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

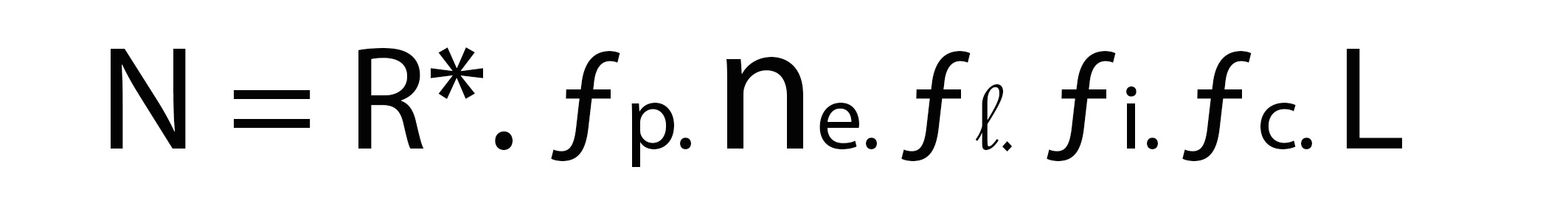
inevitable

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…

