minded regarding the short- and long-term consequences of sustainability	449 show concern for safety and accept the need for rules and regulations 450 be aware of the direct and indirect consequences of their actions *Evident when students, for example,* • read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood • criticize a procedure, a design, or materials that are not safe or that could have a negative impact on the environment • consider safety a positive limiting factor in scientific and technological endeavours • carefully manipulate materials, cognizant of the risks and potential consequences of their actions • write into a laboratory procedure safety and waste-disposal concerns • evaluate the long-term impact of safety and waste disposal on the environment and the quality of life of living organisms • use safety and waste disposal as criteria for evaluating an experiment • assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place • seek assistance immediately for any first aid concerns like cuts, burns, or unusual reactions • keep the work station uncluttered, with only appropriate lab materials present

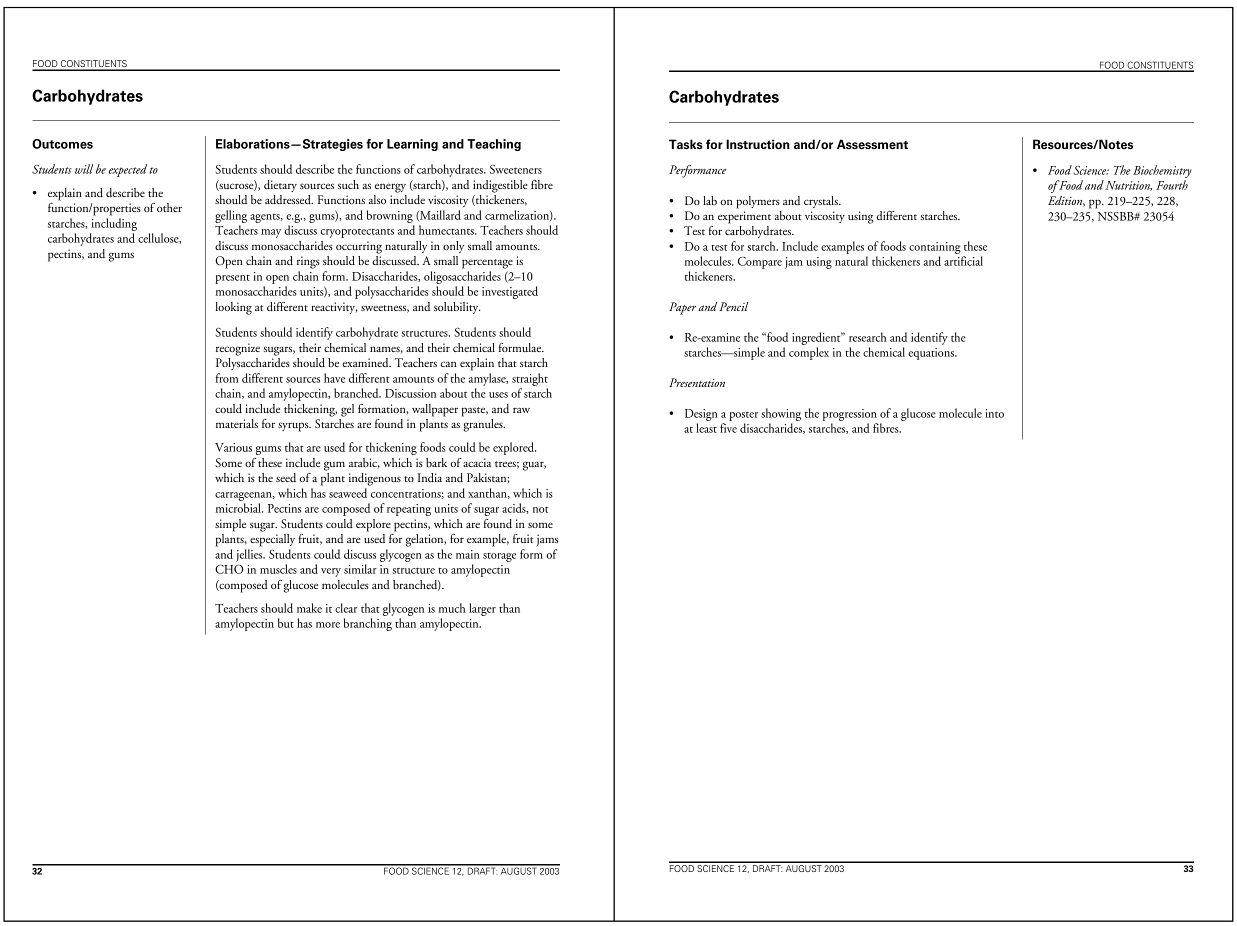
Curriculum Guide Organization

Specific curriculum outcomes are organized by module and topic. Each module is organized by topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement.

The Four-Column Spread

All topics have a two-page layout of four columns as illustrated below. In some cases, the four-column spread continues to the next two-page layout. Outcomes are grouped by a topic indicated at the top of the left page.

Two-Page, Four-Column Spread



FOOD CONSTITUENTS

Carbohydrates

Outcomes

Students will be expected to

- explain and describe the function/properties of other starches, including carbohydrates and cellulose, pectins, and gums

Elaborations—Strategies for Learning and Teaching

Students should describe the functions of carbohydrates. Sweeteners (sucrose), dietary sources such as energy (starch), and indigestible fibre should be addressed. Functions also include viscosity (thickeners, gelling agents, e.g., gums), and browning (Maillard and carmelization). Teachers may discuss cryoprotectants and humectants. Teachers should discuss monosaccharides occurring naturally in only small amounts. Open chain and rings should be discussed. A small percentage is present in open chain form. Disaccharides, oligosaccharides (2–10 monosaccharides units), and polysaccharides should be investigated looking at different reactivity, sweetness, and solubility.

Students should identify carbohydrate structures. Students should recognize sugars, their chemical names, and their chemical formulae. Polysaccharides should be examined. Teachers can explain that starch from different sources have different amounts of the amylase, straight chain, and amylopectin, branched. Discussion about the uses of starch could include thickening, gel formation, wallpaper paste, and raw materials for syrups. Starches are found in plants as granules.

Various gums that are used for thickening foods could be explored. Some of these include gum arabic, which is bark of acacia trees; guar, which is the seed of a plant indigenous to India and Pakistan; carrageenan, which has seaweed concentrations; and xanthan, which is microbial. Pectins are composed of repeating units of sugar acids, not simple sugar. Students could explore pectins, which are found in some plants, especially fruit, and are used for gelation, for example, fruit jams and jellies. Students could discuss glycogen as the main storage form of CHO in muscles and very similar in structure to amylopectin (composed of glucose molecules and branched).

Teachers should make it clear that glycogen is much larger than amylopectin but has more branching than amylopectin.

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FOOD CONSTITUENTS

Carbohydrates

Tasks for Instruction and/or Assessment

Performance

- Do lab on polymers and crystals.
- Do an experiment about viscosity using different starches.
- Test for carbohydrates.
- Do a test for starch. Include examples of foods containing these molecules. Compare jam using natural thickeners and artificial thickeners.

Paper and Pencil

- Re-examine the "food ingredient" research and identify the starches—simple and complex in the chemical equations.

Presentation

- Design a poster showing the progression of a glucose molecule into at least five disaccharides, starches, and fibres.

Resources/Notes

- *Food Science: The Biochemistry of Food and Nutrition, Fourth Edition*, pp. 219–225, 228, 230–235, NSSBB# 23054

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Column One: Outcomes

The first column provides the specific curriculum outcomes. The statements involve the Science-Technology-Society-Environment (STSE), skills, and knowledge outcomes indicated by the outcome number(s) that appears in parentheses after the outcome. Some STSE and skills outcomes have been written in a context that shows how these outcomes should be addressed.

Specific curriculum outcomes have been grouped by topic. Other groupings of outcomes are possible and in some cases may be necessary to take advantage of local situations. The grouping of outcomes provides a suggested teaching sequence. Teachers may prefer to plan their own teaching sequence to meet the learning needs of their students.

Column One and Column Two define what students are expected to learn and be able to do.

Column Two: Elaborations—Strategies for Learning and Teaching

The second column may include elaborations of outcomes listed in Column One, and describes learning environments and experiences that will support students' learning.

The strategies in this column are intended to provide a holistic approach to instruction. In some cases, they address a single outcome; in other cases, they address a group of outcomes.

Column Three: Tasks for Instruction and/or Assessment

The third column provides suggestions for ways that students' achievement of the outcomes could be assessed. These suggestions reflect a variety of assessment techniques and materials that include, but are not limited to, informal/formal observation, performance, journal, interview, paper and pencil, presentation, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in brackets after the item.

Column Four: Resources/Notes

This column notes useful resources and provides an opportunity for teachers to make to own notes.

Food Constituents

Food Constituents

Outcomes

Students will be expected to

- identify and describe science- and technology-based careers related to food science

Elaborations—Strategies for Learning and Teaching

Students may suggest what they think food science means. Teachers should give a definition of food science. From this, students could classify various careers into those that relate to food science and those that do not. Discussions about choices might occur. Questions should be generated and posted, such as "What does a food scientist do?" "What do food and science have in common?" "Where does food science fit with my life?" "Should I be concerned about food development?"

Teachers and students should explore the overall concept of food from inception to table; for example, potato to potato chip. Students might look at additives, their chemical formulae, the reason why additives are included in the food, and where the information was found.

Videos appropriate to this topic may be shown.

