The Enzyme Game

Purposes of game: To reinforce information learned about the function of enzymes (breaking down substances into their individual parts), to learn about 8 specific enzymes, to reinforce the fact that enzymes can only work at certain temperatures and pH levels, and (for students in America) to practice using the Celsius temperature scale.

NOTE: This game is meant to be a review game. Prior knowledge is recommended. (You may want to distribute the cards before you play, and let players take a good look at the cards so they understand which cards go together as matches.)

Target age group: 10-16

Number of players: 2 to 4 is best, but up to 6 could be accommodated if necessary

Time needed to play: 4 players can play the game in about 20 minutes. 3 players will take more like 25 minutes and for 2 players allow at least half an hour.

Materials you will need: Copies of the following pattern pages printed onto heavy card stock, paper fasteners (sometimes called "brads"), small washers (if possible, just to make the spinners work better), scissors, glue, and thin cardboard (cereal boxes work well and offer an opportunity to recycle!).


paper fastener

Set up time required: 30-45 minutes, maybe a little more if you want to let the spinners dry before cutting them. (Of course, this does not include any time you spend running to a store to get things copied.)

How to prepare:

1) Copy the pattern pages onto card stock. This can be done with your computer printer if you put card stock into the paper tray. Usually, printers have a print setting option for "heavy paper" or "card stock." (I've used mine without using the special setting and the card stock has still gone through okay). You could also take the digital file to a print shop (chain stores like Office Depot or Staples can do this-- you don't have to go to a special print shop).

NOTE: Print 2 copies of each card page (as indicated on those pages) if you are playing with 2-4 players. If you are playing with 5 or 6 players you might want to make 3 copies of each card page. The fewer cards per player, the less time it will take to complete a game. But you can always play the game more than once!

SECOND NOTE: If you have a large group, consider making multiple copies of the game. The game works best when the number of players is limited to 3 or 4.

2) Glue the spinner patterns onto thin cardboard. If you are using cereal boxes, glue to the blank side. The printed side is too shiny and the glue may not adhere well. Press and flatten and allow to dry for at least 10 minutes. Longer is better, but I have found that I can move to the next step with even a short dry time.

3) Cut out the spinner squares and the circles and arrows. Punch holes at the center dots. I start the holes with the point of a scissor or compass, then use a ballpoint pen to make them larger. Don't make them larger than the head of the paper fastener!

4) Assemble the spinners as shown on the pattern sheet. Use a washer between the spinner at its base. This will allow the spinner to turn more freely. Don't over tighten the paper fastener. You may have to fuss with the spinner a bit to get it to spin well. Just keep the tension loose and then spin it a number of times to "break it in" before using it with the kids.

5) Cut apart the cards. OPTION: You can add extra notes on the cards if you think your players will need extra info. For example, you might want to add on the Fructose card, "Came from glucose." These notes are not necessary, as you can figure this out as you go along, but if you want your players to have extra hints, feel free to add them.

How to play:

The rules of this game are somewhat flexible. This is not to frustrate you or to make things confusing, but rather to allow you to tailor the game to the age, ability, and personality of your players. When I played it with my class, I found that each group had a different idea about what "trade" should mean. I allowed them to determine how to manage their trading as long as everyone agreed to the same rules. This worked out very well and made the game much more cooperative that I had expected, which was a nice surprise. I design my games to have as much interaction between players as possible, and little or no "dead" time in which players have to wait.

1) The object of the game is to get as many complete sets of three as possible. A complete set consists of an enzyme, the substance on which it operates, and the broken down parts. Example: Starch, Amylase, Glucose. (However, you can't lay down a set until you have correct pH and temperature.)

2) Lay out the cards before you start the game and have the players try to find the sets. This way they will know what they are looking for as the play the game.

3) Shuffle the cards and then place them face down not in a stack but in a loose pile so players may choose any card they wish. (This will make discarding easier, also.)

4) Players start with 3 cards. They should have at least 3 cards in their hand at all times. If, after laying down a set of cards, they end up with less than 3, they should draw enough cards so they have 3.

5) All players will move at once. You don't have to take turns in this game. This avoids "dead time" and makes the game a constant buzz of activity, which I have found is the best possible scenario for optimum use of group time. The opening of each "move" is to spin the large spinner. Players can take turns spinning. If it lands on "Draw a Card" everyone draws a card. If it lands on "Discard" then each player choses one of their cards to return to the draw pile. (This allows for more shuffling of the cards during the game, allowing players to get rid of cards they can't use.)

NOTE: If players get a set of three in their hand, they can't lay it down until they spin correct temperature and pH on a "spin turn" (explanation following).

6) Here's the most flexible part of the game--when the arrow lands on "Spin or Trade." You've got some options here. Probably the best way to explain these options is to start with an anecdote.

When I designed the game, I planned that if any player in the game had a set of three they wanted to lay down, they could call out, "Spin," and therefore that turn was devoted to "Spin" and no one could trade. The pH and temperature spinner would be spun. Then, anyone who had a set of three for which those pH's and temp's were good, could then lay it down (put sets face down to avoid any confusion with other cards they might lay on the table). Then, I thought that if no one had a set of three, the "Trade" option would be the default option, and this would mean that each player must choose one of their cards and give it to the player on their right.

