Names: _____ _____

_____ _____

Grade	

Galaxies

What does man love more than life,

Fear more than death or mortal strife,

What the poor have, the rich require,

and what contented men desire,

What the miser spends and the spendthrift saves

and all men carry to their graves?

What is it?

_____

Pre-Lab Quiz:

Record you team's answer as well as your reasonings and explanations.

1.
2.
3.
4.
5.

Part 1: Hubble's Tuning Fork

1. Galaxies can be broadly classified into five main types: Elliptical, Lenticular, Spiral, Barred Spiral, and Irregular. Describe how to identify each type of galaxy.

Galaxy Type	How to Identify
Elliptical (E)	
Lenticular (S0/SB0)	
Spiral (S)	
Barred Spiral (SB)	
Irregular (Irr)	

2. Irregular galaxies include small dwarf galaxies as well as larger galaxies like those shown on the website. How do these larger irregular galaxies form?

3. Spiral galaxies can sometimes be difficult to distinguish from Lenticular galaxies. **When** and **why** is this the case?

4. Barred and normal Spiral galaxies are further subdivided into three subtypes (a, b, and c). How are these subtypes related to the spiral arm morphology, the bulge-to-disk ratio, and the color?

5. Elliptical galaxies are further divided into subtypes spanning 0 – 7. What do these subtypes indicate?

6. Why might the Elliptical subtypes not represent the actual shape of the Galaxy?

7. Using the provided images, classify each galaxy onto Hubble's Tuning Fork.

Galaxy	Hubble Type
LMC	
M81	
NGC 474	
M33	
M87	
NGC 4477	
NGC 7049	
NGC 4394	
NGC 5866	
M110	
M85	
NGC 1365	

Part 2: The Milky Way Galaxy

1. Draw edge-on and face-on schematics of the Milky Way. Indicate where the Sun is located on each and label the two prominent spiral arms (if applicable).

2. What Hubble type would you assign the Milky Way? Explain your answer.

3. How vast is the Milky Way? To get an idea, look at the GAIA 3D Star Map, which includes about 2 million of the nearest stars. Zoom in until you see Saturn's orbit, then look around and write down some of your thoughts.

4. Describe two ways astronomers can estimate the mass of a galaxy.

5. The Milky Way, as well as most other galaxies, is thought to be surrounded by a dark matter halo. Why have astronomers come to this conclusion?

Part 3: Galaxies in the Universe

1. When plotting brightness against color, galaxies tend to cluster into two regions: a Red Sequence and a Blue Cloud. What type of galaxies occupy each region?

2. On average, how does the luminosity and mass of the red galaxies compare to the blue galaxies?

3. Spiral arms are regions of increased gas density (like a traffic jam), which leads to star formation. In the blue and UV filters these arms are quite distinct (because of the newly formed O and B stars), but at longer wavelengths the arm structure fades into the disk.

When such galaxies start to run of out gas, how will the appearance of the galaxy change over time? Can you explain this change in terms of the Hubble types?

4. What are the largest gravitationally bound objects in the Universe?

5. Emission lines (like Hα) in most galaxy spectra are redshifted, meaning that they are moving away from us. The Andromeda Galaxy, however, is one of the few that has blueshifted emission lines – meaning we are on a collision course.

Make some educated guesses as to what implications this has for our galaxy's morphology. Will its Hubble type change, and if so, what type do you think it will become? **Do NOT watch the video yet!**

6. Watch the simulation showing the interaction of these two galaxies and compare what you observed with your answer to question 5.

7. Giant Elliptical Galaxies, like M87, are the most massive galaxies in the Universe and are found at the center of large galaxy clusters. How do these enormous galaxies form?

Part 4: Observing the Night Sky

1. Find the following objects in the Night Sky and point them out to your TA.

Object	Type	Representation	TA
Aquila	Constellation	Eagle	
Bootes	Constellation	Herdsman	
Cassiopeia	Constellation	Queen of Ethiopia	
Corona Borealis	Constellation	Dionysus' Crown	
Draco	Constellation	Dragon	
Hercules	Constellation	The Greek Hero	