- analyse a food package ingredient listing

Food is composed of chemicals. The properties of food are affected by the composition. Students should look at different food packages and try to sort the ingredients. Students could use various resources to help them classify the foods.

Food Constituents

Tasks for Instruction and/or Assessment

Paper and Pencil

- Using a concept map, organize the suggestions about "food science."

Presentation

- Present, using various formats, the results of "packaged food investigation."

Resources/Notes

Food science can be defined as the application of the basic sciences and engineering to study the fundamental physical, chemical, and biochemical nature of foods and the principles of food processing.

Carbohydrates

Outcomes

Students will be expected to

- explain and describe the function/properties of other starches, including carbohydrates and cellulose, pectins, and gums

Elaborations—Strategies for Learning and Teaching

Students should describe the functions of carbohydrates. Sweeteners (sucrose), dietary sources such as energy (starch), and indigestible fibre should be addressed. Functions also include viscosity (thickeners, gelling agents, e.g., gums), and browning (Maillard and carmelization). Teachers may discuss cryoprotectants and humectants. Teachers should discuss monosaccharides occurring naturally in only small amounts. Open chain and rings should be discussed. A small percentage is present in open chain form. Disaccharides, oligosaccharides (2–10 monosaccharides units), and polysaccharides should be investigated looking at different reactivity, sweetness, and solubility.

Students should identify carbohydrate structures. Students should recognize sugars, their chemical names, and their chemical formulae. Polysaccharides should be examined. Teachers can explain that starch from different sources have different amounts of the amylase, straight chain, and amylopectin, branched. Discussion about the uses of starch could include thickening, gel formation, wallpaper paste, and raw materials for syrups. Starches are found in plants as granules.

Various gums that are used for thickening foods could be explored. Some of these include gum arabic, which is bark of acacia trees; guar, which is the seed of a plant indigenous to India and Pakistan; carrageenan, which has seaweed concentrations; and xanthan, which is microbial. Pectins are composed of repeating units of sugar acids, not simple sugar. Students could explore pectins, which are found in some plants, especially fruit, and are used for gelation, for example, fruit jams and jellies. Students could discuss glycogen as the main storage form of CHO in muscles and very similar in structure to amylopectin (composed of glucose molecules and branched).

Teachers should make it clear that glycogen is much larger than amylopectin but has more branching than amylopectin.

Carbohydrates

Tasks for Instruction and/or Assessment

Performance

- Do lab on polymers and crystals.
- Do an experiment about viscosity using different starches.
- Test for carbohydrates.
- Do a test for starch. Include examples of foods containing these molecules. Compare jam using natural thickeners and artificial thickeners.

Paper and Pencil

- Re-examine the "food ingredient" research and identify the starches—simple and complex in the chemical equations.

Presentation

- Design a poster showing the progression of a glucose molecule into at least five disaccharides, starches, and fibres.

Resources/Notes

- *Food Science: The Biochemistry of Food and Nutrition, Fourth Edition*, pp. 219–225, 228, 230–235, NSSBB# 23054

Lipids

Outcomes

Students will be expected to

- identify and describe the properties and functions of lipids

Elaborations—Strategies for Learning and Teaching

Teachers should categorize lipids: fats, solid at room temperature; oils, liquid at room temperature; cholesterol; phospholipids; and waxes. Students should know the food sources of lipids such as dairy (butterfat), plants (oil seeds, legumes, palm coconut), land animals (beef—tallow, pork—lard, and poultry), and fish (sardines, mackerel, cod [liver], and salmon). Students should discuss the functions of lipids. Students should explain the properties of saturation and chain length.

Students should investigate food uses of lipids. These may include ingredients, such as butter, cheese, and mayonnaise. Students should explain the effect of variables on fat in food products. How lipids contribute flavours (fatty acids), the texture and mouth feel, how they carry flavours and fat-soluble vitamins, and how they are used in cooking could be addressed. Students should explore and identify how glycerol and fatty acids combine to give the triglyceride. Students should describe the structure of triglycerides. Mono- and diglycerides should be looked at. The properties of fatty acids could be discussed. Undesirable reactions such as hydrolytic rancidity and oxidative rancidity could be examined.

Lipids

Tasks for Instruction and/or Assessment

Performance

- Do a fat separation lab.
- Do “light versus regular margarine” food additive lab.
- Do lab, “What substances can replace fats in food products?” An example might be to make brownies with applesauce and conduct a taste test with regular brownies.

Paper and Pencil

- Discuss the physiological functions of lipids.
- Are shorter chain fatty acids more volatile? Explain.
- Discuss “The more saturated the fatty acid, the harder the fat.” How does hydrogenation affect this process?
- Draw a saturated chain. Draw a trans-unsaturated chain.
- What is the difference between hydrolytic and oxidative rancidity?
- Are fats visible in foods? Explain.

Resources/Notes

- *Food Science: The Biochemistry of Food and Nutrition, Fourth Edition*, pp. 239–245, 247–248, 251, NSSBB# 23054

Proteins

Outcomes

Students will be expected to

- describe the structure of proteins found in various foods, including essential amino acids

Elaborations—Strategies for Learning and Teaching

Teachers should discuss amino acids chemicals—carbon, hydrogen, oxygen, nitrogen, and other elements such as sulphur. Teachers can point out that there are over 20 amino acids but there are eight that our body cannot make. Students should recognize that we must consume these in our diet and that not all proteins contain these essential amino acids. Proteins from animals, in general, are complete, but most plant proteins are deficient in one or more essential amino acids.

Students should recognize that proteins are amino acids linked together in long chains. Students should recognize that proteins make up body tissues, enzymes, and blood. The importance of proteins, nutritional and functional, should be addressed. Sources of proteins may be discussed. Protein structure should be explained. Include

- primary structure—sequence of amino acids
- secondary structure—helix, parallel sheets, randomly coiled
- tertiary structure—folding or 3D structure
- quaternary structure—sub units (two or more 3D structures together)

Students should explain denaturation, the breakdown of quaternary, tertiary, or secondary structure of protein. Investigation should include exposure of food proteins to reactive groups and causes of denaturation by heat and chemicals. Teachers should discuss conjugated proteins that contain non-protein components such as lipoproteins containing lipids, glycoproteins containing sugars, and metalloproteins containing metal ions. An example of this is hemoglobin that contains iron. Free amino acids may be discussed in relation to their being easily absorbed by the body and to enhancing flavours.

More investigation of free amino acids might include reacting with reducing sugars such as the Maillard reaction and forming breakdown products such as lysine cadaverine and arginine putrescine.

Teachers may discuss enzymes as a class of globular proteins. A definition of enzymes could be discussed: enzymes are used to catalyse chemical reactions under mild conditions without being used up in the process. The importance of enzymes might be addressed—physiological, industrial, and other.

Proteins

Tasks for Instruction and/or Assessment

Performance

- Do the lab "Testing for Protein."
- Do a lab with milk proteins.
- Make tofu.

Paper and Pencil

- What is the nutritional importance of proteins? What are the functional (non-nutritive properties) of proteins? Can they be manipulated in various ways to give desired physical/structural attributes to foods? Give examples.
- Compare the enzymes' importance with regard to plant and animal life processes (physiological), industrial (food—fermentation and enzymatic browning), and other (detergents).
- What happens when eggs are fried?
- Why are different types of flour used for different food products? Explain.
- What are the optimum conditions for whipping egg whites?
- How do proteins affect the texture of food?

Resources/Notes

- *Food Science: The Biochemistry of Food and Nutrition, Fourth Edition*, pp. 257–268, NSSBB# 23054

Water and Other Constituents in Foods

Outcomes

Students will be expected to

- summarize the functions of water in food preparation and food development
- explain the functions and basic properties of emulsifiers, organic acids, vitamins, enzymes, antioxidants, colour, and flavour
- design an experiment, identify specific variables, and perform it

Elaborations—Strategies for Learning and Teaching

Students should explore how water is present in most natural foods. References to the content of fruits and vegetables and cooked meat might be made. Functions of water should be discussed. These could include water as a reactant, reaction medium, carrier of nutrients and waste, and how it helps maintain structure of some foods. Other properties of water should be identified and discussed. These might include how it affects viscosity, how it freezes and how it boils, how it is a growth medium for microorganisms, and how it is heavy and costly to transport.

Students should recognize emulsifiers as materials that keep fat globules dispersed in water (oil in water) and water globules dispersed in fat (water in oil).

Teachers might discuss the best emulsifier (lecithin). It is structured like a fat but contains phosphoric acid. They are different lecithins. Organic acids should be included. Fruits such as lemons, apples, and grapes contain natural acids and fermentation of food by acid-producing bacteria. An example of the latter is cheese from milk and lactic acid (bacteria).

Teachers might point out that the presence of organic acids can also influence colour, texture, and food safety. Vitamins and minerals should be examined as organic compounds required in small amounts to maintain health. These must be supplied in the diet except vitamin D that is synthesized in skin. Fat soluble and water soluble foods may be addressed. Enzymes may be explored here or with proteins. Antioxidants, colour, and flavours might be discussed.

Water and Other Constituents in Foods

Tasks for Instruction and/or Assessment

Performance

- Do a lab on water's properties.

Paper and Pencil

- What is surface tension?
- What is polarity?
- How do enzymes affect food production?
- What are emulsifiers?
- How are organic acids useful?
- How is food safety influenced by water? by organic acids? by enzymes? by vitamins? by minerals?

