

QUESTION SET TO ACCOMPANY THE PROGRAM
PHYSICS AND BIOLOGY: EVOLUTION OF LIFE AND EVOLUTION OF SCIENCE

1. In the early part of the program, the quote by Galileo, "Measure what is measurable, and make measurable what is not." refers to the practice of scientific investigation in the 17th century. What was considered normal "scientific practice" before the 17th century that would motivate Galileo to say such a thing?
2. Why did scientific and religious prejudice in regards to the Copernican view of the universe hinder the progress of scientific discovery during the Middle Ages?
3. How did the Copernican (Heliocentric) Theory of the Universe finally become accepted by the scientific community?
4. How has the discovery of DNA changed our perception of biology and life?
5. Why would physics and physicists be drawn to the science of biology in the 20th and 21st centuries?
6. How does "Rayleigh-Bénard Convection" relate to cellular biology?
7. List three examples (other than the ones mentioned in the presentation) of morphogenesis:
a) from a physics perspective; and, b) from a biological perspective.
8. Alan Turing's "...Chemical Basis of Morphogenesis" is based on the Fibonacci Sequence in mathematics. What are Fibonacci Numbers and how are they generated?
9. How many pairs of rabbits will be produced in a year, beginning with a single pair, if in every month each pair bears a new pair which becomes productive from the second month on?
Taken from ***Liber Abaci* (pub. 1202)**.
10. What is the "Golden Rectangle", and how is it applied to biological structures? List three of these structures (not mentioned in the presentation) as found in Nature.
11. Explain how the same forces that act on structures (tension, compression, twist, shear) act on crawling cells.
12. What are "stochastic fluctuations?" How are they related to cellular biological mechanisms? How are they seen in physics applications, in particular, as applied to quantum mechanics? Hint: how do these phenomena relate to "uncertainty" as applied to quantum systems and the Heisenberg Principle?
13. How does "planar cell polarity" in biological systems compare to "magnetic domains" in magnets?
14.
 - a. About what percent of modern C-14 remains in a sample that is two half-lives old?
 - b. What percent of modern C-14 remains in a sample that is five half-lives old?
 - c. What is the approximate age, in years, of a sample that contains 90 % of its original C-14?
 - d. What is the approximate age, in years, of a sample that contains 30 % of its original C-14?
 - e. What is the approximate age, in years, of a sample that contains 3 % of its original C-14?
 - f. 0.2% is the smallest activity that a sensitive detector can measure from the emitted beta particles of C-14 decay. Using this value, what is the approximate maximum age in years that can be determined with the C-14 method?
15. The program mentions the use of "feedback loops." List three examples in physics and/or engineering of feedback loops, and state whether they are positive or negative.
16. Compare how calcium ion concentrations in or outside a cell as a signalling agent relates to the quantization of electrodynamics with the atom in terms of "excitability."