**Designing a model of the human digestive system – unit plan**

**Overview**

Students design a working model of part of the human digestive system that can be built in the classroom.

**Purpose**

To design a model of the mechanical, chemical and biological (enzymatic) processes of each part of the human digestive system.

## Background

### *Suggestions for a scenario*

Your class has been asked to design a lab bench model of the human digestive system. The class may be broken into groups, each with the responsibility of designing one part of the digestive system.

This lab bench model could be used by scientists to measure the energy released from different foods. At the moment, these scientists look at the energy release from foods by measuring blood sugar in human test subjects after they have eaten food. However, this method is expensive and time-consuming, and often the rate of digestion can vary widely in different subjects.

### *Where's the biotechnology?*

Scientists at Plant & Food Research’s food concept development programme could use the results from your model to make new foods that release energy at specific rates. They are using plants, like vegetables and cereals, to make new foods. Biotechnology techniques are used by scientists for plant breeding, understanding the physics and chemistry of food structure and looking at how these things influence digestion.

## Curriculum focus

### *Technology*

* Technological practice.
* Planning for practice: Students examine how the human digestive system works and identify the purpose of each stage of digestion.
* Brief development: Students will design functional models of each part of the digestive system and evaluate how the models may perform.
* Outcome development and evaluation: Students will debate the advantages and disadvantages of a model digestive system.

### *Science*

* Investigate the mechanical, chemical and biological features of the human digestive system and their function. Understand that digestion involves a range of integrated processes.
* Design a laboratory model of the human digestive system.
* Identify food groups and their effects on the human body. Discuss how a model of the digestive system may have an impact on food technology and research.
* Compare the usefulness of a laboratory model (in vitro) with a real human subject (in vivo) in food science and health research.

### *Focus of skill and strategy*

There is a case for integration of science and technology programmes for this unit.

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| **UNIT PLAN: DESIGNING A MODEL OF THE HUMAN DIGESTIVE SYSTEM** |
| **Suggested learning intentions** | **Suggested learning experiences***The following learning experiences will provide you with starting points for an exploration of this topic. You may decide to narrow your focus to one component or include most of the ideas in a unit that incorporates science and/or technology themes.* | **Possible teaching/assessment activities** |
| Understand how the digestive system works and how it processes different nutrients, with a focus on energy.  | **Introduction*** Brainstorm the parts of the digestive system and what the class knows about the function of each part, for example, mouth, oesophagus, stomach, small intestine, large intestine, rectum and anus.
* Research food groups and the reasons why our bodies need each nutrient.
* Understand how energy release from food is normally measured.
* Examine the energy release from different foods using the glycaemic load as a measure.
* Investigate the role of in vitro and in vivo testing.
 | Use Hub resources to learn about digestion: [The human digestive system](https://www.sciencelearn.org.nz/resources/1829-the-human-digestive-system)[Food’s journey through the digestive system](https://www.sciencelearn.org.nz/resources/1849-food-s-journey-through-the-digestive-system)[Digestion – breaking the large into the small](https://www.sciencelearn.org.nz/resources/1830-digestion-breaking-the-large-into-the-small)[Digestive enzymes](https://www.sciencelearn.org.nz/resources/1840-digestive-enzymes)Animation: [Digestion of food](https://www.sciencelearn.org.nz/videos/814-digestion-of-food)Video: [Digesting starches](https://www.sciencelearn.org.nz/videos/1732-digesting-starches)To find more about measuring energy release from food, read [Testing food energy](https://www.sciencelearn.org.nz/resources/2479-testing-food-energy). |
| Understand the scenario and identify the need for digestive system models in programmes like the Lifestyle Foods programme. | **Introduce the scenario** * View the video clip [Testing foods in the lab](https://www.sciencelearn.org.nz/videos/1730-testing-foods-in-the-lab).
* Discuss the difference between in vitro and in vivo testing.
* Organise students into working groups.
* Divide the digestive system up into structural or functional components for modelling. Depending on time and resources, the class could all work on one component.
* Allocate each group a part of the digestive system that they are to research and design a model for.
 | Use [Developing healthy food products – an introduction](https://www.sciencelearn.org.nz/resources/2481-developing-healthy-food-products-an-introduction) (and related articles) to demonstrate why scientists need a model of the human digestive system. To help these discussions use these videos: [Testing foods in people](http://www.biotechlearn.org.nz/focus_stories/future_foods/video_clips/testing_foods_in_people_v0285)[Testing foods ethically](http://www.biotechlearn.org.nz/focus_stories/future_foods/video_clips/testing_foods_ethically_v0288) |
| Research the structure and function of a component of the digestive system. | **Developing expertise*** Each group is to research the structure and function of their component of the digestive system. For example, in the mouth, food is broken down first by chewing and then chemical digestion of starches begins with the addition of an enzyme called amylase.
* Mechanical (i.e. chewing, peristalsis), chemical (i.e. pH, emulsification) and biological (i.e. enzyme action) methods of digestion are important and should be replicated in the model.
 | Write a summary describing the structure of a component of the digestive system and explain how it works. To learn more about chewing and making a model of this process, read [Chewing for energy](https://www.sciencelearn.org.nz/resources/2476-chewing-for-energy). |
| Develop an idea for a feasible technological solution.Produce a design portfolio outlining the features of the model and the development of their design. | **Solving the problem**Create a list of specifications for your model based on the information you have researched. This should be a list of all the features your model needs to have. Groups could explore ideas for their design by: * brainstorming
* sharing ideas with the whole class
* writing a list of questions to ask teachers/parents/other class members to help with solutions.

Students need to decide how they will present their design portfolio and allocate tasks within the group and then write material for it. The portfolio could be a poster, slide show or booklet. * Record notes on the design process and the development of the design, including any adaptations, refinements or modifications that were done.
* Discuss how well they think it will work
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| Present ideas to an audience. | ***Presenting your ideas***Each group should produce a summary of their portfolio to present to the class and then present this to the class. They may do this as a poster or short talk. A time allocation should be given for each of these tasks | The design portfolio and the student presentation will form the basis for assessing student learning in this unit.  |
| Compare the usefulness of in vitro versus in vivo modelling in health and medical research. | **Extra for experts:*** Analyse the pros and cons of in vitro and in vivo modelling as tools in health and medical research in order to make a decision about the relative value of each.
* If you have time, you could try making the models that the students have designed.
 | To find out more about in vitro and in vivo testing, read [Testing food energy](https://www.sciencelearn.org.nz/resources/2479-testing-food-energy).Discuss the strengths and weaknesses of the class-designed model of the digestive system. |
| Vocabulary | Design portfolio: A collection of work demonstrating the development of a concept through planning and possibly creating a prototype.Model: A representation of something to allow testing or prediction of function. Adaptation: The process of adjusting or altering to fit new conditions or purposes.Refinement: A very small alteration to a structure or system, usually to make it more efficient, without changing its essential character.Modification: A partial alteration to a structure or system, usually to make it more efficient, without changing its essential character.In vitro: An experiment that occurs outside the body in an artificial environment like a test-tube or laboratory (literal meaning: in glass).In vivo: An experiment that occurs inside the body (literal meaning: in living).Mechanical digestion: Breakdown of foods by physical force.Chemical digestion: Breakdown of foods by chemical changes, such as acidity. Biological digestion: Breakdown of food by enzymes.Glycaemic load: A measure of the speed of energy release for a particular amount of a carbohydrate-containing food.  |