Here' what happened in my class: The players wanted to be able to choose for themselves which option they wanted, trade or spin. Those who had sets ready to lay down each got a turn to try to spin the correct pH and temp. (If either temp or pH wasn't suitable, they had to wait and try again next time the arrow landed on "Spin or Trade.") Those who wanted to use the "Trade" option laid out their cards on the table so everyone could see them, then they began to barter for trades. They could see cards they needed and they tried to arrange suitable barters that the other players would agree to. This actually made the players look very closely at not only their cards but also other players' cards and gave them a greater awareness of all the cards. I had not thought of this beforehand! So I allowed this change to the rules. I told the teams that the trades had to be mutually agreeable. If someone refused to trade, then there was no trade. They all agreed. However, in order to persuade the other player to give them a card, they started offering multiple cards in order to get the one card they needed. Another thing I had not predicted! So we had one group that operated their own little "economy," excitedly arranging elaborate trade deals with each other. They had a lot of fun and paid great attention to what cards they had. It worked very nicely and they all had a lot of fun.

As long as everyone playing agrees to the rules and everyone plays by those rules, then the game is fair.

So you need to decide what rules you will use for the "Spin or Trade" option. If you want to make it a "blind" trade where each player hands a card to the player on their right, then have them keep their hands a secret from the other players. If you want to use the option where players are allowed to barter, they will need to lay

out their cards so everyone can see them. You know your players and can choose the option that is best for your situation.

If a situation comes up for which a rule is not given here, just supervise the team as they decide on how to make a rule to cover that situation. If there is disagreement, the adult supervisor gets to decide what the new rule will be.

Remember, the whole point of the game is to reinforce leaning about enzymes, not to get sets of 3 and win. To increase learning (especially with players in the 10-13 age bracket), the adult supervisor can sit with the team and add comments at appropriate points. For example, I had opportunities to help players by getting them to look closely at the pictures, asking them what the hexagons and pentagons represented. I also refreshed their memory about the difference between cellulose and starch and told them to look carefully at the glucose "flags" to see which way they are oriented. This gave me the opportunity to do tiny bits of individual tutoring at various points.

7) The game is over when all the cards in the draw pile are gone. Whoever has the greatest number of completed sets on the table (the ones they spun correct pH and temp for) wins. Sets still in their hands can be used as tie-breakers.

But remember, everyone wins if they learned about enzymes!!

OTHER GAMES YOU CAN PLAY WITH THESE CARDS:

1) You can play a standard "Go Fish" type game where players try to get sets of three by either asking other players for cards or drawing from the draw pile.

2) A standard "memory" card game where the cards and laid out and players turn cards over trying to get matches. In this case, players would get to turn over three cards on each turn instead of just two.

SUPPLEMENTAL NOTES

The drawings of glucose:
There are quite a few ways to draw glucose. You can draw it as a ball and stick model, a space-filling model, a chemical formula written with only letters, a diagram of letters connected with sticks, a plain hexagon, or a hexagon with a flag (and there may be others). I have chosen the hexagon with a flag because this is easy to draw yet facilitates the learning of an essential aspect of organic chemistry-- the fact that when glucose molecules line up a certain way (alpha links) they form highly-digestible starch, yet when those same exact molecules line up another way (beta links) they form indigestible cellulose. In my classroom I showed paper models of starch and cellulose and had a little paper enzyme "key" that would only fit between the starch glucoses, not the cellulose ones.

Glucose Isomerase:
This enzyme does not function at body temperature, but at the temperature of a very hot drink. Therefore, it cannot possibly be a molecule that the human body (or any other animal body) makes. This enzyme is used in the food industry to turn glucose into fructose. Fructose has some chemical qualities that the other sugars do not. Professional bakers prefer to use fructose for some types of recipes. Food chemists get this enzyme from micro fungi (yeasts).

Pectinase:
This enzyme is another that is not made by human bodies. It is made by fungi (yeasts) and is used by the food industry in applications where it is necessary to break down pectin, a structural polysaccharide found in plants. Fruit contains a lot of pectin, and pectinase is used make juice extraction more efficient. Pectinase is also used in the wine industry to break down pectin that may make the wine cloudy. Plants use a form of pectinase to dissolve the connections between the cells that keep the leaves on the tree. The connections dissolve and the leaves fall off the tree. Pectinase functions most efficiently at the temperature of a hot summer day.

Amylase:
This is found in saliva. If you put a starchy cracker in your mouth you can taste the starches being turned into sugars; the cracker will begin to taste sweet.

