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ENZYME BINDING (Mathematics Lesson Plan)

Original lesson

Grade: 8th grade

Time Allotted: 1 42 – minute class period

Prior Knowledge:

- Calculating combinations
- Probability
- **Key definition:** Probability, combinatorics, factorials

Materials:

- 1 Lock and Key (for demonstration purposes only)
- One container
- Small pieces of paper
- 10 Plastic Cups

Goals:

- Extend the idea of enzyme binding to the mathematical world
- Calculate the number of possible combinations for a given puzzle piece (enzyme)
- Complete a puzzle by communicating and working in a team

Objectives: Students should be able to…

- Understand the relationship between enzymes and combinatorics
- Understand how different puzzle pieces (or keys) can fit with one another, and how that fit affects structure.

NJCCCS:

Procedures:

Prep:

- Label your small sheets of paper with matching numbers, for example if you have 20 pieces of paper label 2 pieces with one with 1s the other with 1e representing a substrate and an enzyme, 2 pieces one with 2s the other with 2e, etc.
- Place these numbered sheets of paper in the container.
- In the plastic cups, put 10 small pieces of paper, 5 labeled substrate (with letters A-E) and 10 labeled enzyme (with letters F-J).

Class:

- Group students in pairs according to mixed ability.
- **Start class of by having a brief discussion on what was taught the previous day in Science.** What did you learn about in yesterday's science class? *Enzyme binding, particular types of enzymes, amino acids, proteins, and the Lock and Key hypothesis.*
- **Today we are going to discuss the Lock and Key hypothesis from a mathematical point of view using puzzles.**
- **Reintroduce the lock and key.** Remember yesterday when we talked about the lock and key hypothesis and Ms. A told you that in general a substrate and enzyme work in pairs? Meaning that a specific substrate can activate a particular enzyme. Today what we are going to do is figure out how many possibly pairings of substrates and enzymes we can have if we had several of them in a container.
- Here is a container (show container) filled with substrates and enzymes. In this container I have labeled sheets of paper with numbers and letters to represent which substrate and enzyme work together (like a lock and key).
- Ask a student to come to the front of the class, reach into the container, and pull out a sheet of paper. Share what he/she picked with the class.
- **What is the probability that if we reach into the container again we will obtain the correct enzyme or substrate to make this pairing function properly?** (Note that it does not matter what the student picked) *1/19.*
- **What if it were possible to pick out only an enzyme/substrate (depending on what the student picked), then what would the possibility be that you obtain the correct enzyme/substrate to make this pairing function properly?** *1/10.* **Why?**
- **Now, what if I make this game a bit harder? What if the pieces of paper were only labeled substrate and enzyme and you did not know which pair would work? This would require the use of combinatorics. Combinatorics is just a fancy name for counting. Let's pretend that there were only 5 substrates and 5 enzymes in this container.** Write substrates A – E and enzymes F – J on the board.
- **If I want to figure out how many combinations of pairings I could have for substrate A what would I do?** *List the possible combinations, A-F, A-G, A-H, A-I, A-J. There are 5 possible combinations.*
- **Your job in this lesson is to figure out the number of possible pairings for each substrate and enzyme. Use the worksheet as a guide as there are several things to look out for. Remember, this is like putting together the puzzle, based on the shape of the puzzle piece you might be able to eliminate certain pairings, this is accounted for in the worksheet. Order does NOT matter, so the pairing A-K is the same as K-A and should NOT be counted twice.**

- After worksheet has been completed, it can be reviewed as a class. If time permits you can introduce the formula of "n choose k". As a class, discuss how each of the questions on the worksheet could have been solved using this formula.

Possible Combinations of Substrates and Enzymes

Name: _____ Date: _____

Directions: Answer the questions below. Use the plastic cup and sheets of paper to help you visualize the question. Remember that order is NOT important. The pairing A-F is the same as F-A and should only be counted as ONE combination. WRITE OUT all possible combinations in the space provided.

1. You are looking to find the enzyme that matches with substrate A. It is possible for substrate A to pair with any enzyme. How many possible pairings are there for substrate A?

2. Enzyme J can NOT pair with substrate C. How many possible pairings are there for enzyme J?

3. Substrate A pairs with enzyme G. How many possible pairings are there for substrate B?

4. Enzyme F must be grouped with 2 other substrates to be activated. How many ways are there for F to be activated? (**Your combinations will now be in groups of 3)**

5. Substrate D must be grouped with 3 other enzymes to work properly. How many ways can this be accomplished? (**Your combinations will now be in groups of 4)**

6. (**Bonus Question, show work on scrap paper**) What is the **probability** that substrate A pairs with enzyme H?