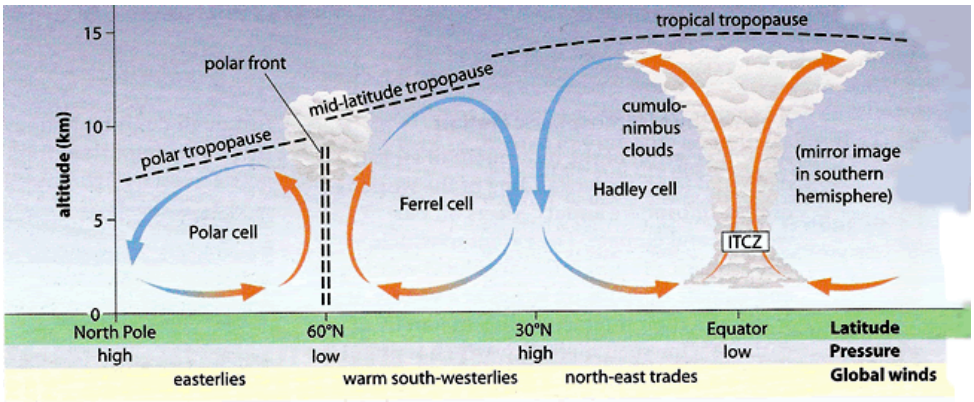
Atmospheric Circulation's Influence on Biomes

Name: _____

Objective: Determine Earth's main atmospheric circulation patterns and analyze their effects on global biomes.



Background:

The Earth's major biomes—like rainforests, deserts, and tundra—are shaped by patterns of temperature and precipitation, which are largely controlled by global atmospheric circulation. This circulation is driven by uneven heating of Earth's surface: the equator receives more direct sunlight than the poles, warming the air and causing it to rise. As warm, moist air rises at the equator, it cools and releases precipitation, creating lush tropical rainforests near the equator.

This rising air forms part of a circulation system called the **Hadley Cell**, which extends from the equator to about 30° latitude. As the air moves away from the equator and descends around 30°, it becomes dry, warming as it sinks and creating the world's deserts—like the Sahara and Australian outback. Near the equator, the **Inter-Tropical Convergence Zone (ITCZ)** marks the area where this warm, moist air converges and rises. The ITCZ plays a critical role in global precipitation patterns and supports the high biodiversity found in tropical rainforest biomes.

Between 30° and 60° latitude lies the **Ferrel Cell**, where air rises again around 60°, generating precipitation and supporting temperate forests and taiga biomes. The final circulation pattern, the **Polar Cell**, operates from 60° to the poles, where air again sinks, creating cold, dry conditions and tundra biomes.

Together, these three circulation cells in each hemisphere (Hadley, Ferrel, and Polar) move heat and moisture around the globe. The rising and sinking of air, along with Earth's rotation, influence where rain falls, where deserts form, and ultimately, where different ecosystems can thrive.

Pre-Lab Questions:

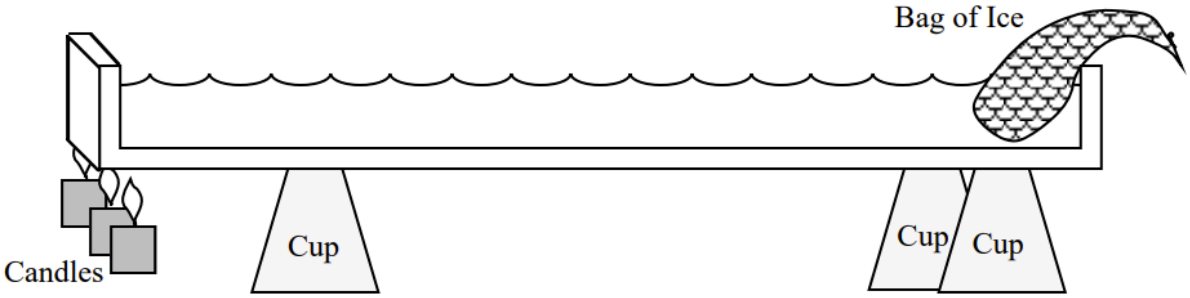
1. What two main factors determine the type of biome found in a region, and how are these influenced by atmospheric circulation?