Resources/Notes

Preservation Factors

Food Microbiology and Food Safety: Fermentation Microbiology

Outcomes

Students will be expected to

- explain how the metabolism of microorganisms introduce new desirable flavours, ingredients, and physical properties to the foods

Elaborations—Strategies for Learning and Teaching

Teachers should introduce the importance of some microorganisms as ingredients or steps in the production of certain foods and beverages.

Students should identify various fermented products common to most supermarkets/grocery stores in the region. Students should use dairy products, such as butter, yogurt, and cheese to explain the main effect on the properties of milk is bacterial, lactic acid bacteria fermentation. Students should make yogurt. Students might visit a dairy.

Teachers could identify the main yeast fermented products, e.g., root beer. Teachers could explain how sugar is converted to ethanol. Teachers could mention that liquor also is fermented and then distilled to increase concentration of alcohol (beyond what can be obtained by fermentation only).

Food Microbiology and Food Safety: Fermentation Microbiology

Tasks for Instruction and/or Assessment

Performance

- Make yogurt. If possible, count the lactic acid bacteria.
- Make root beer.

Resources/Notes

Food Microbiology and Food Safety: Preservation Microbiology

Outcomes

Students will be expected to

- explain food spoilage in terms of the growth of microorganisms (appearance of off-flavours, off-odours, slime, visible growth)
- describe the role that processing and food additives play in eliminating, inhibiting, or delaying the growth of spoilage microorganisms

Elaborations—Strategies for Learning and Teaching

Teachers should discuss factors that affect the growth of microorganisms. The following concepts should be explained:

- intrinsic, such as acidity, available water, and inhibitors in foods
- extrinsic, such as temperature and relative humidity
- implicit refers to characteristics of microorganisms

Teachers should use examples of techniques used for food products to prohibit microbial growth. Some examples are drying (beef jerky), acidification (marinated herring), and salting (cod).

Students should examine the importance of food additives in light of the consumers' desire for safe and shelf-stable products. Students should also discuss the wish for foods to contain fewer additives. Students should explain what some possible choices or compromises might be made.

Students should explore how the metabolic activities of the microorganisms are able to render food products spoiled. Students should have a discussion on why some products, with a near neutral pH or high water activity, are more prone to bacterial spoilage. Milk and meat might be used for examples. Some cultures, historically, separate milk and meat. Students might explore reasons for this. Discussion of other products, such as breads that are characterized by low water activity, will be spoiled by moulds that could occur. Low pH products, such as some jams and yogurt, also tend to be spoiled by moulds or yeast.

Students should construct answers to questions such as "What is the difference among bacteria, yeast, and moulds?"

Food Microbiology and Food Safety: Preservation Microbiology

Tasks for Instruction and/or Assessment

Performance

- Measure the pH in milk and yogurt. Discuss the impact of the different pH values in terms of shelf life and the likely spoilage organisms.
- Look under the microscope at the spoilage mould found on old bread. Discuss how the hyphae of the mould is spreading out through the entire piece of bread.

Journal

- Can I just cut the mould off my food and eat the rest?

Resources/Notes

Food Microbiology and Food Safety: Food Safety Microbiology

Outcomes

Students will be expected to

- explain simple measures that can be taken to keep foods safe
- explain how viruses, bacteria, moulds, and parasites can cause disease

Elaborations—Strategies for Learning and Teaching

Students should identify and discuss microorganisms related to food safety. Infectious and intoxicating bacteria, moulds (mycotoxins), viruses, and parasites should be identified.

Teachers should explain the background for recent outbreaks of food-borne diseases caused by the presence of harmful microorganisms in foods. Teachers should introduce the concept of cross-contamination in the food industry and in kitchens (commercial and domestic). Students should discuss how cross-contamination occurs. Microorganisms are transferred by accident between raw and cooked products or between contaminated and non-contaminated final products. This is a major problem in food. Students should explain simple measure that keep foods safe.

Students should research and explain how viruses, bacteria, moulds, and parasites can cause disease. Teachers should introduce concepts such as bacterial infection, bacterial intoxication, and toxins. Students could make charts to show connections between safety and disease.

Students should discuss how disease-causing (pathogenic) microorganisms may be transmitted from infected cows to foods such as meats and vegetables. One example is *Escherichia coli O157:H7* that may be transmitted from infected cows to foods such as meats and vegetables. This could lead to discussions that meat contamination most likely occurs in the slaughterhouse while vegetables may be contaminated through the usage of contaminated manure used as a fertilizer or contaminated irrigation water with run-offs from cow pastures.

Students should identify and explain the simple preventative measure that can be taken at the various levels to keep the food supply safe. The following should be addressed:

- temperature x time
- sanitation
- personal hygiene
- separation of raw and cooked/processed products
- utensils

Food Microbiology and Food Safety: Food Safety Microbiology

Tasks for Instruction and/or Assessment

Performance

- Do a hand-washing exercise. Use contact plates and/or fluorescent dye. Discuss the effect of proper sanitation.

Paper and Pencil

- Write up food safety recommendations to an organization who is planning a community dinner in a small hall with limited refrigeration capability.

Presentation

- Have the students research a recent outbreak of food-borne illness. Present the results as an oral presentation or written report.
  - IFT milk
  - bacterial growth (UEN)
  - mystery juice
  - blue's the clue

Resources/Notes

Evolution of Food Preservation

Outcomes

Students will be expected to

- explain practical methods of food preservation

Elaborations—Strategies for Learning and Teaching

Students should trace and chart the history of food preservation. Students should include contributions of Louis Pasteur, Nicholas Appert, Clarence Birdseye, and W.H. Carrier. Students should investigate methods of food preservation used today. Students might examine the skills needed to be involved in food preservation. Students should examine and explain the use of pH, temperature, moisture, oxygen and salt levels on preventing spoilage.

For the bulk of the following two-page spreads, teachers should use five or more products to explain all aspects of processing and preservation methods. Possible products include

- canned product (soup—broth and vegetable, beans, pasta)
- frozen vegetables
- yogurt, cheese, milk
- instant coffee
- meat/fish
- bread, cereals, grains
- root beer

These foods should be used to explain **all** aspects of basic microbiology, bacteria, yeasts, and moulds; food safety, post-harvest, enzymes, respiration, post-mortem, pH, water activity, preservatives and ingredients; heat, cold, and dehydration processes; high and low temperature, preservation, dehydration, concentration, irradiation, and food fermentation.

Evolution of Food Preservation

Tasks for Instruction and/or Assessment

Performance

- Do a lab on dehydrating apple slices.
- Perform the enzyematic browning activity using acid to product oxidation on an apple.
- Perform a hamburger lab to test for bacteria growth. This involves the use of temperature to destroy bacteria.

Paper and Pencil

- Design a time line to illustrate the evolution of food preservation methods.

Resources/Notes

Cooling

Outcomes

Students will be expected to

- explain the use of chilling and cold storage of fresh foods in terms of preservation

Elaborations—Strategies for Learning and Teaching

Students should explain how chilling affects enzymes. Students should describe post-harvest changes in fresh food (e.g., corn), and describe the freezing process and changes that take place in food during this process. Students should describe how temperature abuse affects food quality (e.g., ice cream). Students should explain the process of blanching and why it is used (frozen vegetables).

Students should explain the use of cooling on fresh foods in terms of preservation. Discussion of chilling and cold storage should occur. Students should describe respiration and its effects on quality of fresh foods. Students should explain how chilling affects the quality of fresh foods. Students should describe post-harvest changes in fresh food (e.g., corn). Students should describe the freezing process and changes that take place in food during this process. Students should describe how temperature abuse affects food quality (e.g., ice cream).

Students should describe post-mortem changes and how they can affect food quality. Students should explain the use of low temperatures to extend the shelf life of foods and use practical demonstrations with foods stored at various temperatures. Students should explain the concepts of biological as well as chemical spoilage of food.

Cooling

Tasks for Instruction and/or Assessment

Performance

- Prepare and do a taste test on fresh cooked corn and old corn.
- Design and do an experiment on chilled foods and the effects of temperature on spoilage.

Paper and Pencil

- Why do some fruit and vegetables keep longer in the refrigerator? Explain.
- Does corn taste better the day it is picked than three or four days later? Explain.
- Discuss why ice cream texture is sometimes grainy/sandy.
- Is there a difference to freezing fruit and vegetables?
- What is UEN?

Presentation

- Prepare and present information about the scientist and his/her contribution to food preservation. Include information on germ theory, thermal processing, refrigeration, frozen foods, and others as applicable.

Resources/Notes

Heating

Outcomes

Students will be expected to

- identify and give examples of the different types of high temperature cooking

Elaborations—Strategies for Learning and Teaching

Students should identify different types of high temperature cooking. Students should give examples of where and why each are used. Students should explain how they are different by referring to cooking, blanching, pasteurization, and sterilization.

Students should explain the process of canning foods. Students should describe common can defects. Students could explain the basic outline of Hazard Analysis Critical Control Points (HACCP). Students could explain what a “Bot.cook” is. Students should describe convection and conduction heating. Students should explain the concepts in heat processing to reduce bacteria, fungi, yeasts, viruses, and enzymes by cooking, baking, boiling, and microwave heating. Trial and error methods versus the use of simple math skills to determine how much heat to apply might be explored. The advantages and precautions of home canning should be identified. Product examples that could be used in this are canned soup (both broth and vegetable), milk for pasteurization, and jam for pH.

