STUDY GUIDE FOR PART 5 (Astronomy)
The Galaxy and the Universe

INTRODUCTION:
    In the last section we looked at the stars that surround us. They were many in number and many in type. In this last section we try to organize and relate all of these stars to each other and to us. In doing this we will reach out into space and time as far as we possibly can.
    In Section A we consider the organization and structure of all the stars and star clusters that are anywhere near us. This group of stars we call the Milky Way Galaxy.
    In Section B we find that by looking out beyond our own galaxy that there are other separate groups of stars, i.e., other galaxies.
    In Section C we try to make up a theory that will explain what we have seen in the previous chapters of this part: We try to explain the whole universe as it is now, how it came to be as it is, and how it may change with time.
    Finally, in Section D we consider all that we've talked about in the whole course and see what we can say about alien life and alien intelligence.

A. The Milky Way

OUTLINE:
1. Where is it in the sky
2. Its structure and size
3. Stellar populations
4. Galactic motions
5. Interstellar matter

Study Questions for Part A:
  *1.   What is the Milky Way? What is its shape and size? How many stars does it contain?
   2.   Where is the solar system in the Milky Way and how is it oriented with respect to the Milky Way? To explain your answer, be able to identify at least two constellations through or near which the Milky Way passes.
   3.   What effect does interstellar matter have on our ability to see our own galaxy?
  *4.   What motion do we have with respect to the Milky Way galaxy?

B. Other Galaxies

OUTLINE:
1. Types of galaxies
    a) elliptical
        (1) designations and sub-types
        (2) sizes
    b) spiral
        (1) designations and sub-types
        (2) sizes
    c) irregular
    d) other
        (1) radio
        (2) quasars

2. Clusters of galaxies
   a) the local group
   b) other groups (clusters)
   c) superclusters

3. Evolution of galaxies

Study Questions for Part B:
 *1. What are the three basic types of galaxies.
 *2. What type of galaxy is the Milky Way?
 *3. What type of galaxy, how big, and how far away is the Andromeda galaxy?
 *4. What is the local group?
 *5. What is a Quasar?

C. Cosmology

OUTLINE:
1. Observations
   a) Olber's paradox - the night sky is dark
   b) Hubble's law and the red shift
   c) Temperature of the universe

2. Theories
   a) Steady State
   b) Big Bang
      (1) open and infinite
      (2) closed and finite

Study Questions for Part C:
 *1. What are the three main cosmological facts?
 2. Describe the steady state theory and discuss how it explains (or fails to explain) the three main cosmological facts.
 **3. Describe the "Big Bang" theory and discuss how it explains the three main cosmological facts.
 *4. According to the "Big Bang" theory, how old is the universe? Indicate two ways this age is arrived at?
 5. What do the terms "open" and "closed" mean when used to describe the universe?   What physical parameter determines which kind we have?

D. Alien Life in the Universe

OUTLINE:
1. Conditions of life
   a) formation of elements (H, C, N, O plus traces of others)
   b) right kind of star (not too hot, not too cold, not too much UV)
   c) existence of right kind of planet (rocky, not gaseous)
   d) placement and orientation of planet

2. Probabilities of life and intelligence
   a) total probability of star having life from 1. above
   b) added conditions for intelligence
   c) total probability within galaxy
   d) average distance between civilizations and its implications

Study Questions for Part D:
   1. What does element formation have to do with ETI (extra-terrestrial intelligence) ?
   *2. Explain the statement: "We are made of star stuff".
   *3. List two conditions on a star if a civilization is to develop about that star.
   *4. List three conditions on a planet if that planet is to develop life.
   5. What are plausible upper and lower limits on the fractions of all stars that have planets that bear intelligent life?
   6. What should the distance to the nearest civilization be based on question #5 and the number and distribution of stars in our galaxy?

Study TRUE/FALSE Questions for all of Part 5:
(questions similar to these may be on the test)

_____a) We appear to be orbiting the center of the Milky Way galaxy with a speed of about 500,000 mph (about means within a factor of 5).

_____b) The Andromeda galaxy is a galaxy very much like our own and is about 2 million light years away from us.

_____c) A REGULAR cluster of galaxies has THOUSANDS of galaxies
        (counting both major and minor galaxies).

_____d) There do NOT appear to be SUPER-clusters of galaxies.

_____e) There appears to be enough visible matter for the universe to be CLOSED.

_____f) CARBON is the BEST element on which chemical life could be based.

_____g) The Steady State theory of the universe explains the red-shift of the galaxies as due to the galaxies actually receding, but explains the steady state nature of the universe as being due to the creation of matter in the intergalactic regions from which new galaxies are being formed. This theory is NOT currently in favor but for reasons OTHER than those stated above.

LIFE

Abundance of elements: (in %)

SUN	EARTH	CRUST	ATMOSPHERE	BACTERIA	HUMANS
H 93.4	O 50	O 47	N 78	H 63	H 61
He 6.5	Fe 17	Si 28	O 21	O 29	O 26
O .06	Si 14	Al 8.1	Ar .93	C 6.4	C 10.5
C .03	Mg 14	Fe 5.0	C .011	N 1.4	N 2.4
N .011	S 1.6	Ca 3.6	Ne .0018	P .12	Ca .23
Ne .010	Ni 1.1	Na 2.8	He .00052	S .06	P .13
Mg .003	Al 1.1	K 2.6			S .13
Si .003	Ca .74	Mg 2.1			
Fe .002	Ti .44				
S .001		H .14			

The concentrations of **trace** elements in bacteria, in fungi, in plants, and in land animals show a strong correlation with the concentrations of these elements in sea water (which is quite different than relative abundances of trace elements on Mars or interstellar dust clouds).