2. Why might two places at the same latitude (e.g., 30°N) have very different climates and biomes? *(What other factors, in addition to latitude, influence local climate?)*

3. Give the latitude range for each of the three atmospheric cells:
   a. Hadley cell:
   b. Ferrel cell:
   c. Polar cell:

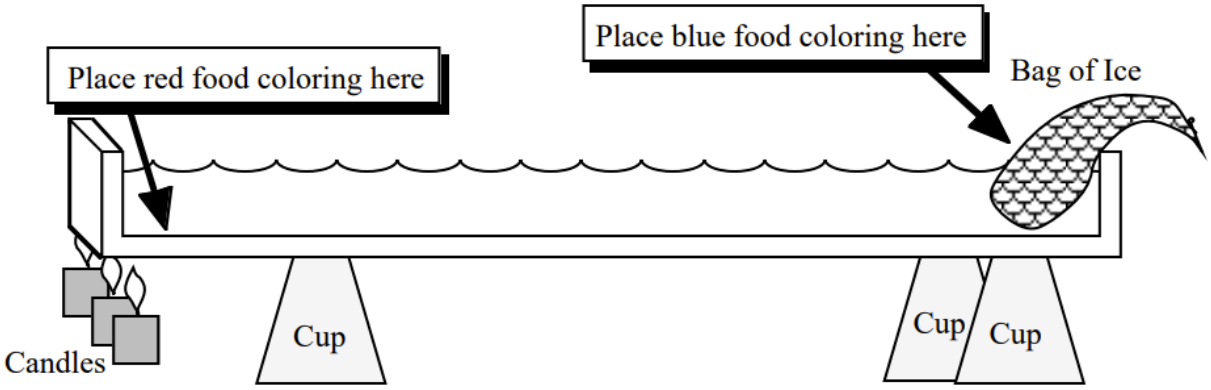
PART ONE: Temperature and Direction of Air Flow Lab

1. Fill the cake pan two-thirds full with water.
2. Place the three Styrofoam cups, upside down on the lab table, forming a triangle that the cake pan can rest on and remain stable. Place the cake pan on the three cups.
3. Light the candles and place them in a line underneath one end of the cake pan. This end of the cake pan represents the warm equatorial regions of the earth.
4. Put some ice in the large Ziploc bag and place the bag of ice in the cake pan on the side opposite the candle. This end of the cake pan represents the cold polar regions of the earth. The set up should look like the diagram below.



- On the diagram above, use arrows to show any (invisible) motion of the water that you think may be occurring, due to the temperature differences across the cake pan.
- EXPLAIN why you think the water is moving this way.

5. After the cake pan has rested undisturbed for a few minutes, place several drops of blue food coloring in a line along the bag of ice, near where it touches the water (see diagram below).
6. Carefully place several drops of red food coloring into the water in a line along the BOTTOM of the cake pan directly above the candles (see diagram below).
7. Watch the motion of the colored water and answer the following questions.

