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| ACTIVITY PLAN | | | | |
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| **Theme** | **Subtopic** | **Activity Title** |
| Collaboration and Communication in EcoSTEAM Projects | Cross-disciplinary Collaboration for Sustainable Solutions | Cereal Crops |

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| Introduction part (or activity overview) |
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| **Introduction part (or activity overview)** | One of the major scourges of the modern world is the problem of hunger. Even though biotechnologies are advancing rapidly, humanity still suffers from a lack of food. This problem can be addressed by reducing the consumption of animal products. Cultivating and consuming plant-based food is much more efficient in terms of energy and economy.  Students will become familiar with the main cereal plants of the country and the structure of the grain; they will investigate the chemical composition of the grain; calculate the energy efficiency of long and short food chains, and explain the advantages and disadvantages of alternative food sources. |
| **SETTING** | Class and Laboratory |

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| Materials Needed |
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| **Materials Needed** | Computers, phones, interactive whiteboard, microscopes, magnifying glasses, grain slides, soaked wheat grains, plates with wheat, barley, rye, and oat grains, scales, measuring cylinders, funnels, paper filters, glass rods, pipettes, test tubes and their stands, 10% flour solution, 10% NaOH solution, 0.5% CuSO4 solution, distilled water, 5% alcoholic iodine solution. |