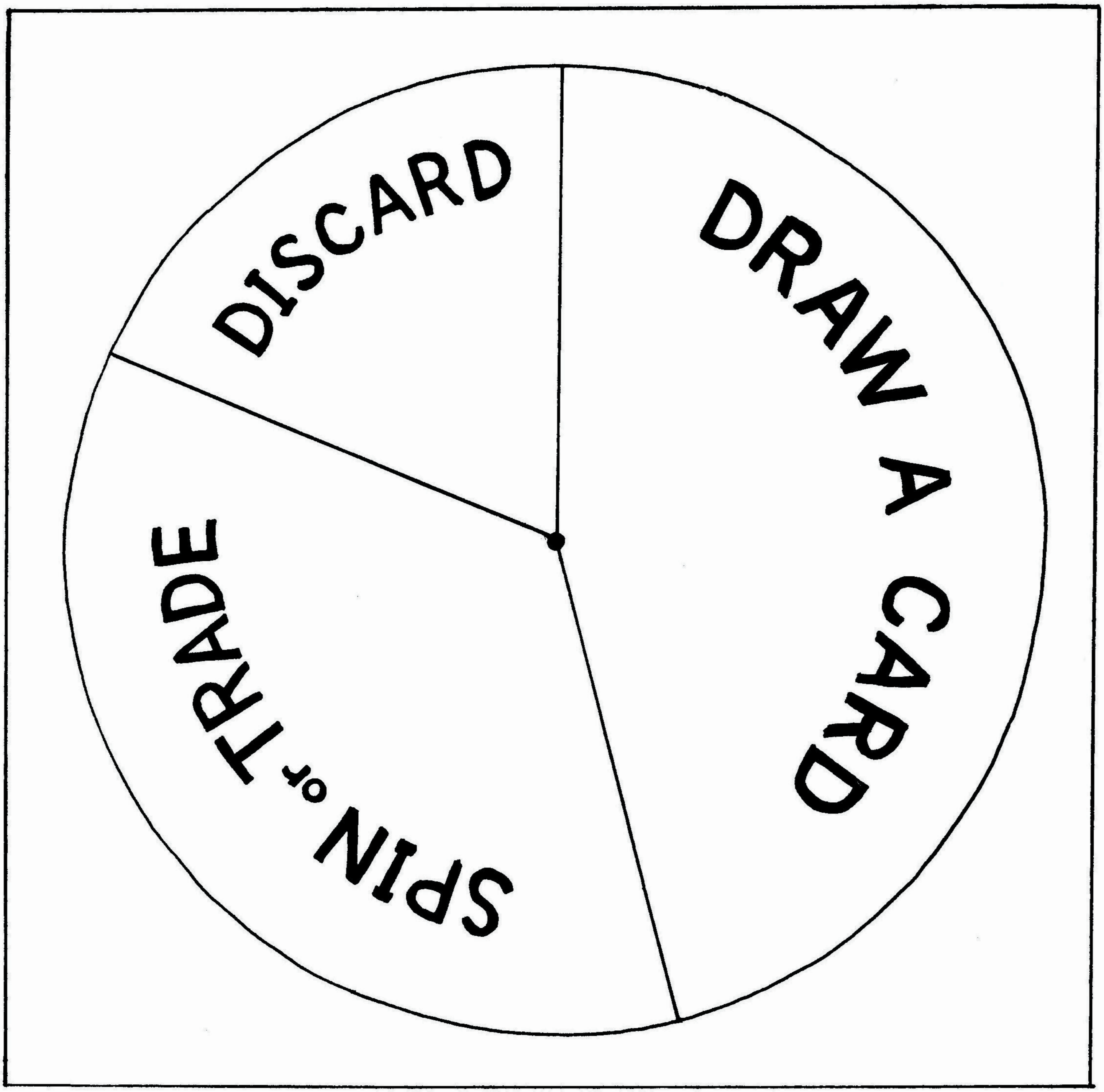
Lipase:
There are many types of lipases. Some are extracted from microorganisms and used in the food industry. This one is made by the human pancreas. Notice the pH necessary for it. Lipase can't function in the highly acidic stomach. The pH of the intestines is much higher (less acidic) so the lipases don't get added to the food until after it passes out of the stomach.

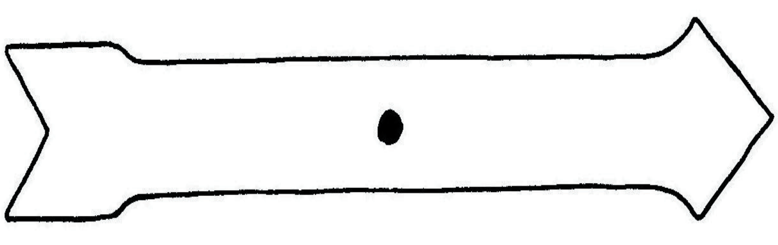
Pepsin:
Human stomachs produce hydrochloric acid which has a pH of less than 2. This is perfect for the functioning of pepsin!

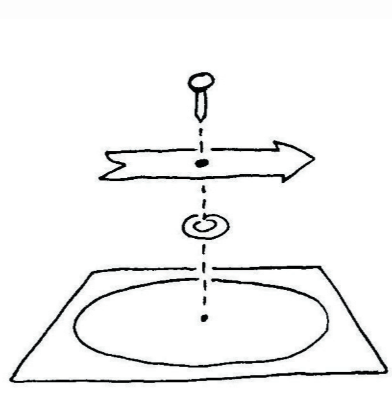
Lactase:
People whose bodies stop producing this enzyme become "lactose intolerant." They lack the enzyme needed to break apart lactose. Dairies have found a way to put this enzyme into milk, making "pre-digested" milk (such as Lactaid). Milk that has had lactase added to it tastes a bit sweeter than regular milk because the lactose has been broken down into glucose and galactose, which taste sweeter than lactose.