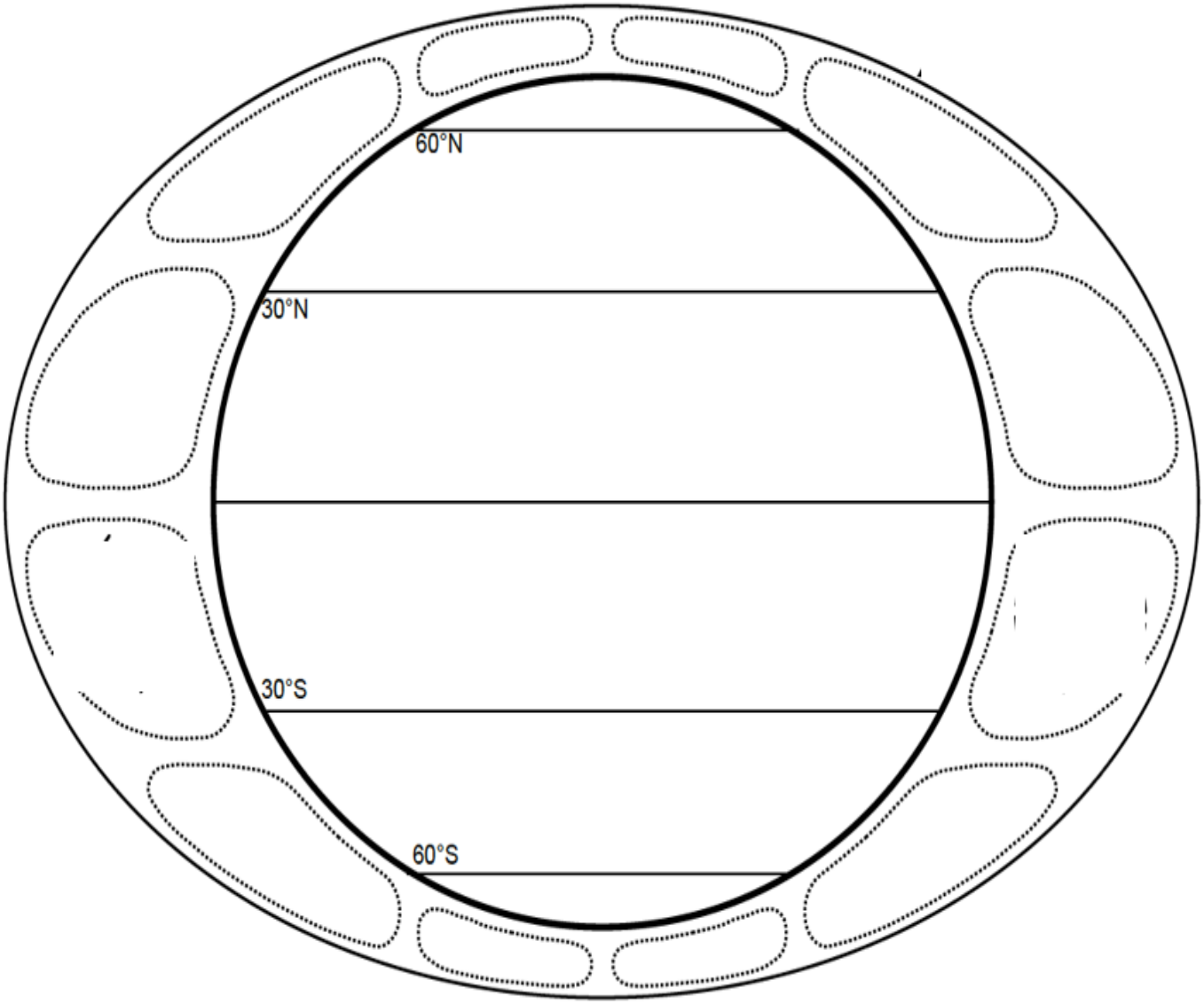


- On the diagram above, use arrows and colored pencils to show the motion of the red and blue water in the cake pan.
- Did the motion you observed match your predictions from the first diagram? If not, explain why the motion that you DID observe occurred.

PART TWO: Label the Diagram

Refer to the diagram of global atmospheric circulation cells. Label the following on the diagram:

- Equator (0°) (also label this the ITCZ)
- Tropics (approximately 30°N and 30°S)
- Mid-latitudes (approximately 60°N and 60°S)
- Poles (90°N and 90°S)
- Hadley, Ferrel, and Polar cells
    - General wind direction in each cell (use arrows)
    - Areas of rising air (Trace the line in red to show warmer air)
    - Areas of sinking air (Trace the line in blue to show colder air)
- Locations of major biomes: tropical rainforests, deserts, tundra, and polar ice
- Color code: Green = warm, moist; Yellow/Brown = dry; Purple = cold.



PART THREE: Analysis Questions

1. What is the latitude of Cary, NC? _____ Place a ⭐on the diagram above to represent Cary's location.

2. Which of the atmospheric cells is influencing Cary's climate?

3. What causes warm air to rise at the equator?

4. What happens to air as it rises in the atmosphere?

5. What type of weather is typically found near the equator, and why?

6. What are Hadley Cells and how do they influence the formation of deserts?

7. Where are the Ferrel Cells located and what types of biomes do they support?

8. Describe the general conditions at the poles and name the circulation cell that operates there.

9. Tropical rainforests are located near the equator, while deserts are often found at 30° latitude. Using your knowledge of atmospheric circulation, explain why this pattern occurs.

10. Consider a city located at approximately 45°N latitude. Predict its likely biome and justify your answer using the concept of the Ferrel cell and prevailing wind patterns.

11. Suppose global temperatures rise significantly. Predict how the boundaries of the Hadley, Ferrel, and Polar cells might shift, and describe one possible effect on a specific biome.

12. If the Inter-Tropical Convergence Zone (ITCZ) were to shift northward permanently, what could be the impact on rainfall and agriculture in regions just north and south of the equator?