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| **Learning Outcomes** | * Learn to use the identification key and recognize the grains of cereals grown in the country. * Identify the parts of the grain and indicate their nutritional value. * Develop microscopy skills. * Be able to determine the proteins and carbohydrates in grains. * Mathematically prove the energy efficiency of short food chains. * Critically evaluate alternative food sources. |  |
| **Activity Contents** | **Activity 1: Grain Structure**  **Theoretical Part (Duration: 10 minutes):** Introductory discussion. Discussion about cereal plants grown in the country for food: wheat, barley, rye, and oats, showing their photos and describing their characteristics.  **Task (Duration: 35 minutes):**  Step 1: Work individually. Using a grain identification key (Appendix 1), magnifying glasses, and grain samples, identify the grains of wheat, barley, oats, and rye. Fill in the table (Appendix 2).  Step 2: Work individually. Using selected information sources, familiarize yourself with the structure of the grain and its parts used for food. Examine a grain slide under a microscope and find the embryo with the seed coat, endosperm (aleurone and starchy layer), and germ. Using a picture of the grain, fill in the table (Appendix 3).  **Information for the Teacher**  **Grain Characteristics**  The oat grain is yellow, the lower part is covered with sparse white hairs, becoming denser towards the top and forming a brush at the very tip. The grain is elongated, has glumes, with a longitudinal narrow groove.  The barley grain is spindle-shaped or elliptical, slightly curved, with a whisker at the base on the belly side, has glumes, with a longitudinal wide groove.  The wheat grain is elongated, egg-shaped, with convex sides, without glumes, with a longitudinal deep narrow groove on the belly side, pinkish, sometimes with a yellow hue.  The rye grain is elongated, slightly compressed from the sides, the top may be covered with hairs, without glumes, with a deep groove along the belly. The grain is wrinkled, grayish-green, sometimes with a brownish hue.  **Grain Structure and Its Use in Food**  The grain is a dry fruit, consisting of the ovary and the seed.  The seed consists of the seed coat, germ (rootlet covered by the root sheath – coleorhiza; shoot covered by the shoot sheath – coleoptile; seed leaf – cotyledon) and endosperm (proteinaceous aleurone layer and starchy or floury layer).  Nutritionally, all parts of the grain are very valuable.  Bran – a by-product of grain processing. It consists of parts of the grain coat and aleurone layer. It contains a lot of proteins, fats, carbohydrates, vitamins (A, E, B1, B2, B6), minerals (Mg, K, P, Fe, Na, Ca, Zn).  Germs – a by-product of grain processing, containing a lot of fiber, polyunsaturated fatty acids, vitamins (A, E, B1, B2, B6, PP, D), minerals (Mg, K, P, Fe, Na, Ca, Zn, Cu).  Endosperm – the part that makes up the largest mass of the grain. Flour is made from it by grinding, containing a lot of starch and proteins.  **Activity 2: Chemical Composition of the Grain**  **Theoretical Part (Duration: 10 minutes):** Introductory talk during which the teacher explains how proteins and carbohydrates accumulated in the grain's endosperm are determined using chemical reagents.  Protein Determination. In alkaline solutions, copper ions, reacting with proteins, dye the test solutions a pinkish-olive color.  **Workflow:**  Prepare the test solution from flour and distilled water. 10 g of flour is poured with 100 ml of water and left overnight. Then, the solution is filtered through a paper filter.  Pour 2 ml of the test solution into a test tube and, while stirring, add about 2 ml of 10% NaOH solution.  Into the obtained solution, drop 0.5% CuSO4 until the contents of the test tube change color.  If the contents of the test tube turn blue, it is concluded that there are no soluble proteins in the test material.  If the contents of the test tube turn a pinkish-olive color, it can be stated that there are soluble proteins in the test material.  Carbohydrate (Starch) Determination. The presence of starch in plant tissue can be determined with an iodine solution: the substance turns blue when dyed.  **Workflow:**  Pour about 2 ml of the prepared flour solution into a test tube and add a few drops of iodine solution.  Observe how the iodine solution dyes the sample.  If the contents of the test tube turn blue, it is concluded that there is starch in the test material.  Starch granules can be clearly seen under a microscope.  **Workflow:**  Grains are soaked for 1 day before the experiment. The grain is cut in half, and a bit of the soft part is taken with a needle or scalpel. It is placed on a microscope slide, iodine solution is added, and it is observed under a microscope.  **Task (work individually) (Duration: 30 minutes):**  Step 1: Using reagents, determine whether there are proteins in the flour solution. Fill in the table (Appendix 4).  Step 2: Using reagents, determine whether there are carbohydrates in the flour solution. Fill in the table (Appendix 4).  Step 3: Microscopically examine the endosperm of a soaked wheat grain, find starch granules, and draw them (Appendix 5).  **Activity 3: Energy Efficiency of Food Chains**  **Theoretical Part (Duration: 15 minutes):** Introductory talk. The energetic functioning of ecosystems is explained. Discussion about energy flows in food chains. It is emphasized that reducing the negative agricultural impact on the environment can be achieved by shortening food chains.  Plants, using the energy of sunlight, create primary production. A portion of the assimilated energy is used for respiration, a large part of the plant mass becomes detritus and goes to decomposers. Only a small portion of energy is transferred to a higher nutritional level. A portion of the energy received from producers is not assimilated by consumers; some is assimilated but used for work and turns into heat, which dissipates into space. The longer the food chains, the greater the energy losses, hence long chains are inefficient. Energy losses in shorter chains are smaller, thus plant-based food is cheaper, requiring less energy and agricultural resources to produce.  It is also discussed how the negative impact of agriculture on the environment can be reduced by using alternative food sources.  **Task (Duration: 90 minutes):**  Step 1: Mathematically prove that short food chains are more energy-efficient than long ones.  A diagram depicting the agricultural ecosystem's food chain is presented.    Wheat accumulated 52,000 kJ of energy, 16,000 kJ of energy was transferred to the pig, and 4,000 kJ to the human.  Calculate the percentage of wheat's accumulated energy that reaches the pig (the primary consumer).  Calculate the percentage of wheat's accumulated energy that reaches the human (the secondary consumer).  How can energy losses in the food chain be reduced? (Appendix 6)  Step 2: Working in groups, find information about a chosen alternative food source, specifying its advantages and disadvantages.  Alternative food sources:  Products of genetically modified organisms  Algae  Crickets  “In vitro” meat, etc.  **Activity 4: Alternative Food Sources**  **Theoretical Part (Duration: 15 minutes):**  Students are introduced to alternative food sources that could help address the problem of hunger: genetically modified organism products, algae, crickets, and in vitro meat.  **Task (Duration: 60 minutes):**  Step 1: Working in groups, find information about a selected alternative food source, and identify its advantages and disadvantages.  Step 2: Present the group work and create a collective visual aid on the smart board about alternative food sources, indicating their advantages and disadvantages. |  |
| **Assessments** | The individual activities specified in the task sheet are evaluated with cumulative points (Appendix 7).  The evaluation and self-assessment of the group work are conducted by the students themselves (Appendix 8). |  |
| **Key Competences** | Cognitive competence  Creativity competence  Communication competence  Social, emotional and healthy living competences  Digital competence |  |
| **Connections with Eco STEAM** | Eco – understand that the consumption of plant-based food is energetically much more efficient than that of animal-based food.  Science – connect knowledge of chemistry and biology.  Technology – use digital technologies cleverly and creatively.  Engineering – be able to make a micro-preparation and microscope it.  Art – develop skills in the art of visualization.  Math – mathematically prove the energetic efficiency of plant-based food. |  |
| **References** | 1. Alyda Daulenskienė. Biologija. Pratybų sąsiuvinis 11-12 klasei I dalis. Vilnius, 2000 2. Algirdas Grigas. Lietuvos augalų vaisiai ir sėklos. Vilnius, 1986 |  |
| **Notes** |  |  |
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| Student’s name, surname ..................................................................................................................  **APPENDIX 1. KEY TO IDENTIFY GRAINS**   1. The grain has glumes............................................. see 2  * The grain is bare, without glumes............................ see 3  1. The grain's groove is narrow.................................... oats  * The grain's groove is wide....................................... barley  1. The grain is elongated, compressed from the sides......... rye  * The grain is elongated, egg-shaped, with convex sides... wheat   **APPENDIX 2. VARIETY OF GRAINS**   |  |  |  | | --- | --- | --- | | Plant name | Plate Number with Grains Drawing | Drawing | | Barley |  |  | | Wheat |  |  | | Rye |  |  | | Oats |  |  |   Evaliuation (4 points).....................  **APPENDIX 3. GRAIN STRUCTURE**   |  |  |  | | --- | --- | --- | | Parts of the grain | Image number | Nutritional value for humans | | Ovary |  |  | | Seed coat |  |  | | Endosperm aleurone layer |  |  | | Endosperm starchy layer |  |  | | Germ |  |  |   Evaluation (5 points)..................... |