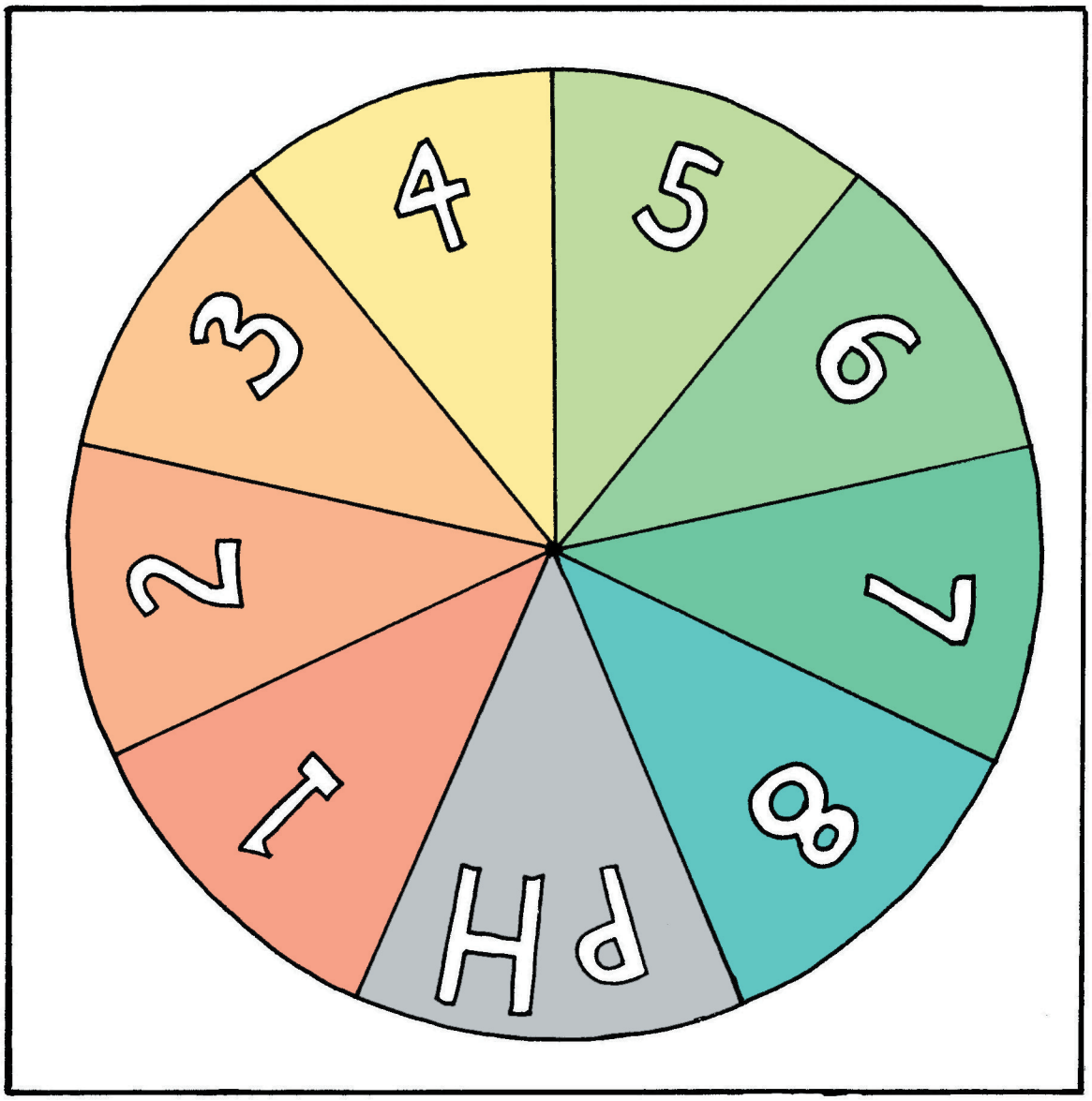
Sucrase:
This enzyme is also called "invertase" and is used to produce "invert syrup" which is used extensively by professional bakers and food companies because this form of sugar has chemical properites that give the baked goods a smooth and moist texture.

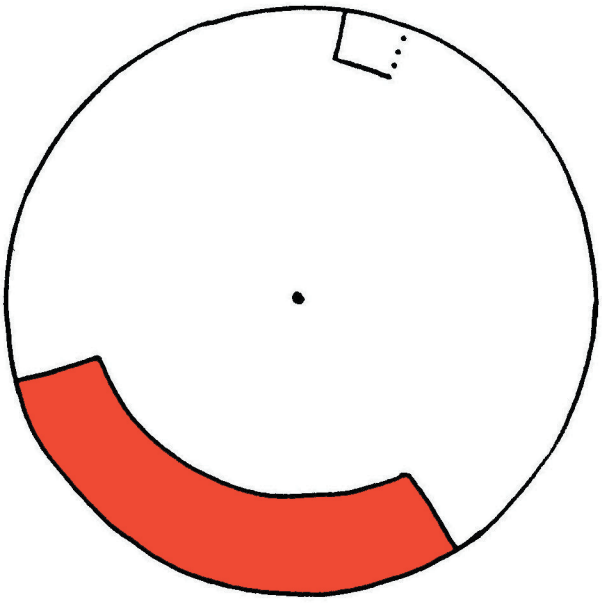
Fructose:
This is the sugar found in fruits, and is considered to be the sweetest of all the sugars. Bakers use a dried and powdered form of fructose in their recipes.


