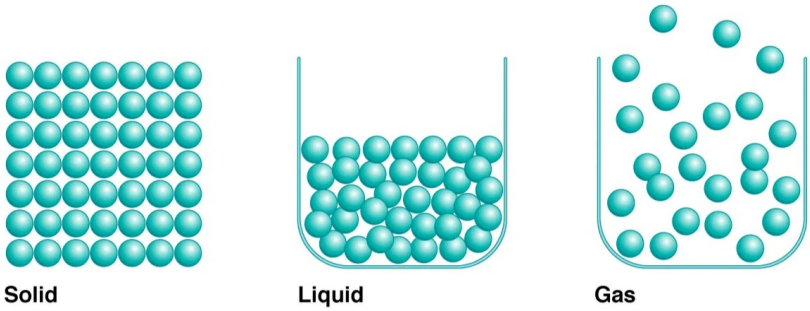
States of Matter: Solid, Liquid, and in Between

- Everything is made of **matter**
- All matter has **mass** and takes up space (**volume**)
- Matter can be in different phases: solid, liquid, gas, and some in between.



Part 1: Solids

1. Gently press down on the jello with your finger. The jello will **deform** (change shape).
What does it do when you let go?

springs back stays deformed fractures

Fill in the blanks with 'more' or 'less":
The _____ you push, the _____ the jello deforms.

2. Push a toothpick down into the jello so that it sticks out vertically.
What happens if you push the tip of the toothpick gently sideways and let it go?
Deformation then springing back permanent deformation fracture

Now push the toothpick sideways further (until it is almost horizontal). What happens?
Deformation then springing back permanent deformation fracture

3. On a different part of the jello, press down with your finger and with the sharp tip of a chopstick, pressing roughly the same amount.

Discuss: is it easier to fracture the jello with your finger or with a chopstick? Why? What is different between the two?

- A **solid** object has a preferred **shape**
- Applying force will make the solid change shape (deform).
  - Small force → **elastic deformation**. Object springs back when force removed.
  - Larger force → **fracture** (object breaks)
  - The same force concentrated on a smaller area causes more deformation or fracture of the material.

Part 2: Liquids

1. Try pressing down the plunger of an empty syringe.

When you release the plunger, does it spring back? Yes / No

2. Plug the syringe tip with your finger. Try pressing the plunger on the empty syringe again.

Are you able to push the plunger down some amount? Yes / No
When you release the plunger, does it spring back? Yes / No

Discuss: Why is the syringe resisting your push? What is inside it? Can that material change its volume when pressed?

3. Fill the syringe with water and plug its end with your finger. Try to press down the plunger again.

Are you able to press the plunger down as you did when the syringe was empty? Yes / No

Discuss: Why is it much harder to press down the plunger? Can the water in the syringe change its volume?

- **Volume** is measured in "milliliters" (mL)

4. Pour 40 mL of water into the graduated cylinder.
5. Pour the water into a bowl.
Did the liquid change its shape? Yes / No

6. Pour it back into the cylinder.
Did the liquid change its volume? Yes / No

4. Pour the water back into a bowl again. Sprinkle some pepper on the surface (to help see what the water is doing). Try making a 'rip' in the water.

Discuss: what does the water do when you push or pull on it? Is it possible to rip or fracture the water? When you stop pushing, do all parts of the water spring back to their original place? (look at where the pepper goes)

- A **liquid** maintains a fixed **volume** but no fixed shape.
- Applying a force makes the liquid flow. When the force is removed the liquid stops moving but does not spring back.

Part 4: Viscoelastic Materials

1. Make "Oobleck" by mixing the following in a bowl:
- 5 tablespoons cornstarch
- 35 mL water (measure with the graduated cylinder)
If needed add a little more water or a little more cornstarch

2. Push on the oobleck with your finger.

Discuss: How does the oobleck behave if you push on it slowly? What if you push hard and fast?

Can you roll a marble rapidly over its surface?
What happens to the marble if it stops rolling?

3. Pull through the oobleck with a chopstick.

What happens when you pull slow? oobleck fractures or oobleck flows
What happens when you pull fast? oobleck fractures or oobleck flows

Can you form the oobleck into a ball by rolling it between your hands?
What happens to the oobleck in your hand when you stop rolling?

Discuss: In what ways is the oobleck like a solid? Like a liquid?

- A **viscoelastic material** has properties of both solids and liquids. It will flow and change shape when pushed slowly, but will bounce back and rip when pushed quickly.