Heating

Tasks for Instruction and/or Assessment

Performance

- Cook a hamburger to various stages from rare to well done. Give evidence to support the various cooking stages with reference to product safety, human consumption, and other variables.

Paper and Pencil

- What makes canned food safe to eat and their shelf life so long?
- What is food poisoning?
- Explain the science involved in this thermal processing. Talk about the effects of heat on food-related enzymes and bacteria.

Resources/Notes

Fermentation

Outcomes

Students will be expected to

- describe the fermentation process and make a fermented product

Elaborations—Strategies for Learning and Teaching

Students should describe the process and make a product such as root beer, yogurt, or cheese. Students should explain fermentation and its importance in food preservation.

Product examples that can be used in this are cheddar cheese, Swiss cheese, root beer, and yogurt.

Fermentation

Tasks for Instruction and/or Assessment

Performance

- Make one of the following and describe the process:
  - say cheese (UEN)
  - yogurt (UEN)
  - IFT What affects yeast growth?
  - IFT root beer production
  - IFT pickle fermentation
  - mould-fermented food products
  - yeast (UEN)

Paper and Pencil

- Explain why there are holes in some types of cheese.
- Explain why there are bubbles in beer.
- What are some reasons that fermented foods are made?

Resources/Notes

Drying Processing Techniques

Outcomes

Students will be expected to

- explain what water activity is, how it is important, and how it can be controlled

Elaborations—Strategies for Learning and Teaching

Students should examine the process of freeze drying and spray drying. Dehydration should also be examined. Students should freeze dry, spray dry, and dehydrate some foods. Students should discuss the water activity and how it can be controlled. Product examples here may be freeze and spray dried instant coffee and cereals.

Students should investigate novel techniques for processing including microwave, irradiation, high pressure processing, and ultrasound.

Drying Processing Techniques

Tasks for Instruction and/or Assessment

Performance

- Dry some food. Explain the process.
- Demonstrate simple dehydration techniques with special emphasis on control of browning reactions.
- Use a technique for food processing. Report on its strengths and weaknesses.

Paper and Pencil

- Explain why some brands of instant coffee dissolve better than others.
- Why does my cereal not go “bad?”

Resources/Notes

Food Quality and Commodities

Food Commodities

Outcomes

Students will be expected to

- analyse the properties of specific food commodities
- select and use different resources and materials to collect information about their commodity
- devise and conduct an experiment on their commodity

Elaborations—Strategies for Learning and Teaching

Commodity should be thought of in terms of food groups—look at the process of raw product to finished product in each category. Students should relate the process (e.g., cooling, freezing) to the specific commodity that they are studying. Teachers might introduce the concept of sampling plans. (Sampling plans refer to extensive testing of products to find defects that would make the product unsafe, undesirable, or impractical to produce.)

Teachers should choose a food commodity whose development may be tracked from source to consumer. The needs and wants of the consumer should be addressed. Some examples for this unit are dairy products, meat products, fruits and vegetables, beverages including brewing, confectionary products, bread and baked foods, eggs and egg by-products, seafoods and cultured fish products and grains and oilseeds. Teachers may wish to focus on a commodity from their geographical region. An example of this might be an area where there is a dairy cattle farm that has a dairy processing plant. It might have an industry based on dairy production, and processing might be a relevant resource for classroom application.

Teachers or students could invite guest speakers to talk about the production of their product. For example, students may generate a list of questions about the commodity. A guest speaker could be given the questions and invited to address student issues. Examples of questions might include "Is a licence needed to produce milk?" "How is milk gathered?" "What tests are performed on the milk before it is transported?" " How do I know that the milk is safe?"

In groups, students could design a presentation on their commodity. If they are using milk, this could include a milk production chart of data collected from the last few years in Nova Scotia. Students might produce a pamphlet that might include information on production in the mammary glands of lactating cows, selected breeding for milk capacity, duration of lactation, and fertilizing cows. Another section of the pamphlet should include comparing different types of milk such as human, cow, goat, sheep, and seal milk. Students should identify the major constituent of the commodity. For example, casein, the major milk protein constitutes 80% of the total milk proteins.

Food Commodities

Tasks for Instruction and/or Assessment

Paper and Pencil

- Using Inspirations, design a flow chart relating your commodity to the preservation processes.
- Research Nova Scotia Web sites on commodity production and present a report on your findings.

Performance

- Tour local production site such as a farm, processing plant. In your report, include interview, pictures, and comments by the organizers and by visitors.

Journal

- Write a reflection of your thoughts and reaction to the presentation by the guest speaker or write twenty points that you learned from the guest speaker.

Resources/Notes

Food Commodities *(continued)*

Outcomes

Students will be expected to

- analyse the properties of specific food commodities
- select and use different resources and materials to collect information about their commodity
- devise and conduct an experiment on their commodity

Elaborations—Strategies for Learning and Teaching

Students should design and conduct a lab that demonstrates a behaviour of their chosen commodity. Examples could be demonstrating development of milk curds using rennet, tenderization of beef, or oxidation of apples. Teachers must approve the lab design and students should prepare a pre- and post-lab report.

Students may refer to previous explorations of preservation and relate them to this topic. Examples could be pasteurization of milk, curing of meat, smoking of fish, dehydrating of fruits and vegetables.

Students could identify and list information about their food commodity and different products that it could make. (They know about heating, cooling, dehydrating, and other preservation methods, so they can demonstrate how their commodity can be changed into different types of foods available to the consumer.) Some of these foods may be what the consumer wants, what the consumer needs, what industry wants to promote, or a new food combination introduced to the market. For example, teachers may want to talk about types of fluid milk such as homogenized, skim, partly skimmed, chocolate, cereal cream, table cream, whipping cream, and canned evaporated milk. Students may look at and explore how milk has developed into other milk products such as ice cream, powdered milk, cheese, evaporated milk, and UHT milk.

Students could interview local farmers about production including questions about the technology and transportation of milk. Then, questions could be formulated and a representative from the milk industry could be invited into the classroom to talk about industrial processing of milk.

Food Commodities *(continued)*

Tasks for Instruction and/or Assessment

Paper and Pencil

- Record questions to ask your guest speaker before the presentation is given.

Presentation

- Using visuals, share with the class what you have learned about your commodity.

Resources/Notes

Food Quality

Outcomes

Students will be expected to

- identify psychological factors used to market and develop food products
- collect and compare sensory data

Elaborations—Strategies for Learning and Teaching

Quality control is the maintenance of quality at levels acceptable to the buyer while minimizing the cost to the producer. Quality factors include appearance, texture, flavour, and quality standards.

Students should identify and analyse psychological factors such as product appeal and marketing techniques that address consumer needs and demands. Students could look at various potato products, design a questionnaire based on the product's visual appeal, and collect data from people representing various age groups. Students could then present their results to their classmates for their comments and feedback. Potato products might include a box of mashed potatoes, a box of scalloped potatoes, a bag of fresh potatoes, a bag of frozen French fries, a bag of frozen potato patties, a bag of barbecued potato chips, a can of potatoes, and a bag of potato thins. Students could present their results in chart form to include the potato type, the packaging used, the characteristics of the packaging, the target market, and possible characteristics.

Potato Product Packaging

Potato Types	Packaging Used	Characteristics of Packaging	Target Market	Possible Characteristics
frozen patties	cardboard and plastic	- information given - can see finished product	youth for meal or snack	- entice buyers - protection of product
fresh potatoes	plastic	- see through with holes - printed info		- observe quality - holes for ventilation - type, nutrition info, origin
fresh potatoes	paper bag			
frozen shapes			children	
potato chips	foil bag	black and gold colours		shiny and very colourful

Teachers should identify issues relating to transportation of the product to make it safe when it reaches the processing plant and when it reaches the consumers. Issues that might be addressed are health issues such as contamination, damage such as bruising, and shelf life such as the use of carbon dioxide for ripening. Students should identify products that go from the origin to the plant and then from the processing plant to the consumer. Students could investigate all of the factors that make the product marketable.

Food Quality

Tasks for Instruction and/or Assessment

Performance

- Bring in examples of an advertisement of a food product. Share with the class the marketing strategies used.
- Examine different potato products. Design your own chart and compare the various products. Present your results to the class.
- Perform a lab on the sensory test—particularly taste and colour—and write a lab evaluation of the results.
- Perform a lab on product triangle test. Write a lab report using graphs and charts.

Journal

- In your journal, write your reaction to the facts and information presented by the guest speaker or recorded interview.

Resources/Notes

Food Quality *(continued)*

Outcomes

Students will be expected to

- identify psychological factors used to market and develop food products
- collect and compare sensory data

Elaborations—Strategies for Learning and Teaching

Students should investigate the impact of the senses on consumer desirability of products. Students could do some product testing on taste and colour of various foods. Videos are available. Students should collect and compare sensory data and report this to the class. The products they may choose might be

Colour
- different samples of salmon
- green ketchup versus red ketchup

Taste
- cola test
- puddings—scratch versus prepared

Smell
- apple pies (cinnamon versus nutmeg)
- popcorn (make during bake sale to increase sales of other products)
- fried onions (make during hamburg/hotdog sale to sell more product)

Sound
- crackers
- pickles

Students should conduct experiments that involve taste panels and collection of sensory data. Sensory data are collected during the initial development of the product and, once the product has been marketed, used for ongoing quality control. While the analysis concepts range from simple tests to quite difficult ones, a simple triangle test can be used to determine whether two samples differ from one another (e.g., cola test).