DISCARD
DRAW A CARD
SPIN or TRADE

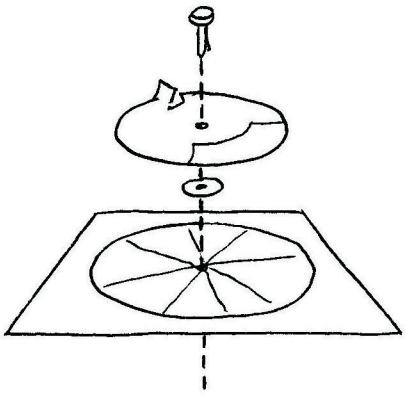




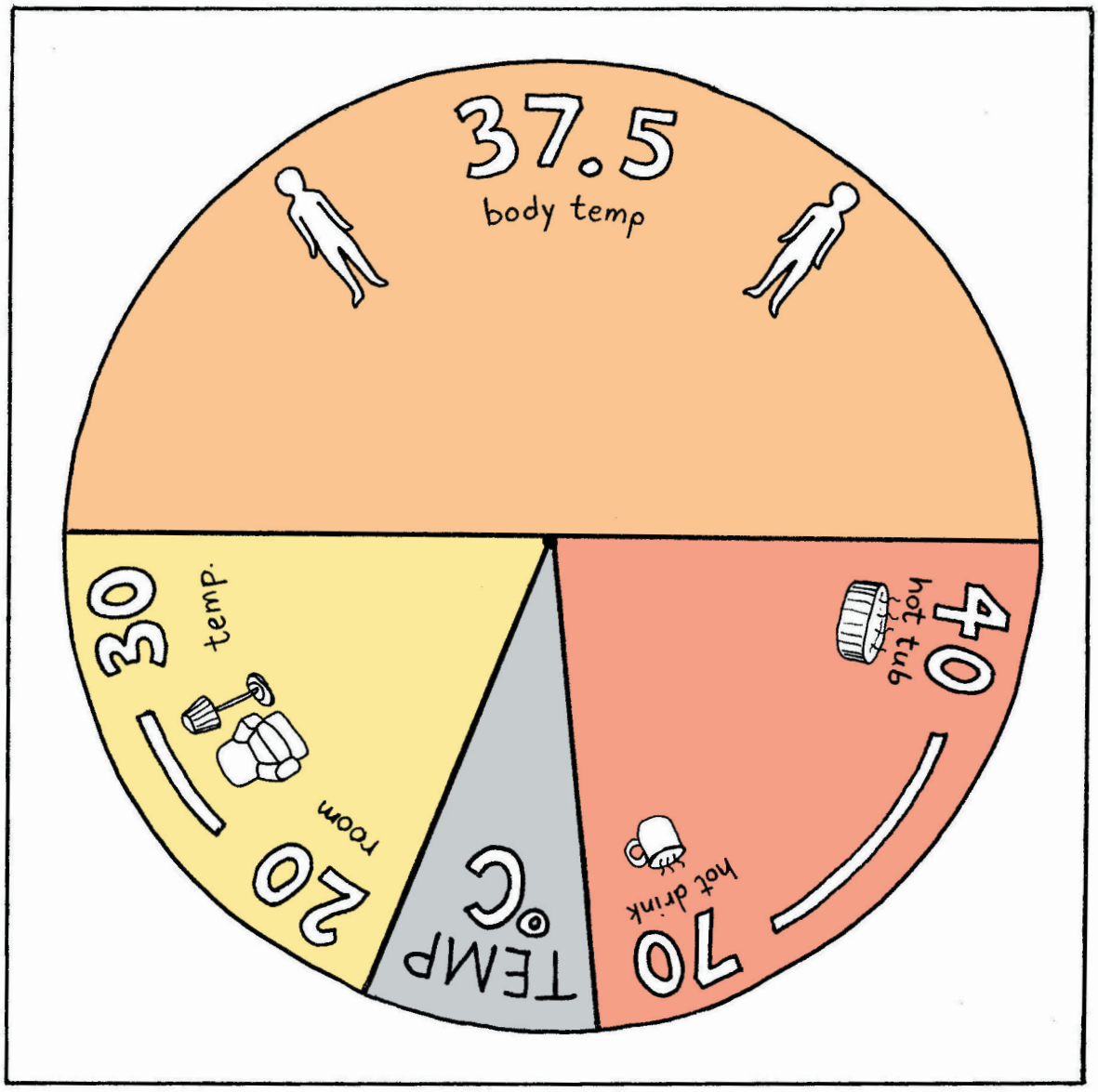


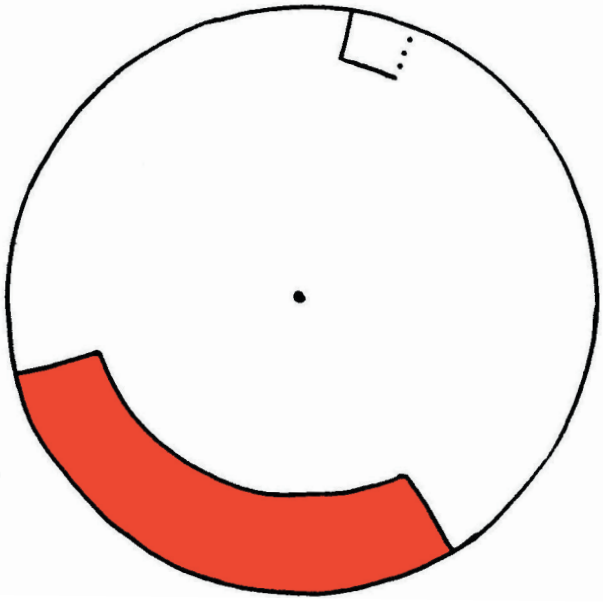


The red bar replaces a pointer. Any wedge (even a small portion of it) that touches the red bar is okay.



NOTE: Cut the notch on the wheel and fold it up to make a tab that can be used to flick the spinner.





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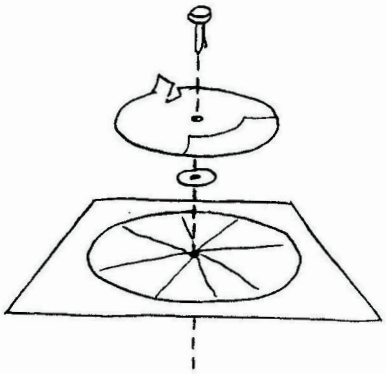
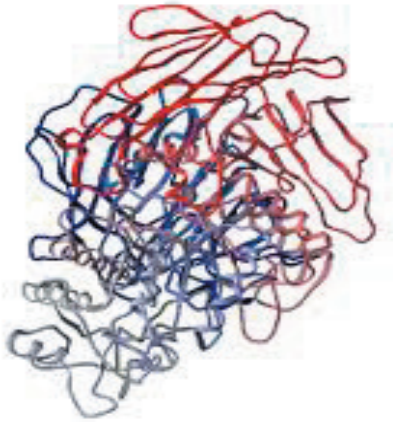


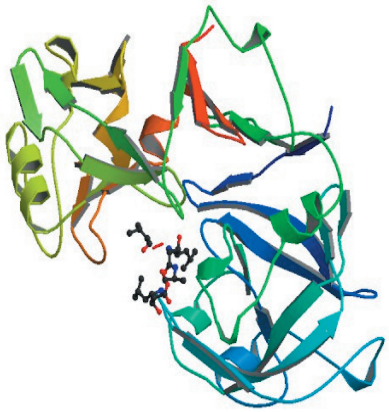