**APPENDIX 4. DETERMINATION OF CHEMICAL SUBSTANCES IN GRAIN**

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| Flour Solutions | Substance Detected | Solution Color |
| Solution with NaOH and CuSO4 |  |  |
| Solution with Iodine |  |  |

Conclusion............................................................................................................................................................................

Evaluation (1 point for solution preparation, 1 point for performing the experiment, 1 point for conclusion)

**APPENDIX 5. WHEAT STARCH GRANULES**

Evaluation (1 point for preparing the micro-preparation; 1 point for finding the microscopic image; 1 point for the drawing)

**APPENDIX 6. ENERGY EFFICIENCY OF FOOD CHAINS**

1. The amount of wheat energy available to the pig....................

Calculations

1. The amount of wheat energy available to humans ....................

Calculations

1. How to reduce energy losses in the food chain?

Evaluation (3 points)

**APPENDIX 7. EVALUATION TABLE**

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| Evaluated Activities | Points |
| Variety of grains | \_\_/4 |
| Grain structure | \_\_/5 |
| Determination of chemical substances in grain | \_\_/3 |
| Microscopy of starch granules | \_\_/3 |
| Energy efficiency of food chains | \_\_/3 |

# APPENDIX 8. GROUP WORK SELF-ASSESSMENT

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| Self-Assessment Criteria | Points |
| Ability to use digital technologies for information search | \_\_/5 |
| Ability to work in a group (discuss, listen to different opinions) | \_\_/5 |
| Ability to generate ideas, suggest solutions | \_\_/5 |