Students should report their findings using a variety of formats. Students could explain their data using statistical sampling and statistical analysis. Product quality is audited through sampling plans and measurement. Sampling and control charts, sensory evaluation of flavour, colour, texture, etc., should be discussed. Students should be introduced to the concepts of Quality of Conformance (how well a product conforms to its original design) and Quality of Design (how well a product is designed to meet the consumers' wishes).

The importance of HACCP should be discussed in this section. (For further information on HACCP, teachers should refer to *Food Science* by Potter and Hotchkiss). Teachers might invite a representative from the Canadian Food Inspection Agency (CFIA) to talk about the importance of quality control. Food scientists from other organizations such as industry and universities make excellent speakers and resource people for students and teachers. If they are not available to come in person, phone interviews and/or videos are a possibility.

Food Quality (*continued*)

Tasks for Instruction and/or Assessment

Paper and Pencil

- Choose a food product, design a questionnaire, and survey people from various age groupings.
- List different food products that are available in your area. Choose one product from your list and brainstorm the steps that they take to go from field to store and the issues that must be considered to make this happen efficiently and safely.

Resources/Notes

Hotchkiss, Joseph H., and Norman N. Potter, *Food Science*, Chapman and Hall, 1998. ISBN: 083421265X

Product Development—Schemes and Stages

Outcomes

Students will be expected to

- explain how well a product is designed to meet consumer wishes

Elaborations—Strategies for Learning and Teaching

Students have already done frequency charts for statistical analysis in their math program. Students can use their knowledge of mean, range, and normal frequency (from grade 10 math) to develop quality control charts that graph the variation of a measured attribute from a mean value of time. This is an excellent opportunity to incorporate statistics into their collection and interpretation of data for quality control. Examples of this include such things as using automated instrumentation systems to monitor carbon dioxide levels in soft drinks and alcohol and carbohydrates in “light” beer. Infrared analysers and computers are among the technology used for quality control.

Students should identify, plan, and analyse the development of a product from concept to consumer. Students should examine research on a chosen product already on the market. Students should compile and display evidence and information by hand or computer in a variety of formats including diagrams, flow charts, tables, and graphs. Students should analyse and describe examples where technologies were developed based on scientific understanding. Students should demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques. Students should analyse society’s influence on market value of a product.

Students could discuss a product that has been developed and but is no longer available. Teachers could brainstorm with students about products that have been introduced that may or may not still be available. Such examples might be purple ketchup, yellow tomatoes, pink milk, seedless watermelon, chocolate covered ants, “Orbit” (drink with floating particles), and peanut butter and jam swirls in a jar. Students should identify what people want, what people will buy and how unpopular commodities that are readily available can be developed into marketable products.

Students should discuss the creation of new tools and technologies for product development. For example, for apple processing, industrial tools may include automated apple washer, peeler, cutter, and corer. The influence of technology on processing plants allows production to be totally automated without humans used in the assembly line process. Students should investigate the impact of technology on quality control. This investigation may include sampling techniques, statistics, and procedures. An example might be meat inspection twenty years ago, ten years ago, and today.

Product Development—Schemes and Stages

Tasks for Instruction and/or Assessment

Performance

- Complete a WHMIS training course.

Paper and Pencil

- Research and chart statistical analysis of data for quality control of a particular food product
- Create a mind map of technology that would allow completely automated production of a food product (for example, an apple pie).
- Design and produce a pamphlet demonstrating your knowledge of WHMIS as it relates to food production.
- Design a game that will help students learn the steps used to produce a new food product. Use various food products.

Resources/Notes

Product Development—Schemes and Stages *(continued)*

Outcomes

Students will be expected to

- explain how well a product is designed to meet consumer wishes

Elaborations—Strategies for Learning and Teaching

Students should investigate and explain WHMIS rules in relation to the workplace for food development. Students could design posters and/or pamphlets that include diagrams to explain these rules. Students might choose to complete their WHMIS training.

In recent years, companies have been using product development systems. There are several processes for this. A leader in this field is a Cooper, a Canadian, who has developed a system ("Winning at New Products") which first generates product development ideas, screens them, and then develops "winners." If teachers find other recognized product development stages, these can be incorporated into this module.

Students should explore all the stages involved in product development from concept generation through production to evaluation and promotion. In general, these steps could include the following:

- Identify needs and wants of target market.
- Develop product idea.
- Examine related research on the product.
- Examine related research on the market.
- Project costs of production and end product.
- Develop prototype for sampling and evaluation.
- Determine viability of prototype and make decision whether or not to proceed.
- Develop quality control procedures and confirm exact recipe.
- Revise prototype and market plan.
- Promote product (product market introduction and feedback).

Product Development—Schemes and Stages *(continued)*

Tasks for Instruction and/or Assessment

Presentation

- Present group results of a discussion on critical analysis of a food product that is no longer available in the stores and why it has been taken off the market.
- Debate the effect that technology has had on quality control of automated food production.
- Present research on the history of a particular product produced in a processing plant (such as a meat processing plant or vegetable processing plant).

Resources/Notes

Food Packaging

Food Packaging and Food Labels

Outcomes

Students will be expected to

- explain the functions and considerations for food packaging

Elaborations—Strategies for Learning and Teaching

Packaging serves many purposes. It is required to protect the food from damage as well as from contamination. Labels are used to deliver information to the consumer such as nutritional information and use instructions. Different types of packaging include metal cans, glass jars, and plastic pouches or containers.

Students should identify the functions of packaging. These include protection, containment, communication, sanitation, pilferage protection (tamper evidence), and convenience (for example, single serving). Students should examine different packaging materials such as metal, paper, glass, paperboard, cellophane, foils, plastic, and composites (plastic plus paper, plastics, metal plus paper). Students could discuss the properties of metal cans. These properties might be identified as strong; easy to make; inexpensive; lightweight; easy to open; impermeable to microorganisms, light, air, or water; and non-toxic. Students could determine the pros and cons of the properties of aluminum. These include its resistance to corrosion, its ability to be recycled, and the fact that it is more ductile than steel. Other things to address include that it is less strong than metal plate, it cannot be soldered, it bleaches some products, and its cost effectiveness. Students could discuss the properties of glass and their implications for use in industry. These properties might include transparency that enables the product to be seen, higher costs that may limit its use to high-quality products, higher processing costs, returnable containers that may create problems with sanitation, and replacement of plastic containers.

Students should discuss the requirements and functions of package design. These should include marketing, technical research, manufacturing and engineering, and purchasing. Students should identify considerations of packages such as product characteristics (size, shape, composition, hazards), processing and handling needs (temperature, processing, tamper evidence), retailing needs (size, shape, display, price, UPC, durable date), and consumer needs (disposable/reusable, convenience, sales appeal).

- identify and explain the information required for labels on food products made in Canada

Students should investigate what is required on a label for food products according to Canadian standards. Students could make an information sheet for a target audience explaining what is included in the label and its importance for the consumer. Students might make a brochure for specific age levels such as grades primary to three, four to six, seven to nine, teens, adults, special interests/needs groups, and seniors.

Food Packaging and Food Labels

Tasks for Instruction and/or Assessment

Informal/Formal Observation

- Assess student contribution to a discussion regarding packaging.

Performance

- In pairs, students select and analyse sample product packages and respond to the following:
  - Describe the package.
  - What material makes up the package?
  - What are the advantages and disadvantages of the package?
  - How do you think the package is produced?
  - Suggest an alternative or improvement for the package.
- Perform a comparison of orange juice experiment.
- Have "research teams" with one materials rep, one food safety consultant, one production engineer, one food scientist in product development to discuss and develop a particular product (have students all choose the same food product, e.g., cheesecake) and design and produce prototypes of own particular group design.

Paper and Pencil

- Students brainstorm different considerations in packaging.
- Students list examples of food packaging.
- Carousel brainstorm of advantages and disadvantages of different types of food packing.
- Self-evaluation of product designed by "research and development team."
- Evaluation of each other's product (using a pre-assigned rubric).

Presentation

- Present results from Paper and Pencil activities.
- Each "research and development team" presents its prototype and product including product design, packaging, nutritional value, and target group.
- Design and present an advertisement, jingle, song, or poem of a product.

Resources/Notes

New Food Product

Outcomes

Students will be expected to

- design, develop, make, and present a food product identifying and anticipating major variables that may impact on the final quality of the product

Elaborations—Strategies for Learning and Teaching

The final project focusses on student development of a food product. Groups of students will design and produce an original food product. This project uses all of the student skills from designing and implementing a product. As well as their food science knowledge, students might use their skills from other subject areas including design, communication, presentation, and WHMIS to complete their food product. Students should carry out procedures controlling the major variables and adapting or extending procedures where required. Students should select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate ideas, plans, and results in a science log. Students should work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise. Students should illustrate how technology might facilitate product development, potential viability, and production. Students should assess the importance of peer review in the development of a new food product.

Students could develop products that may be marketable or sold as a result of this project. Teachers should model this project. As the students complete parts of their project, teachers should do the same with their project. Time lines may be used in order to help everyone see the deadlines involved in product development. This is project-based science that is integral to development of all science projects whether these are a study, an experiment, an innovation, or a combination of all three.