NOTE: Cut the notch on the wheel and fold it up to make a tab that can be used to flick the spinner.

SUCRASE



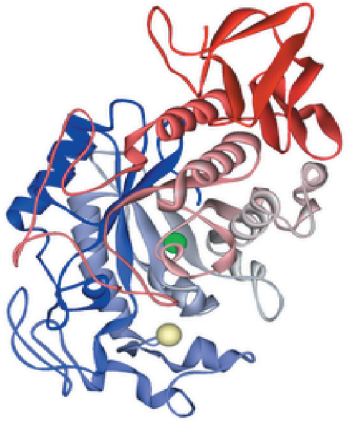
Breaks apart: **sucrose**
Works best at **pH 6**
Most efficient temp: **37.5° C**

PEPSIN



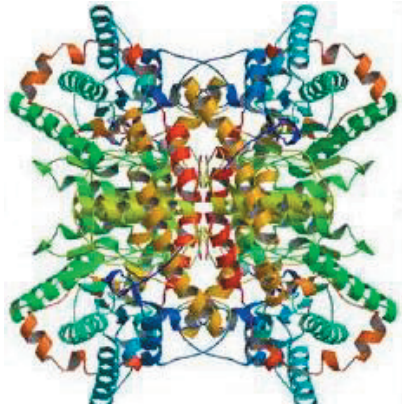
Breaks apart: **proteins**
Workds best at **pH 1-3**
Most efficient temp: **37.5° C**

AMYLASE



Breaks apart: **starch**
Works best at **pH 6-7**
Most efficient temp: **37.5° C**

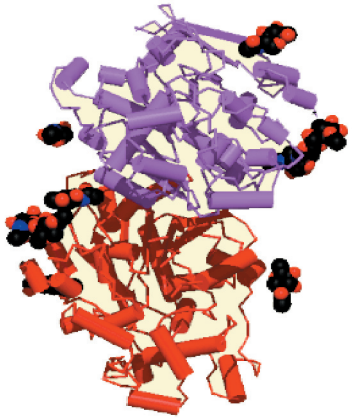
GLUCOSE ISOMERASE



Changes glucose to fructose
Works best at **pH 7-8**
Most efficient temp: **60-70° C**

