Ch 15 Life in the Universe

I. **Cosmic Calendar**:

 The 7 stages in the history of the

 universe are particulate,

 \_\_\_\_\_\_\_\_\_\_\_, stellar, \_\_\_\_\_\_\_\_\_\_\_,

 chemical, \_\_\_\_\_\_\_\_\_\_\_, & cultural.

II. **The Drake Equation**

 A. Has no answer –just an \_\_\_\_\_\_\_\_\_

 1. Divides a large question into a

 a series of smaller ones

 2. Estimates the number (N) of

 advanced civilizations in the

 \_\_\_\_\_\_\_\_ \_\_\_\_\_\_ today

 B. The terms:

 1. **R\***-# of \_\_\_\_\_\_\_ in our galaxy

 2. **fS** -Fraction of \_\_\_\_-like stars

 3. **fp** -Fraction of stars w/ \_\_\_\_\_\_\_

 a. At least \_\_\_ planet per star

 seems likely.

 b. Our guess is getting better!

 4. **fE** – Fraction of \_\_\_\_\_\_\_\_-like
 planets per Solar System

 a. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the key

 i. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to star

 ii. Thickness of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 iii. In the **habitable zone**

 b. 1 out of \_\_\_ perhaps? More?

 c. What is meant by

 “Earth-like”?

 i. Mars had a warm, wet past

 – could there be fossilzed life

 in \_\_\_\_\_\_\_\_\_\_\_\_\_\_? What about

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ microbes??

 ii. Europa – ocean \_\_\_\_\_\_\_\_?

 iii. Enceladus - water \_\_\_\_\_\_\_\_\_\_

 iv. Titan - carbon, but \_\_\_\_\_\_\_!

 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. **fL** - Fraction of habitable
 planets which have \_\_\_\_\_\_\_
 a. Low value: life is \_\_\_\_\_\_ or

 nonexistent in the galaxy

 b. Value of 1: Life is inevitable

 given enough time

 c. We need more examples!

 \_\_\_\_\_\_\_\_\_\_\_? \_\_\_\_\_\_\_?

 d. What is meant by “life”?

 No set definition Ex/ \_\_\_\_\_\_\_

 e. Typical attributes of life

 i. React to their environment

 (heal themselves, etc..)

 ii. Can \_\_\_\_\_\_\_\_

 iii. Can \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 iv. Can \_\_\_\_\_\_\_\_\_ over generations

 f. . A Chemical Evolution for life?

 i. **Urey-Miller** Experiment (1953)

 Exposed simple elements to

 early Earth-like environment

 (\_\_\_\_\_\_\_\_\_\_\_, “lightning”, etc..)

 ii. \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_ & complex

 organics formed! These are

 the building blocks of life!

 g. . An Interstellar origin for life?

 i. Organics can form in

 \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_

 ii. \_\_\_\_\_\_\_\_\_\_ contain organics

 iii. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ have been

 found with organics

 Ex/ \_\_\_\_\_\_\_\_\_\_\_\_\_ Meteorite

 found w/ \_\_\_\_ amino acids

 h. . Alternative biochemistry?

 i. Carbon is chemically

 flexible, but so is \_\_\_\_\_\_\_\_\_\_\_\_

 ii. Water has a wide temp. range as a liquid, but \_\_\_\_\_\_\_\_\_\_ might be used as a medium on a cold planet

6. **fI** - Fraction of Worlds that
 Develop \_\_\_\_\_\_\_\_\_\_\_\_\_ Life

 a. \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ would

 seem to favor intelligence

 b. However, intelligence took

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of yrs. to develop

 c. We could be the most

 intelligent life in the galaxy!

 d. Biological evolution was an

 incredibly slow process early on

 i. 3.5 billion yrs. ago:

 Single-celled blue-green \_\_\_\_\_\_\_\_

 ii. 2 billion yrs. ago: \_\_\_\_\_\_\_\_\_\_\_\_

 iii. 1 billion yrs. ago: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

 e. Biological ‘\_\_\_\_\_ \_\_\_\_\_\_\_\_’ (570

 million years ago –Cambrian era)

 i. Number of species exploded

 ii. Advantageous traits such as

 intelligence evolved

 Ex/

7. f**T** - Fraction of intelligent species

 that develop \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 i. Every isolated \_\_\_\_\_\_\_\_\_\_\_\_

 civilization developed tech.

 ii. Other life on Earth uses

 “technology”, but not radio…

 Ex/ Tool usage in \_\_\_\_\_\_\_\_\_\_\_\_

 iii. Conclusion: Probably

 inevitable

8. **L** – \_\_\_\_\_\_\_\_\_\_ of technologically-
 advanced civilizations

 i. \_\_\_\_\_\_\_\_\_ - late 1800’s

 ii. \_\_\_\_\_\_\_\_\_\_\_ power - 1940’s

 iii. \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ 1962



III. **SETI** 

 A. The drawbacks

 1. Even if there were 1 \_\_\_\_\_\_\_\_\_\_

 civilizations in our galaxy, they

 would be \_\_\_\_\_\_ light years apart

 2. Stars too \_\_\_\_ away for travel there

 a. \_\_\_\_\_\_\_\_\_\_\_ years to Alpha Centauri

 b. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ yrs. to go 100 l.y.

 B. Do we want E.T. to find us?

 1. We’re a young, \_\_\_\_\_\_\_\_\_\_\_\_\_

 technological civilization

 2. Just in case, we sent a

plaque on *Pioneer 10*

 C. Radio Broadcasts

 1. Cheaper, more practical

 2. Earth’s radio has reached over

 \_\_\_\_\_\_\_\_\_\_\_\_ stars (~65 l.y.)

 3. The “\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_” (H & OH)

 4. SETI (Project Phoenix ‘90s)

a. Home-based SETI

 b. \_\_\_\_\_\_\_ Telescope Array (ATA)

 350 radio dishes

 D. The timeline of scientific

 achievement & the next great

 chapters in the story of

 human disovery…