Teachers should choose groups for this project. There must be a great deal of discussion in the group during the process of this project. Students should identify every aspect of design, developments, and production, availability of materials (food) in this area, and cost to produce. Students should design a product with a particular target group in mind and be able to explain the process of their development and defend their product and packaging.

Each group is to develop an original food product—one that is not on the shelves of the grocery stores or on TV ads yet. It must be made from original ingredients. It is recommended that they try the recipe at home before the final product is made at school. As students strive for perfection of their product, practice will improve the quality and appearance. Teachers might provide ingredients for the final product (unless an unusual or particularly expensive ingredient is required and members of the group will be expected to supply that specific food component). Teachers and students should recognize that stabilizers and special chemicals may not be available for use.

New Food Product

Tasks for Instruction and/or Assessment

Journal

- At the conclusion of your project, write a summary about your process.
- Give yourself a mark out of 25 for the work that you did on this project and explain why you think that you deserve this mark. Each journal is to be handed in on the due date.

Paper and Pencil

- Do a formally written submission that accompanies the food product. The written work must be secured in a duotang folder that has the name of every person in the group and the name of the food product on the front of the folder. The following items should be included for consideration of full marks:
  - a colourful title page that advertises the product and includes a picture and slogan
  - table of contents
  - introduction: explanation of why the group chose this food product, who the target market is for the food product, what media will advertise the product, and where the product will be sold
  - product defence: review of the process that led to development of your particular product. Questions to address include "What other foods were considered?" "Explain why you chose this one." "What particular ingredients were used and what were the reasons these were chosen?" "What is the shape of the product?" "Is decorating a factor? Explain." "What environmental concerns were considered?" "What nutritional concerns are needed?" "What ingredients are used and where were they purchased (were some local products)?"
  - packaging defence: What were the packages considered? Give reasons for choosing this package. How does the package store the product? What is the shelf life of the product? Explain why this shelf life has been recommended. What environmental concerns/issues have been considered? Have you thought of the disposal of the packaging?
  - reflection: This might include what worked well, what you would change, what you learned, and what recommendations you would make if other groups were to do this assignment.
  - a "group" mark with evidence to support the evaluation

Resources/Notes

See *Secondary Science: A Teaching Resource*

New Food Product *(continued)*

Outcomes

Students will be expected to

- design, develop, make, and present a food product identifying and anticipating major variables which may impact on the final quality of the product

Elaborations—Strategies for Learning and Teaching

Students should design and produce an appropriate packaging, complete with picture of the finished product, storage recommendations, ingredient label, nutrition label, best before date, method of preparation, recommended price, and striped code. The cover should be professional and also original. It should include any additional information that will help the consumer. Students should use original materials for packaging.

Students should provide a specific recipe with the food product by the time the prototype is produced. The recipe ingredients should be measured in exact quantities.

Students should decide on their advertising promotion. This could be a full-sized Bristol board poster with advertising and a slogan to promote the product. This should be as professional as possible. Other display formats should be considered.

Students must check the Internet for any relevant information about food-agricultural, health ad safety issues, transportation, etc., of their product.

Students should keep a journal or science log of their project process. This is essential to the project's duplication.

Each time a group meets to discuss or work on the project, a science log entry must be made by each person in the group. Students are to document the progress that the group made during each meeting—what was discussed, what was decided, the reasons for the decision, ideas presented and who presented them, how decisions were reached. This must be an individual, detailed entry every time the group met, and also whenever work was done on the project. At the end of each journal entry, thoughts, concerns, and perceived/real successes that are being experienced at that time should be documented. The journal could be kept in a small, bound book and must be individual.

New Food Product *(continued)*

Tasks for Instruction and/or Assessment

Presentation

- Your group will do a presentation to the class. Imagine the class was to be a company that could be purchasing your idea to produce. You have to do a formal, thorough, presentation that will persuade the CEOs of the interested company to purchase your product instead of the other products. Be prepared for questions from the audience.
- Display your project.

Resources/Notes

Appendices

Appendix A: Activities

Enzyme Coagulation of Protein

Question

What effect does an enzyme have on protein bonds?

Safety

- The product should not be consumed since the buret test requires inedible chemicals.
- Wear gloves when handling the reagents needed for the buret test.

Information

- Make a 10% sodium hydroxide (NaOH) solution (10 g NaOH dissolved in 100 mL water).
- Prepare a 5% copper (II) sulphate solution (5 g anhydrous cupric sulphate $CuSO_4$ dissolved in 100 mL water). This solution will be blue in colour.
- Foods with no peptide bonds (potato, for example) will test with a blue colour. This is a negative response.
- Foods with three or more amino acids (casein, for example) will test with a purple-violet colour. This is a positive response.

To Test:

- Place a pea-sized sample of curd on a Petri dish.
- Place 1 mL of NaOH solution on each curd.
- Add 5 drops of copper sulphate to each curd.
- Record your observations as positive or negative for the presence of protein.

Materials

- rennin (called rennet tablets in the grocery store)
- Petri dishes
- pasteurized animal milk—cow or goat
- eye droppers
- cheese cloth
- elastics or string
- stir rod or wooden stir sticks
- 250 ml beaker
- graduated cylinder
- hot plate
- thermometer

- heatproof gloves and pad
- soy milk
- rice milk
- aluminum foil

Procedure

- Find and record the mass of a beaker.
- Add 125 mL milk to the beaker. Find and record the mass of the beaker + milk.
- Crush the rennet tablet between two pieces of aluminum foil.
- Heat milk to 43º C. Remove from heat.
- Add the crushed rennet tablet to the hot milk and stir for 2 minutes. Allow milk to sit 5 minutes. The casein will have precipitated to the bottom of the beaker in curds.
- Cut two layers of cheesecloth to cover the top of the beaker. Fasten with elastic or string.
- Gather the casein in the beaker into a ball in the cheese cloth. Squeeze whey from curds until dry.
- Find and record the mass of the precipitate (not the cheesecloth).
- Test the precipitate using the buret test. Record your observations.
- Repeat procedure with soy milk and/or rice milk.
- Test variables: higher and/or lower temperatures

Analysis

- Compare the mass of the curds from the different types of milk. What information do your data give you about the protein content of the different milks?
- Which milks produced a precipitate? Which did not? Why?
- Compare the mass of the curds produced using this method with that of acidic coagulation. What can you comment on about the comparison?
- What did the buret test tell you about the presence of protein in the milks you tested?

Lipid Extraction

Questions

- Is the fat in some snack foods saturated or unsaturated?
- What percentage of some snack foods is fat?

Safety

The foods used in this experiment are NOT to be consumed. The extraction materials used are poisonous if ingested. A fume hood should be used to safely contain the fumes from the acetone or alcohol.

Teacher Information

Mineral spirits or denatured alcohol can be substituted for acetone. Nail polish remover or rubbing alcohol have too much water included to properly extract the lipid.

Materials

- semi-sweet chocolate chips
- sunflower seeds
- potato chips
- balance
- microwave
- paper towel
- acetone
- foil
- hammer
- Petri dishes (100 mm)
- latex gloves
- graduated cylinder
- safety goggles
- beakers (100 ml/600 ml)

Procedure

Part I: Basic procedure for invisible fats in foods

- Measure 2 g of chocolate chips and place on a paper towel.
- Microwave on high for 40 seconds.
- Fold the paper towel over the chocolate and gently press flat with your fingers.
- Allow to sit 5 minutes. Record your observations.
- Label the sample and carefully set aside to observe again next day.

Part II: Basic procedure for quantitative measurement of invisible fats in foods

- Label beakers—one for chocolate chips, one for potato chips, one for sunflower seeds. Record the mass of each beaker.
- Measure out 5 g chocolate chips. Using the hammer, crush them between two layers of aluminum foil.
- Add crushed chocolate chips to a beaker. Record the mass of beaker + chocolate chips.

- In a fume hood or a well ventilated area, add 10 mL acetone to the crushed chocolate in the beaker. Swirl one minute.
- Carefully decant the acetone into a Petri dish. Make sure all chocolate remains in the beaker.
- Add 10 mL more to the chocolate, swirl for a minute, decant again into the same petri dish.
- Place the beaker with the chocolate and the petri dish in a fume hood overnight to dry.
- Record your observations for the Petri dish the next day.
- Record the mass of the beaker and chocolate the next day.

Extensions

Using the basic procedures above try variables such as

- baked versus fried snack foods
- brands of chips, crackers
- nuts, such as peanuts or sunflower seeds
- different types of popcorn
- snack bars
- comparing regular cookie to "fat free" or "low fat" cookie

Analysis

- In Part I, how can you tell that the dark wet spot on the paper towel is fat and not water?
- Why did some snacks need to be gently pressed or crushed before heating?
- Is the fat you see naturally occurring in the product or has it been added during processing?
- What was the purpose of the acetone (or alcohol) in Part II?
- What did you discover about invisible fats in some of your snack foods? What does the nutrition label tell you about this fat? Does the product make any dietary claims that are not born out by your analysis?
- In the Petri dishes, you found fat the next day. Which snacks had saturated fats? How can you tell? Which snacks had unsaturated fats? How can you tell?
- Rank your snacks from lower percentage of fat to highest. Compare your results with the nutritional information on the snack labels. Did your ranking agree or disagree with the product labels? Explain your results.

Making Root Beer

Questions

- What factors affect the production of traditional root beer?
- How does traditional root beer flavour and sweetness compare with commercially made root beer?