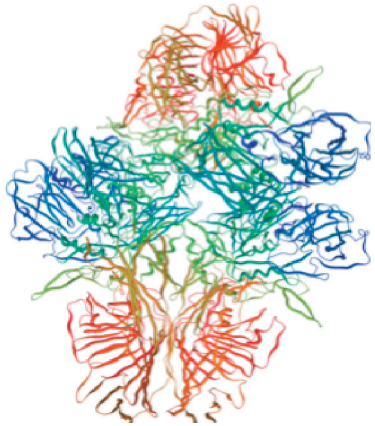
LIPASE

(Pancreatic lipase)



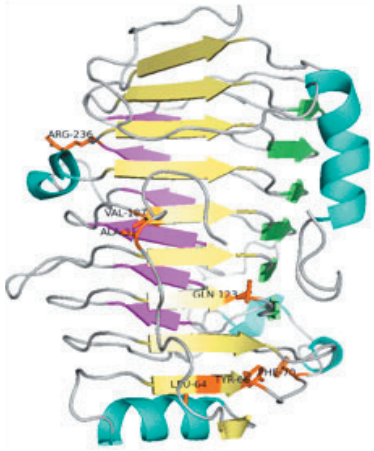
Breaks apart: **triglycerides**
Works best at **pH 8**
Most efficient temp: **37.5° C**

LACTASE



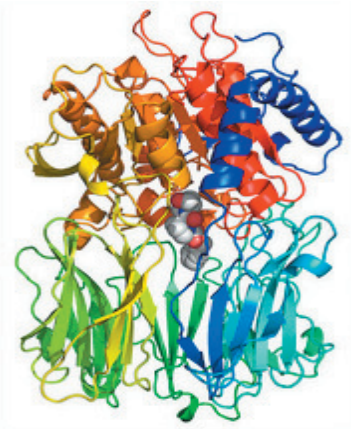
Breaks apart: **lactose**
Works best at **pH 8**
Most efficient temp: **37.5° C**

PECTINASE



Breaks apart: **pectin**
Works best at **pH 4-5**
Most efficient temp: **30-40° C**

CELLULASE



Breaks apart: **cellulose**
Works best at **pH 5**
Most efficient temp: **40-50° C**

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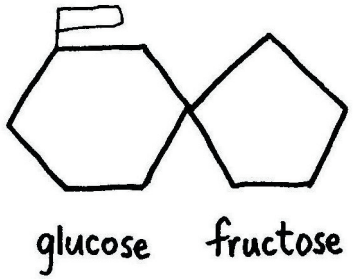
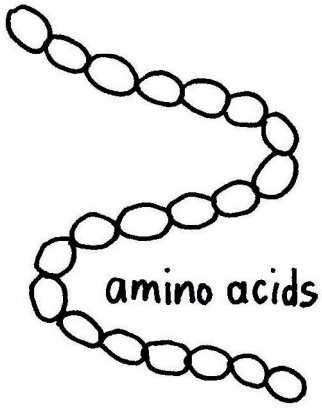
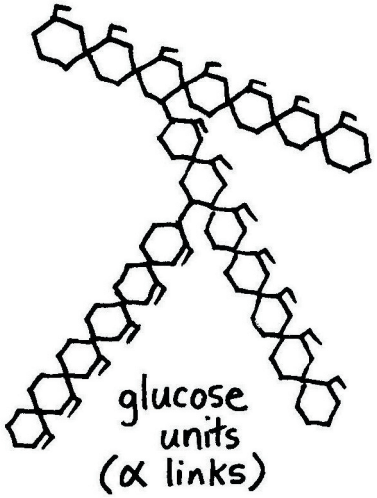
Sucrose



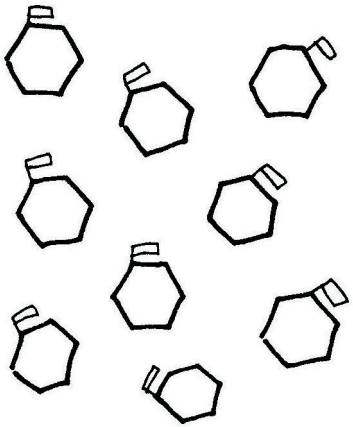
Proteins



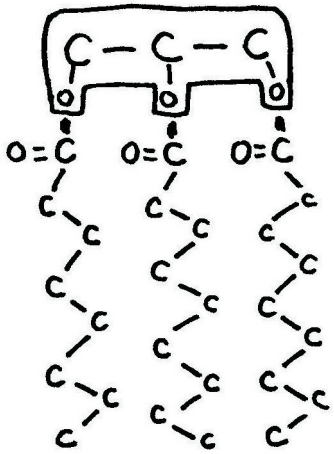
Starch



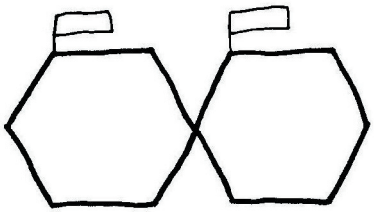
Glucose



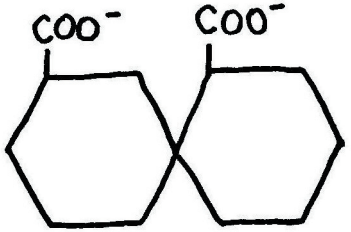
Lipids (triglycerides)



