

## Enzyme Simulation

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There are six "enzymes", each one having a different action upon a different "substrate". I make up enough copies and cut them up so that each student in my class has his or her own individual enzyme action. I then take them over to the lab tables and have them cluster around with about 8 people around each table. Some enzymes require a scissors and some require a pencil (a plain wooden pencil or colored pencil works much better than a rubber-coated mechanical pencil). I then start feeding individual substrates onto the tables and let the enzymes do their job.

### Rules:

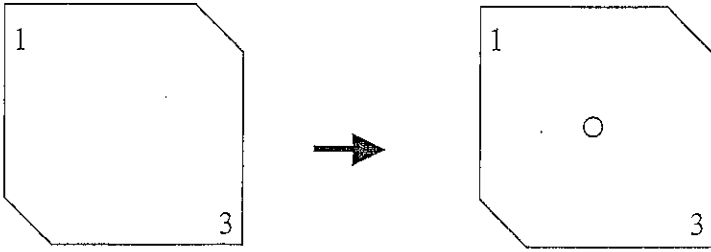
1. **Only do your action upon your substrate.** This is the toughest one, because the kids don't take the time to look at their substrates. I usually take three different kids in front of the class before we begin and walk them through it so that they understand that they can only act upon a particular substrate. (Some still don't get it, though, so you need to watch over them and keep an eye out for improperly cut/folded/punched substrates.)
2. **If you can't operate upon a particular substrate, move it on to another person or another table.** If you start to see a pile showing up on a table, you can pick it up and "diffuse" it to another table or person.
3. **Enzyme E is the last step in the process.** Although the description only shows two of the monomers stuck on the pencil, it will continue adding more and more until it is full.

After a few minutes of my going around and tossing the starting substrates onto their tables, the kids have usually figured out where they need to go and have established a metabolic pathway of sorts. An analogy to this process might be digestion and then use of the resulting monomers to manufacture a protein. We just got done learning about organic polymers, so they can usually identify the final product as something like a starch or protein molecule made up of repeating units joined together. The way our lab is set up, with peninsulas and inlets in between, they can imagine the highly folded membranes of mitochondria, chloroplasts, or ER where such important metabolic pathways take place. The increased surface area of such an arrangement makes the process that much more efficient as molecules "diffuse" quickly back and forth across the tables and from one table to the next.

To further enhance the experience, I ask one of the middle enzyme actors to drop out. Without this critical step in the process, an intermediate byproduct quickly builds up. This is an analogy for many genetic disorders such as PKU, Tay-Sachs, lactose intolerance...

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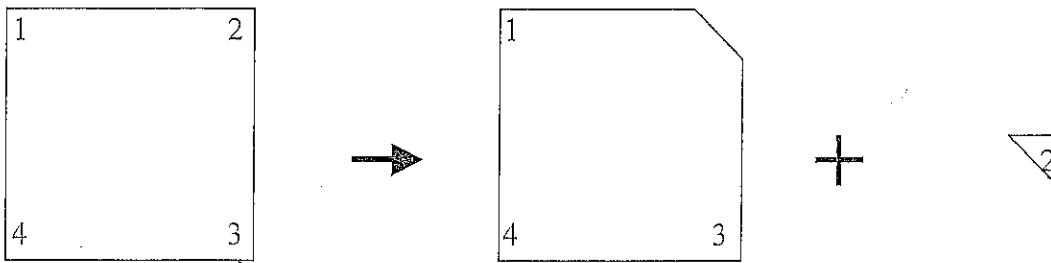
**Enzyme A:** *Hexagon center puncturase*    **Action:** Punch hole in center (need pencil).



Turn this substrate into...                      ...this product.

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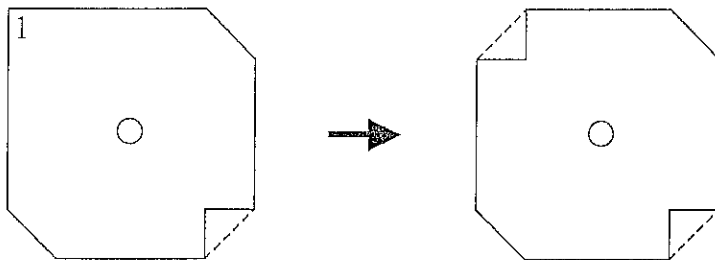
**Enzyme B:** *Square corner-2 decornerase*    **Action:** Cut corner 2 off of the square.



Turn this substrate into...                      ...these products.

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**Enzyme C:** *Punched, 3-folded, corner-1 foldase*    **Action:** Fold over corner 1.

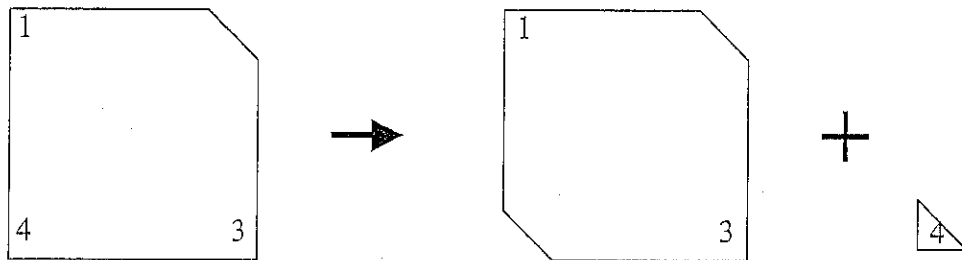


Turn this substrate into...                      ...this product.

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**Enzyme D:** *Pentagon corner-4 decorerase* **Action:** Cut off corner 4 (need scissors).

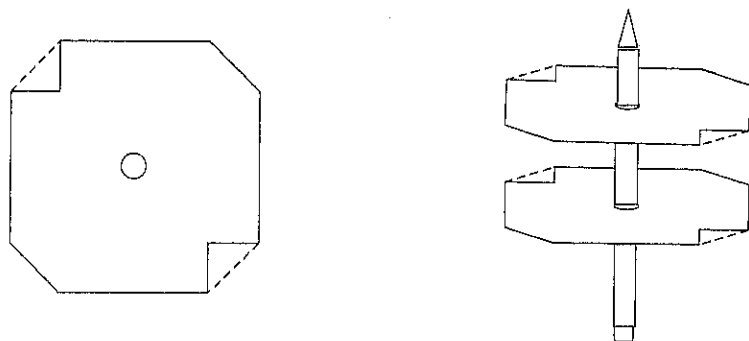


Turn this substrate into...

...these products.

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**Enzyme E:** *Hole-punched octagon polymerase* **Action:** Put octagons on pencil and keep them.

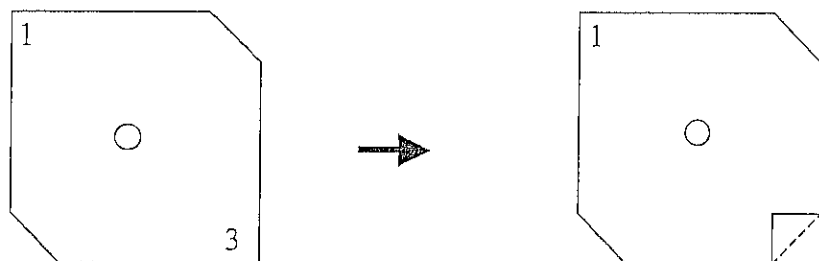


Turn this substrate into...

...this product

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**Enzyme F:** *Punched-hexagon corner-3 foldase* **Action:** Fold corner 3 toward the center.



Turn this substrate into...

...this product

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