

When stars are viewed through a telescope, they typically appear as bright points of light without any apparent size or structure. However, there are some objects in the sky that, when viewed through a telescope, look “fuzzy” and cloudlike. Some of these objects, like those shown in the *Hubble Space Telescope* image to the right, are actually galaxies (containing billions of stars) that are much farther from us than the individual stars we see in the night sky.



## Part I: Applying Hubble's Classification Scheme

- Using the images of galaxies provided on the inside back cover of your *Lecture-Tutorial* book, sort these galaxies (using *Hubble's* categories) as being either an elliptical or a spiral galaxy. Use the table below to record your results. Try to find patterns in terms of shape, size, color, or any other distinct features that help in sorting the galaxies.

<b>Hubble's Categories</b>	<b>Galaxy ID Numbers</b>	<b>Defining Characteristics</b> (Describe the characteristics that you used to distinguish one class of galaxy from the other)
Elliptical		
Spiral		

**Part II: Understanding the Types of Galaxies**

In Part I you classified the galaxies into different categories according to their appearance, or *morphology*. We will now investigate what a galaxy's morphology can tell us about its physical characteristics. These physical characteristics include: (a) the ages of the stars in the galaxy; (b) the presence or absence of dust in the galaxy; and (c) the presence or absence of gas and star formation. Keep in mind that these properties are linked together in a physical way. The objective of this activity is for you to learn how these characteristics are related to galaxy classification and morphology.

**The Ages of Stars:**

- 2) Which of the galaxies appear to be mostly red? (Note: The word "red" is used to also include the colors orange and yellow.) Record the number and classification (elliptical or spiral) of each galaxy. Why do you think these galaxies appear red?
  
- 3) Which of the galaxies appear to be mostly blue? Record the number and classification (elliptical or spiral) of each galaxy. Why do you think these galaxies appear blue?
  
- 4) Which types of galaxies appear to have many young stars: elliptical, spiral, or both? Explain your reasoning.
  
- 5) Do the galaxies that you identified in Question 4 also contain old stars? Explain your reasoning.

**Dust in Galaxies:**

Besides stars, galaxies sometimes also contain dust. This dust produces dark bands across, or patches in, the galaxy.

- 6) Which of the galaxies show evidence of dust? Record the number and classification (elliptical or spiral) of each galaxy.

## Gas and Star Formation in Galaxies:

In addition to stars and dust, galaxies may also contain gas.

- 7) Would you say that a galaxy that is experiencing active star formation contains little or abundant gas? Explain your reasoning.
  
  
  
  
  
  
  
  
  
  
- 8) Which type of galaxy (elliptical or spiral) would have abundant gas available? Explain your reasoning.
  
  
  
  
  
  
  
  
  
  
- 9) Which type of galaxy (elliptical, spiral, both, or neither) is likely to contain both O-spectral type stars as well as M-spectral type stars? Explain your reasoning.
  
  
  
  
  
  
  
  
  
  
- 10) Which type of galaxy (elliptical, spiral, both, or neither) is likely to contain many M-spectral type stars but very few (if any) O-spectral type stars? Explain your reasoning.
  
  
  
  
  
  
  
  
  
  
- 11) Which type of galaxy (elliptical, spiral, both, or neither) is likely to contain only O-spectral type stars? Explain your reasoning.

12) Consider the discussion among three students about a galaxy that appears red.

- Student 1:** *Because there is mainly red light in this galaxy and no blue light, I think that only small, red stars formed in this galaxy and not any big blue ones.*
- Student 2:** *I disagree; it's just that blue stars don't last very long. I think the blue stars that may have been there in the past have already evolved into red giants, so the galaxy looks red due to the light from all the red giants.*
- Student 3:** *Wait a minute; I think you are both wrong. I thought that both blue stars and red giants live short lives, so they should both be gone. I think that all the blue stars that formed early on have evolved into the red stars that are there now. So the galaxy appears red because it's full of a lot of old, red stars that used to be the blue stars.*

Do you agree or disagree with any or all of the students? Explain your reasoning.

13) *Hubble* imagined the tuning fork diagram (shown at right) as representing an evolutionary sequence for galaxies, with galaxies starting off as elliptical and developing more structure over time. Do you think *Hubble's* proposed evolutionary sequence is correct? Why or why not?