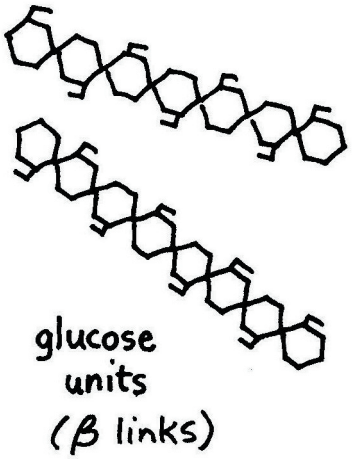
Lactose



Pectin



Cellulose



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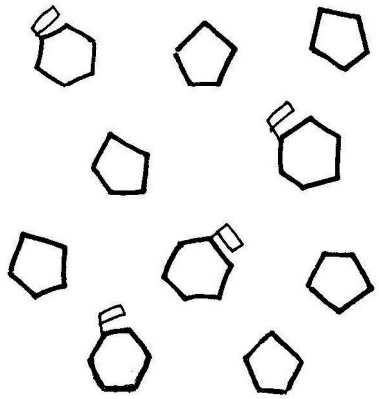
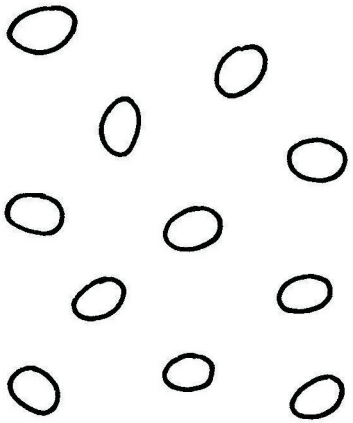
Glucose and fructose

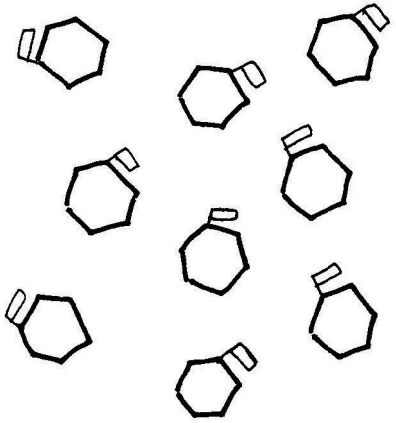


(glucose + fructose = sucrose)

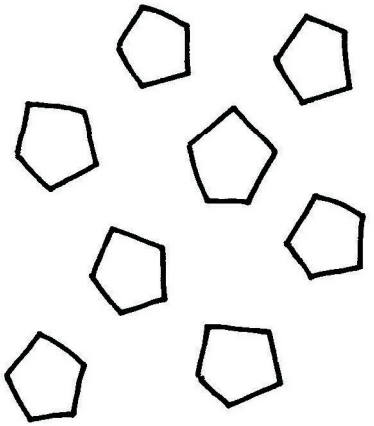
Amino acids



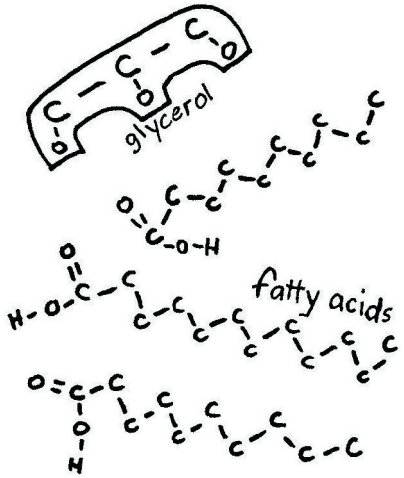
Glucose



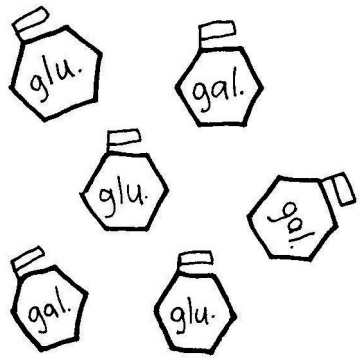
Fructose



Glycerol and fatty acids

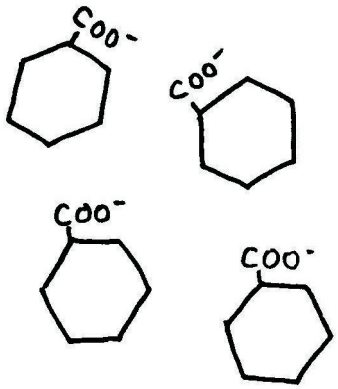


Glucose and galactose

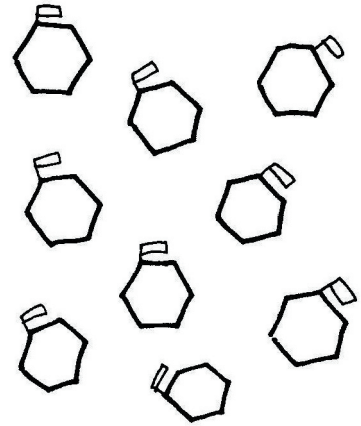


(glucose + galactose = lactose)

Pectic acid sugars



Glucose



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