Promoting the Use of Educational Technology in Learning and Teaching in Science (S1-3) Learning and Teaching Resources

Digestive System

Part A: Background and connections	
Topic	Digestion of starch
Relevant theme, topic and learning focus	12.2 Nutrition and health - Understand that food has to be digested into simple and soluble substances before it can be absorbed and use by body cells - Recognise that there are mechanical digestion and chemical digestion - Recognise the role of teeth in mechanical digestion - Recognise that different digestive juices contain enzymes for chemical digestion - State that most digested food substances are absorbed in the small intestine and carried to all parts of the body via the transport system
Prior knowledge	- Be aware of the building blocks of carbohydrates, lipids, and proteins - Identify the main parts of the digestive system in humans - State the functions of the main parts of the digestive system in humans
Previous and subsequent learning activities	- Previous learning activity: *Physical model-supported whole-class discussion*: Examine a human torso to identify the main parts of the digestive system *Video-viewing*: A tour inside the digestive system - Subsequent learning activity: *Group laboratory work*: Chemical digestion by amylase

Part B: Details of the learning activity	
Rationale	This learning activity involves using a technological platform, DragGame, to support students' consolidation of their skills to develop particle-level explanations of the chemical digestion of food substances. Specifically, students construct their understanding of the particle-level happenings of the polysaccharides exemplified by starch. After learning the current unit, students could move on to study the digestion and protein and lipids with ease, as they have developed an understanding of the roles of enzymes in the digestive processes and the role of pH in the functioning of different enzymes. In this lesson, students are required to create visual representations instead of learning from these presentations. This aligns with the current trend of science education research, as reviewed by Tippett

	(2016). Student-generated diagrams can reveal what students know about given concepts, as the diagrams function as external representations of their ideas. The four visual representations that the students need to produce with the aid of DragGame provide an easy way for teachers to assess students' learning of such a multi-staged digestive process. Tippett, C. D. (2016). What recent research on diagrams suggests about learning with rather than learning from visual representations in science. *International Journal of Science Education*, 38(5), 725-746.
Learning objectives	*After the current learning activity, students should be able to:* <u>Knowledge</u> - Explain the needs of digestion in humans in terms of the type of substances to be absorbed - Distinguish between mechanical and chemical digestion - State the role of teeth in digestion - State the function of enzymes in the digestion of carbohydrates - Explain the role played by the small intestine in human digestion <u>Skills</u> - Create diagrammatic representations for a given chemical process - Deduce the pH of the different fluids given information regarding the functioning of biomolecules - Explain the necessity of a given biochemical process when the starting materials of subsequent bioreactions are given <u>Attitude and values</u> - *Perseverance*: Demonstrate courage in face of challenging learning tasks - *Respect for others*: Maintain friendly and peaceful relationships with peers that hold different views in discussion - *Diligence*: Demonstrate the will to work persistently and carefully in the construction of personal understanding
Segment time	80 minutes
Materials	Pre and post-test (Appendix 1) Student Worksheet 1 tablet per student (or pair/trios of students) 4 DragGame activities, available at: - Chemical digestion in the mouth (amylase): https://draggame.e-learning.hk/en/templates/302/view/ - Digestion in the Small Intestine 1 (amylase): https://draggame.e-learning.hk/en/templates/304/view/

	- pH of different parts of the Digestive System: https://draggame.e-learning.hk/en/templates/331/view/ - Digestion in the Small Intestine 2 (disaccharidase): https://draggame.e-learning.hk/en/templates/305/view/

Part C: Implementation	
Lead-in	5 minutes; whole class (Slides 2 – 5) - Transition: The teacher explained the need for human digestion regarding the human diet and the particles that could be absorbed. Possible guiding questions: 1. Can you name some foodstuff you ate as your breakfast/lunch? Can you classify them in terms of their types? 2. What must the human body do if the starch particle is so big and the particles that could be absorbed are so small? - Framing question: How does the human body break down the large particles in food into smaller ones?
Development	55 minutes: individual work + group work + whole class *Part 1: Digestion in the mouth (20 minutes)* (Slides 6 – 15) - Lead-in: (4 minutes; whole class, Slide 6) 1. Question: What is the function of teeth? [*breaking down food into small pieces*] 2. Introduction of the concept of "mechanical digestion." 3. Instruction on the access of the DragGame platform (https://draggame.e-learning.hk/en/templates/302/view/) - Guided inquiry: (16 minutes; whole class) 1. Introducing "chemcial digestion" (Slide 7) 2. Explain the representation of starch (Slide 8) 3. Question: Why don't we represent the starch molecule more realistically? [*Simplicity, ease of communication, better focus*] 4. Hand-on: Labelling of starch as "polysaccharides" by dragging the appropriate label (Slide 9) 5. Question: We know that the product of the chemical digestion of starch in the mouth is not directly absorbable. So, which of the remaining labels seems like the product? Why? [*Disaccharides, since it is simpler than polysaccharides but not as simple as monosaccharides, as hinted by the prefix "di", which*