Safety

Plastic drink bottles are safer to use than the traditional glass bottles in case of explosion. Yeast carbonated root beer contains some alcohol. 100 bottles of root beer is the equivalent of one brewed beer.

Fill bottles to 2.5–5 cm from top of bottle. Bottles with too little head space do not allow for the expansion of gas; bottles with too much head space allow gas to escape from the liquid.

Use plastic that is categorized as food safe. Chemical residues can cling to plastics.

Materials

- 4 L food safe plastic container
- 1 pkg. brewing yeast (not bread yeast)
- 15–30 mL root beer flavouring extract
- sugar
- 6–8 (2L) soft drink bottles with caps or 12–16 (1L) bottles
- 5% bleach rinse
- food safe glass stir rods
- balance
- permanent marker

Procedure

- To make a 5% bleach rinse, add 5 mL of chlorine bleach to 95 mL water.
- Use the bleach rinse to carefully clean the bottles and caps and plastic mixing container. Rinse several times with clean, warm water.
- In a clean beaker, dissolve 0.12 g brewing yeast in 250 mL warm (37ºC) water. Let stand at least 5 minutes.
- With the permanent marker, mark on the outside of the large mixing container where 4L of liquid would be.
- In the mixing container, combine 15 mL root beer extract, 45 g sugar and approximately 500 mL warm water.
- Add the proofed yeast mixture. Mix thoroughly.
- Add enough warm water to bring liquid level up to the 4 L mark you made. Mix thoroughly.
- Fill bottles with the root beer mixture to within 2.5–5 cm from the top.
- Cap tightly and lay bottles on their sides to check for leaks. Reseal any that leak.
- Store bottles on their sides in a cardboard box 3–4 days at room temperature. The cardboard box will contain any spills from exploding bottles.

- After 3–4 days, move bottles to a cool (15–18ºC) dark place. Total aging takes 1–2 weeks for improved flavour.
- Refrigerate bottles before opening them.
- Taste products initially, after 5 days, at end of fermentation (10 days), at 2 weeks.

Use a blind taste panel test and a rating scale of 1 = more, 2 = same, 3 = less to compare the experimental samples with a commercial brand for root beer flavour intensity, sweetness, and degree of carbonation.

Variables to experiment with

- amount of sugar
- amount of extract
- temperatures (higher and/or lower) of fermentation
- amount of yeast
- type of yeast
- type of sweetener used
- temperature (hotter/colder) of the water used in the mixing of the yeast

Analysis

- Does the type of yeast affect the quality of the root beer?
- What effect does the temperature of water have on the fermentation product?
- What is the purpose of the sugar in this process? What effect did varying the amount and/or type of sweetener have in this process? Would a sugar substitute work in this process? Why or why not?
- Could sugar be eliminated altogether in this process? Why or why not?
- Where did the CO_2 come from?
- Describe the natural carbonation process.

Appendix B: Project-Based Learning Checklist

Background Research	Laboratory Work (if applicable)	Scientific Observation	Cooperative Groups	Relating Concepts	Experimental Research (if applicable)
used a variety of pertinent resources	created a storyboard as an organizer and/or a summary for a lab project	was able to communicate my observations clearly and concisely	actively participated with other group members	connected concepts with other unit areas we have studied in class	found something to observe and clearly described my question
correctly cited all sources used	wore safety glasses throughout the duration of the lab during all of the required times	observations were appropriate in number	showed respect and support for fellow team members	showed an ability to connect these concepts with larger ethical issues	gathered information that helped me understand what I am investigating
collected enough information to understand the main idea of the project	cleaned all of the glassware when was through with it	careful observation allowed me to discover something I did not know before	contributed both time and effort	connected these concepts with other issues of importance to our society or community	chose a title for the project that allows others to know what it is about
used information from electronic sources	cleared up any mess created during the lab	described in detail the object(s) I was instructed to observe	listened to my partner's ideas	connected these concepts with my previous knowledge in the area	explained why I chose the topic that did and what I needed to do to answer my question
used information from scientific journals	answered all lab questions to the best of my understanding	able to separate my opinion from fact in what I observed	listened to my group's ideas	My new knowledge allowed me to ask a higher-level question than I previously could have.	stated what kinds of variables could effect my results
used information from textbooks in class	wore appropriate shoes for the lab	drew all items as accurately as I could	provided ideas that contributed to success of the project	showed how this scientific lesson related to social issues outside of science	formulated a hypothesis and worded it so it could be tested
found recent materials so my information is up-to-date	reported any accidents to my teacher, no matter how minor I thought they were	labelled all items	Without my help, we could not have completed this project.	showed how the historical context of this area relates to our present understanding of it	designed an experiment to try to answer my question(s)
used only reliable resources	returned all lab materials and equipment after use to where they belonged	described as many physical properties as I could find	held both myself and other group members accountable for high quality work	described how technological advances have changed our understanding of this topic	used appropriate equipment and techniques to perform my experiment
used resources that had data to support the claims					performed the experiment and recorded the results
					summarized the results and then drew conclusions

Appendix C: Examples of Instructional Strategies and Approaches

Teachers recognize that an effective learning environment is one in which students interact with each other co–operatively, construct meaning, and confirm understanding through conversation. Such a learning environment is dynamic. It is one in which teachers guide students in searching for meaning, acknowledging and valuing uncertainty, and assuming a large measure of responsibility for their own learning. Particular strategies and approaches have been developed that foster such a climate. Brief descriptions of a number of these follow.

Group Discussion

Group discussion allows for students to formulate and strengthen ideas. Discourse is encouraged during class discussion as this is how students put concepts together. Students need to be encouraged to listen to others' ideas, value others' opinions and recognize the need for people to disagree at times. These are part of the attitude outcomes for science. By articulating ideas and opinions based on concepts learned in a unit, students strengthen their own learning and come to value that while facts remain somewhat concrete and constant, opinions and ideas are different among people for a variety of personal and cultural reasons.

Turn to Your Partner and ... (TTYPA)

This strategy is used frequently in interactive classrooms. As a concept or idea is presented to the class, students are asked to turn to a partner and talk about it. Students explore personal connections to the topic under discussion. By articulating ideas to each other, students enhance their learning. These short interactions are followed by a transition to a small-group or full-group discussion.

Think, Pair, and Share

In the think/pair/share design of co-operative interaction, a teacher's question is deliberately followed by 3 to 10 seconds of silence, called "wait time" by its original researcher, Mary Budd Rowe. After giving students sufficient wait time to think through a question and make some personal connections, the teacher asks the members of the pairs to share their thinking with each other. As students share their ideas, each partner can benefit from the other's perspective. Partners examine their statements, searching for examples and clarifying their thinking. The teacher may ask the partners to synthesize their ideas into one.

Triads: Observer Feedback

In this strategy, partner work is complemented by a third role, that of an observer. While partners engage in the learning task, the observer outside the interaction records observable behaviours and later provides feedback to the pair.

Triads: Three–Step Interview

Students work in triads. Each group member assumes, in turn, one of three different roles: interviewer, interviewee, or recorder. Usually, the teacher provides a number of open-ended interview questions and a form for recording responses. Though the initial questions are pre-established, interviewers are encouraged to use their own questions to prompt and probe.

Triads: Carousel Activity

In this activity, students have the opportunity to develop a collective knowledge base and respond to one another's ideas and opinions. Open-ended questions are written on pieces of chart paper. The questions are placed in accessible locations around the classroom, and student triads move in rotation to these sites. They record their knowledge and/or viewpoints and respond to the ideas of prior groups. Triads may prepare for this activity in a variety of ways (e.g., by reading related material or watching a video). Through full-class critical dialogue, students review their ideas and opinions.

Co–operative Learning in Groups

Co-operative learning occurs when students work together in groups of three to five to accomplish shared goals. The co-operative groups work on a particular task. Participants work over a period of days or weeks on a shared assignment. The co-operative "base group," heterogeneous in nature, may be in place for a long term, possibly the duration of the course. Its members help, encourage, and support one another over the long term. Formal co-operative learning groups may work together for several weeks to complete specific tasks and assignments. Informal co-operative learning groups are temporary, ad hoc groups that work together for a few minutes or a single class period to process information through, for example, three-to five-minute focussed discussions or two- to three-minute turn-to-your-partner discussions. Key elements for co-operative groups include positive independence, individual accountability, group processing, social skills, and face-to-face interactions. Assigned roles may include timekeeper and recorder.

Jigsaw Activity

This activity involves students in learning and teaching. In essence, individual students become familiar with a portion of an assigned task and "teach" the selected material or skill to a small group of their peers. Two types of groupings are involved: base and expert. Each member of the base group selects or is assigned a different portion of the task (e.g., one aspect of curriculum content). Students with the same materials meet as an expert group, review their task, and decide what to teach and how to teach it. Students then return to their base groups and provide a series of mini-lessons as each student shares his/her information and knowledge.

To perform the jigsaw effectively, students need explicit instructions on how to select and share information.

Red Tag Technique

This technique is designed to encourage some level of participation from all students and to ensure that individual students do not monopolize group discussions. Each member of the group is given four red tags (the teacher may vary this number). Each time a member makes a contribution, he/she must discard one tag. The group cannot finish the discussions until all the participants have used up their red tags. A student asking a question for clarification does not have to discard a tag. Teachers may wish to have students practise this technique on a topic that generates vigorous discussion such as "gender issues in the food production sector."

