

## Galaxies (Question References)

Paragraph 1 Astronomers classify galaxies into three major categories.

### Spiral Galaxies

- 2 Like the Milky Way, other spiral galaxies also have a thin disk extending outward from a central *bulge* (Figure 1). The bulge itself merges smoothly into a *halo* that can extend to a radius of over 100,000 light-years. Together, the bulge and halo of a spiral galaxy make up its **spheroidal component**, so named because of its rounded shape. Although no clear boundary divides the pieces of the spheroidal component, astronomers usually consider stars within 10,000 light-years of the center to be members of the bulge and those outside this radius to be members of the halo.
- 3 The **disk component** of a spiral galaxy slices directly through the halo and bulge. The disk of a large spiral galaxy like the Milky Way can extend 50,000 light-years or more from the center. The disks of all spiral galaxies contain an *interstellar medium* of gas and dust, but the amounts and proportions of the interstellar medium in molecular, atomic, and ionized forms differ from one spiral galaxy to the next. Spiral galaxies with large bulges generally have less interstellar gas and dust than those with small bulges.
- 4 Not all galaxies with disks are standard spiral galaxies. Some spiral galaxies appear to have a straight bar of stars cutting across the center, with spiral arms curling away from the ends of the bar. Such galaxies are known as *barred spiral galaxies*.
- 5 Other galaxies have disks but do not appear to have spiral arms. These are called *lenticular galaxies* because they look lens-shaped when seen edge-on (*lenticular* means “lens-shaped”). Although they look like spiral galaxies without arms, *lenticular* galaxies might more appropriately be considered an intermediate class between spirals and ellipticals because they tend to have less cool gas than normal spirals, but more than ellipticals.
- 6 Among large galaxies in the universe, most (75% to 85%) are spiral or lenticular. (Spiral and lenticular galaxies are much rarer among small galaxies.) Spiral galaxies are often found in loose collections of several galaxies, called **groups**, that extend over a few million light-years. Our Local Group is one example, with two large spirals: the Milky Way and the Great Galaxy in Andromeda. Lenticular galaxies are particularly common in **clusters** of galaxies, which can contain hundreds and sometimes thousands of galaxies, extending over more than 10 million light-years.

### Elliptical Galaxies

- 7 The major difference between elliptical and spiral galaxies is that ellipticals lack a significant disk component (Figure 2). Thus, an elliptical galaxy has only a spheroidal component and looks much like the bulge and halo of a spiral galaxy. (In fact, elliptical galaxies are sometimes called *spheroidal galaxies*). Most of the interstellar medium in large elliptical galaxies consists of low-density, hot x-ray, emitting gas like the gas in bubbles and superbubbles in the Milky Way. Elliptical galaxies usually contain very little dust or cool gas, although they are not completely **devoid of either**. Some have relatively small and cold gaseous disks rotating at their centers; these disks might be the **remnants** of a collision with a spiral galaxy.



- 8 Elliptical galaxies appear to be more social than spiral galaxies: They are much more common in clusters of galaxies than outside clusters. [A] Elliptical galaxies make up about half the large galaxies in the central regions of clusters, while they represent only a small minority (about 15%) of the large galaxies found outside clusters. [B] However, ellipticals are more common among small galaxies. [C] Particularly small elliptical galaxies with less than a billion stars, called **dwarf elliptical galaxies**, are often found near larger spiral galaxies. At least 10 dwarf elliptical galaxies belong to the Local Group. [D]

### *Irregular Galaxies*

- 9 A small percentage of the large galaxies we see nearby fall into neither of the two major categories. This *irregular* class of galaxies is a miscellaneous class, encompassing small galaxies such as the Magellanic Clouds and “peculiar” galaxies that appear to be in disarray. (Figure 3). These blobby star systems are usually white and dusty, like the disks of spirals. Telescopic observations probing deep into the universe show that distant galaxies are more likely to be irregular in shape than those nearby. Because the light of more distant galaxies was emitted longer ago in the past, these observations tell us that irregular galaxies were more common when the universe was younger.

1. What does this passage mainly discuss?

- (A) The major components of spiral galaxies
- (B) The most important types of galaxies
- (C) The Milky Way and the Andromeda galaxies
- (D) Measuring galaxies in light-years

2. What distinguishes a spiral galaxy from an elliptical galaxy?

- (A) Elliptical galaxies have a much larger halo.
- (B) Elliptical galaxies have more dust and cool gas.
- (C) Spiral galaxies are more irregularly shaped.
- (D) Spiral galaxies have a more prominent disk.

3. The word **devoid** in the passage is closest in meaning to

- (A) hidden
- (B) empty
- (C) dense
- (D) bright

4. The word **remnants** in the passage is closest in meaning to

- (A) remains
- (B) origin
- (C) damage
- (D) evidence



5. The word **either** in the passage refers to

(A) bubbles or superbubbles  
(B) elliptical or spheroidal galaxies  
(C) dust or cool gas  
(D) small or cold disks

6. According to paragraph 5, *lenticular galaxies*

(A) look like spiral galaxies without arms  
(B) consist of a bulge and a halo in a spiral galaxy  
(C) appear to have a bar of stars across the center  
(D) are in the shape of a white spiral disk

7. Which of the sentences below best expresses the information in the highlighted statement in the passage? The other choices change the meaning or leave out important information.

(A) Spiral galaxies with small bulges have more gas and dust.  
(B) Spiral galaxies have more gas and dust in their bulges.  
(C) There is less gas and dust in a spiral galaxy with a small bulge.  
(D) Gas and dust collect in the bulges of the large spiral galaxies.

8. Irregular galaxies are described as all of the following EXCEPT

(A) very white and dusty like the Magellanic Clouds  
(B) older than most of the other types of galaxies  
(C) similar to the disks of a spiral galaxy  
(D) an intermediate class between spirals and ellipticals

9. It can be inferred from the passage that

(A) astronomers do not agree on the classifications of galaxies  
(B) galaxies always collect together in clusters  
(C) the Milky Way is a typical spiral galaxy  
(D) most halos extend to about 100,000 light-years

10. Four squares (□) indicate where the following sentence can be added to the passage.

***A good example of a dwarf elliptical galaxy is Leo I in the Local Group.***

Where would the sentence best fit into the passage?

(A)  
(B)  
(C)  
(D)

11. Complete the table below by classifying each of the answer choices as a *spiral*, *elliptical*, or *irregular* galaxy. Two of the answer choices will NOT be used.

(A) Less gas or dust is found.  
(B) A disk component is prominent.  
(C) More radiation is noted.  
(D) The stars are older.  
(E) Their atmosphere is slightly blue.  
(F) The Milky Way is an example.  
(G) They are often found in large clusters.  
(H) A miscellaneous class of galaxies.

Spiral	Elliptical	Irregular
•	•	•
•	•	•