	means 2, and "mono", which means 1.] (Slide 10) 6. Hand-on: Students drag the blue circles to represent the product, i.e., disaccharides. (Slide 11) 7. Question: How many circles do you use? Why? And should they be stuck with each other? [*Two, as implied by the name "disaccharides". They should be stuck together as disaccharide particles are independent entities on their own; further chemical reaction is needed to break them into monosaccharides.*] 8. Question: What should be the label placed in the middle to represent the brown biomolecule? Why? [*Enzyme, as this is the only non-carbohydrates here*] (Slide 12) 9. Question: What are the roles of the enzyme? Can the digestive reaction be done without the enzyme? [*To speed up the chemical digestive process. Without the enzyme, the digestive reaction will be too slow for human's efficient uptake of nutrients.*] 10. Hands-on: Drag the blue circles to represent the chemical changes that occurred in the enzyme (Slides 13 & 14) 11. Discussion: Ask students to explain the reasons behind their arrangement of the blue circles. The teacher subsequently highlighted the key features of the accepted explanation. 12. Question: Concerning this graph, what should the pH in the mouth be? Why? [*pH 7, when the salivary amylase, which breaks down starch into disaccharides, works best*] (Slide 15) *Part 2: Mechanical digestion in the stomach (5 minutes)* (Slide 16) - Whole-class discussion: (5 minutes) 1. The teacher outlines the formation of chyme. 2. Question*:* Does the chemical digestion of starch stop in the stomach? Why? [*Yes, as the pH is too low, and the amylase denatures/becomes unusable*.] *Part 3: Chemical digestion and absorption in the small intestine (30 minutes)* (Slides 17 – 21) - Discussion: (2 minutes; whole class) (Slide 17) 1. Question: What must the body do to allow the chemical digestion of starch to re-start? Why? [*Alkaline substance to neutralise the acid and a new batch of enzyme; Because the pH is too low for the enzyme responsible for the digestion of starch to work, and the salivary amylase has already been denatured.*] 2. Instruction for the students to access the second DragGame task. (https://draggame.e-learning.hk/en/templates/304/view/)

	- Individual/pair manipulative task 1: (2 minutes; seat work) Students individually drag the particles in the appropriate positions in the second activity on the DragGame platform (Slide 18) - Group discussion: (2 minutes; group work of 4 students) Students describe their pictures to their peers and explain why they arrange the particles in such a way. - Individual/pair manipulative task 2: (1 minute; seat work) Students adjust their DragGame representation individually after the previous group discussion. - Whole-class discussion 1 (5 minutes; whole class) *Dialogic prompts can be used:* 1. Can you describe the diagram that you have drawn? 2. Can you share why you arrange the circles in such a way? 3. Can you compare the two diagrams here, pointing out the similarities and differences? 4. What have been well-represented in these two diagrams? 5. How would you change the arrangement of circles in the diagram(s) to improve the representation? 6. Why do you make these changes? - Individual/pair manipulative task 3: (4 minutes; seat work) (Slide 18) 1. Instruction for the students to access the 3rd DragGame task. (https://draggame.e-learning.hk/en/templates/331/view/) 2. Students individually drag the arrows in the appropriate positions in the third activity on the DragGame platform to help explain "why the chemical digestion of starch happens in the mouth and small intestine, but not in the stomach". - Whole-class discussion 2: The teacher picks some students to explain the question above. (4 minutes; whole class) - Individual/pair manipulative task 4: (5 minutes; seat work) (Slide 20) 1. Instruction for the students to access the 4th DragGame task. (https://draggame.e-learning.hk/en/templates/305/view/) 2. Students individually drag the particles in the appropriate positions in the fourth activity on the DragGame platform to help explain the breaking down of disaccharides into a

	substance that the human body could absorb. - Whole-class discussion 3 (5 minutes; whole class) *Dialogic prompts like that of whole-class discussion 1 above can be used.*
Debriefing	20 minutes, whole class (Slides 21 & 22) - Consolidation: (8 minutes) The teacher can ask the question on slide 21: "Can you use the saved diagrams to explain to others how the human body breaks down the starch in bread into smaller particles that the body can absorb?" Two minutes are given for the students to discuss with their neighbours, and two will be picked in the remaining six minutes to report their description. - Whole-class discussion: (8 minutes) The teacher can ask the question on slide 22: "Can you guess why scientists use diagrams when they wish to exchange ideas with each other?" Three minutes are given for the students to discuss with their neighbours, and then some students will be invited to report their views to the rest of the class. The activity is brainstorming in nature, and the teacher should highlight the common norms of scientific communication (clarity, conciseness, comprehensiveness, etc.) (Ref.: Feliú-Mójer, M. I. (2015, Feb 24). Effective communication, better science. *Scientific American: Guest Blog.* https://blogs.scientificamerican.com/guest-blog/effective-communication-better-science/) - Transition: (4 minutes) In the current session, we have considered how starch is being digested into monosaccharides, which are to be absorbed through the small intestine and carried to other parts of the human body for respiration to take place. This is true for all many kinds of polysaccharides. However, how are the protein and lipids digested in the human body? In what ways are their digestion similar or different? These questions will be resolved in the coming lesson.