Community Circle

A circle provides a supportive setting for sharing ideas. In the circle, one person is the speaker. All other group members should listen carefully and respectfully to the speaker. When finished, the speaker turns to the student beside him/her and that student becomes the speaker. This procedure is followed until all students have had an opportunity to speak. Students may pass if they do not wish to speak at that time. This activity is effective in allowing students to share their feelings and ideas. Initially, the teacher may have to take an active role to ensure that individual students in the circle speak in turn and that other students listen carefully. Often a decorated talking stick or South American rain stick is helpful in focussing both speakers and listeners.

Oral Presentation

Oral presentations are a means by which students communicate ideas, concepts, stories, and research findings to their peers. Oral presentations are important in this course as they allow students to practise and enhance communication skills. Students need to understand the importance of body language (showing confidence and making eye contact with the audience), voice and projection (clear and strong voice), and organization (use of interesting visuals, involving the audience by inviting and answering questions, and keeping within the time frame) in conducting a successful presentation. This process is easier for some students than others, and sensitivity, especially to cultural differences, is required in modelling and coaching.

Debate

A debate is a formal discussion that begins with a statement of one point of view on a particular issue. Participation in debates allows students to explore different points of view and to respond critically to a range of issues. The three standard forms of formal debate are

- Cross examination—modelled after courtroom procedures; in addition to presenting various points, debaters question or cross-examine their opponents

- Academic—the most basic form where two teams of two or three members each debate the resolution point by point; emphasis is placed on the debating skills of each team
- Parliamentary—modelled after parliamentary procedure; after the prime minister and the leader of the opposition have spoken, members of the government and the loyal opposition take turns debating various points of the bill before the House

Choose an interesting, two-sided topic that is relevant to the interests and abilities of the students.

Field Study

Field studies provide the opportunity for students to gain a first-hand impression of science in the world. The local community often provides an excellent forum for students to investigate a range of experiences. Field studies can be teacher-directed, student-directed, or expert-led experiences.

Examples of field studies are
- a walking tour of a local area
- a field trip to a museum, attraction, celebration, or nature site
- a travel experience that focusses on a particular environmental experience such as a alternative energy sites, sensitive ecological areas, or an endangered species site
- a project that includes data gathering, observation, and analysis such as the interviewing of industry professionals

Case Studies

Case studies are written narrative scenarios that typically relay a particular problem or dilemma centred around a set of issues or concerns. Case studies are useful in the study of science as they allow students to consider situations that they would not normally encounter in class, and they provide a forum for students to practise the skills and knowledge they have gained through classroom instruction. Students can work individually, in small groups, or as a class to analyse, interpret, and respond to the material. Students should be encouraged to use and expand on their knowledge base and skills as they formulate their responses.

Interviewing

The process of preparing and participating in an interview provides a range of learning opportunities and experiences for students to apply and develop their reading, writing, speaking, listening, and critical-thinking skills. Interviews help students gain a better understanding of concepts developed in the classroom setting as well as helping them to build important links among themselves, their community, and their school. Planning for an interview is crucial for its success and usefulness. Students should research their topic in advance and prepare a list of questions to review with their teacher before the interview. Decisions on the date, time, place, and method of recording should be confirmed well in advance of the interview. A well prepared and confident student will gain from most interviews a wealth of information and an important connection to his/her community.

Journal Writing

The use of personal or interactive journals provides an effective means by which students may reflect upon most classroom proceedings and activities. Reflective journals assist students in articulating what they have learned, how they have learned it, and what they want to learn next. The form and content of journals can be tailored to suit the particular activity and the needs of the individual student. It is important that the journal be an interactive means by which teachers can respond to students' questions, concerns, and ideas.

Appendix D: The Research Process

Research

The research process involves many different skills and strategies grouped within phases or stages. The process is cumulative in nature, each stage laying the groundwork for the next. The phases or stages are commonly identified as

- planning (or pre–research)
- accessing and gathering information (or information retrieval)
- evaluating and interacting with information
- organizing information
- creating new information
- preparing, sharing, and presenting information
- evaluating the research process

Students' use of the information process is not linear or purely sequential. A new piece of information, artifact, or conversation with a resource person may lead a student to revise a question under consideration, determine a perspective or point of view from which to examine critically the information available, or develop an alternative plan.

Planning

During the introductory stage of the research process, students usually

- identify the topic or question—decide on a general area of interest that warrants further investigation, then clarify or narrow the area of focus to make it manageable
- formulate broad and specific questions to guide their research
- identify a variety of potential sources of information
- decide what strategies they will use to record information and keep track of the materials they used

Accessing and Gathering Information

Students access appropriate resources (print, non–print, information technology, human, community). The actual resource is located, and the information is found within the resource.
Students will need to learn and apply several important skills

- search (with direction) a card catalogue, electronic catalogue, the World Wide Web to identify potential information resources such as books, journals, newspapers, videos, audios, data bases, or other media
- locate resources (e.g., community, text, magazines, artifacts from home, World Wide Web sites) and determine appropriate ways of gaining access to them
- select appropriate resources in a range of media

- use organizational tools and features within a resource (e.g., table of contents, index, glossary, captions, menu prompts, knowledge tree for searching electronically, VCR counter to identify video clips for specific relevance)
- skim, scan, view, and listen to information to determine the point of view or perspective from which the content is organized/told
- determine whether the content is relevant to the research question
- determine whether the information can be effectively shaped and communicated in the medium the student will use to complete the project

Teachers should help students realize that fewer appropriate resources are better than a multitude of inappropriate resources.

Interacting with Information

Students continue critical evaluation of the information they find to determine if it will be useful in answering their questions. Students apply reading, viewing, listening, and critical thinking skills:

- question, skim, read (QSR)
- use text features such as key words, bold headings, and captions
- use navigation features or software
- use pause points or topic shift points in video
- read and interpret charts, graphs, maps, and pictures
- listen for relevant information
- scan videos, bookmark and highlight Web sites
- compare and evaluate content from multiple sources and mediums
- determine accuracy, relevance, and completeness of information

Teachers should help students develop a range of strategies for recording the information they need to explore their topic and answer their guiding questions. Simple point–form notes (facts, key words, phrases) should be written or recorded symbolically (pictures, numerical data) in an appropriate format, such as a concept map, Web site, matrix sheet, chart, computer database, or spreadsheet.

Teachers may also need to assist students in citing sources of information accurately and obtaining appropriate copyright clearances for images, data, sounds, and text they intend to reference or include in their work.

See also: *Secondary Science: A Teaching Resource*.

Organizing Information

Students may use a variety of strategies to organize the information they have collected while exploring their topics and answering their guiding questions:

- numbering
- sequencing
- colouring, highlighting notes according to questions or categories
- establishing directories of files
- creating a Web page of annotated links to relevant Internet sources
- archiving e–mail collaborations using subject lines and correspondents' names
- creating a data base of images and sound files using software

Students should review their information with regard to their guiding questions and the stated requirements of the activity to determine whether they need additional information or further clarification before creating their products, planning their performance or presentation, or exhibiting their work. They may need to reframe the research in light of information and sources gathered.

Sharing Information

Students review and reflect on the information they have collected, connecting new ideas with their prior knowledge and evaluating new information that may not fit with their previous understandings. As they integrate new information into their current knowledge, students develop new understandings and draw conclusions. Teachers may need to assist students in deciding how best to convey the results of their research process to the intended audience.

Students should have many opportunities to share with a variety of audiences what they have learned, discovered, and created and to examine carefully the responses of those audiences to their work.

Evaluating the Research Process

Students should reflect on the skills and learning strategies they are using throughout activities and examine and discuss their learning processes.

Teachers and library professionals can help students with evaluation by

- providing time and encouragement for reflection and metacognition to occur (e.g., What did we/you learn about gathering information?)
- creating a climate of trust for self–assessment and peer assessment of process, creation, or performance (Students tend to be realistic and have high expectations for their own work.)
- asking questions, making observations, and guiding discussions throughout the process
- conferencing
- monitoring and providing feedback on student progress (e.g., demonstrated ability to organize notes)

Media Analysis

The development of media analysis skills is a component of Food Science 12. Media studies can be integrated into the curriculum as a source of current information, as a means to stimulate student interest and discussion, and as a vehicle to present real-world issues and situations to students.

It is important for students to be able to evaluate media critically. Students should be able to distinguish fact from opinion and propaganda from responsible, objective reporting. Analysis of media products requires students to consider the following:

- the purpose and qualification of the author(s)
- the type of source and how that source is monitored (e.g., an established newspaper as opposed to an article appearing in an interest group's site on the Internet)
- the type of audience that the information is directed to
- the reasons a particular target audience was chosen
- the ways the author(s) chose to reach that audience
- identification of inaccuracies, contradictions, or illogical reasoning
- the presentation of opinions
- evidence of bias in the work
- the source(s) of and interpretation of information by the author
- the presentation of unsupported ideas and/or conclusions

When analysing advertising students should focus their attention on the use of unsupported conclusions, testimonials by unknown or unqualified people, and the use of unsubstantiated events or quotes to draw conclusions.

Evaluation of Media Analysis

The evaluation process for a media assignment in Food Science 12 will depend on the nature of the assignment and the criteria established by both the teacher and students. Criteria might include the following:

- the inclusion of appropriate topic–related materials
- the use of a variety of relevant sources
- sources properly identified
- appropriate topic concepts identified
- topic aspects of material identified
- purpose(s) of material properly identified
- target audience identified
- point of view identified
- open, unbiased approach to analysis