Part D: Extensions	
Possible adaptations / extensions / modifications	- Questions for the class that completes all learning tasks faster than originally scheduled: 1. In what ways could we express the process of the digestion of starch systematically? [*Use of sequence adverbs, e.g., firstly, secondly, then, finally, to help organise a sequence of events, and the use of connectors like "because", "due*

	to", and "therefore" in the statement of causal effects.] 2. What expression should we use when we are referring to a diagram? [*Use of terms like "It can be seen from Diagram X that*", *"Diagram X illustrates", "One could see from Diagram X that", etc. when referring to a diagram.*] - <u>Questions for classes that require more help</u>: *(Guidance to be provided orally and individually)* ● *Individual/pair manipulative tasks 1 & 2:* Do you expect the diagram to be like the one we have drawn, i.e., the chemical digestion of starch in the mouth? Why? [*Yes. The starting materials and products of the reactions are the same.*] ● *Individual/pair manipulative task 3:* What substance lowers the pH? [*hydrochloric acid*] What is the substance that could neutralise the acid? [*sodium hydrogencarbonate*] ● *Individual/pair manipulative task 4:* Try dragging the blue circles to the lower part of the diagram. How large could a particle be for it to pass through? So, what kind of particle can be absorbed? [*Only one blue circle could pass through the gap. It represents that only monosaccharides (among the carbohydrate particles) could be absorbed.*] So, what should the reaction here be, given that all polysaccharides have been broken down into disaccharides? [*The enzyme should break the disaccharides into monosaccharides.*] - <u>Other possible modifications</u>: Students could be instructed to write a partial written account after each DragGame task (i.e., write a single sentence to describe the biochemical process in question) if they are not too confident in producing continuous proses.
Assessment	Formative assessment using the drawings in the four DragGame activities, in which students receive feedback on the following: - Correct labelling and the use of appropriate diagrammatic representation of reactants - Correct labelling and the use of appropriate diagrammatic representation of products - Correct labelling of the enzyme Students' oral/written accounts of the digestive process of starch could be accessed in terms of the following: - Knowledge ● Mechanical digestion of bread in the mouth ● Chemical digestion of starch into disaccharides in the mouth

	● pH inside the mouth and the functioning of amylase ● pH inside the stomach, the substance that lowers that pH and the denaturation of amylase and ● Mechanical digestion in the stomach ● pH inside the small intestine, and the substance that raises the pH ● Chemical digestion of starch into disaccharides in the small intestine ● Chemical digestion of disaccharides into monosaccharides in the small intestine ● Absorption of monosaccharides in the small intestine and the transport of absorbed particles by blood (circulatory system) – Presentation skills ● Use of appropriate linking words to distinguish and sequence the key processes, e.g., “Firstly”, “Secondly”, “Thirdly”, etc. ● Use of appropriate linking words to explain the causal effect, e.g., “The monosaccharide particles are small enough. Therefore, they can be absorbed in the small intestine.”, etc. ● Use of appropriate adverbs/adverbial phrases to indicate simultaneous processes, e.g., “At the same time”, “simultaneously”, “in addition”, etc. ● Use of appropriate sentence starting phrases to refer to the diagram, e.g., “As shown in the first diagram”, “One can see from the first diagram that”, etc. ● Correct spelling of biological terms, e.g., polysaccharides, enzyme, etc. ● Spelling and grammatical accuracy

Appendix 1: Pre and post-quiz

Digestion of starch – A quiz

Class:_____ Class Number: _____

Circle the correct answers for each question. There may be one or two correct answers for each question.

1. Why does the human body need to digest food, e.g., bread?

   a. The size of each piece of bread is too big.
   b. There is too much nutrient in the bread.
   c. Starchy food, e.g., bread, is not a suitable part of the human diet.
   d. Only small particles can be absorbed by the small intestine.

2. Where does amylase, an enzyme responsible for breaking starch into tiny particles, work?

   a. Mouth
   b. Stomach
   c. Small intestine
   d. Large intestine

3. Under what pH range does amylase work?

   a. Strongly acidic
   b. Neutral
   c. Slightly alkaline
   d. Amylase works in conditions of any pH value

4. What is/are produced after amylase has worked on the starch?

   a. Monosaccharides
   b. Disaccharides
   c. Polysaccharides
   d. Enzyme

5. Which chemicals are present in the human digestion system?

   a. Ethanoic acid
   b. Hydrochloric acid
   c. Sodium hydrogencarbonate
   d. Calcium carbonate

6. Which of the following can be absorbed in the small intestine?

a. Monosaccharides
b. Disaccharides
c. Polysaccharides
d. Enzyme

Bonus question: Do scientists use diagrams to express their ideas to other scientists? Why?

Answer to pre-quiz & post-quiz

MCQs

1. A and D
2. A and C
3. B and C
4. B
5. B and C
6. A

* 1 Point / Correct Answer
* 10 points, each mistakenly chosen answer result in 1 point

Bonus Question

* Yes, for easier representation of the interrelationship between concepts, for scientist representation of data, and for illustration of complication or invisible processes etc.

1 point for each valid answer