THE AMOEBA IS ONE EXAMPLE OF

MAGIC Under the Microscope

by Eugene Kinkead

1 If the history of the protozoa were to be represented by a four-story building forty feet high, then the history of humankind would be represented by the wing of a fly laid across the building's façade.

2 The story, as microbiologist Roman Vishniac tells it, started with the formation of the earth—a process that scientific opinion now estimates began three or four billion years ago—and followed this roughly approximate course: A whirling ball of gases torn from the sun gradually solidified in a pattern that placed the heaviest elements of our present chemical scale centrally and worked outward to the lightest, principally hydrogen and oxygen, the components of water; these intermingled and rose in blankets of clouds many miles high. As the still-molten globe whirled on its pathway through space, the moon was born from the bulk of the earth in a repetition of the process that ripped the earth from the sun. On the earth's surface the continental platforms floated into place; the global covering gradually hardened and cooled so that it could receive the vaporous layer's endless precipitation as water, instead of reconverting it instantly to steam and sending it aloft again. When this occurred, the heavy clouds, piled on each other mile after lofty mile, loosed their burdens like weary sponges; the skies were cleared by rain that lasted centuries, filling the ocean beds. "All this for protozoa," Vishniac says happily, "for life began in the sea."

3 Protozoa were not the first life; they were merely the first animal life. In the still mysterious beginnings of living things—things that are born, grow, reproduce, and die—science ordains a certain order of historical events: first came the formation of organic molecules from the inorganic substances, like nitrogen and calcium, which were brought, dissolved by the rains, into the ocean from the continents. Next came the development, from the combinations of these molecules, of certain higher forms of creation like the viruses, which sometimes seem living and sometimes do not. Then the first plants

arose, and subsequently the protozoa, the first animals, emerged. Protozoa were too soft-bodied in the beginning to leave in the rocks any record that would enable us to date their arrival. But in 1954 an announcement was made in the press of the finding of the oldest plant fossils yet discovered, in a sediment that is 2.6 billion years old. By the current system of reckoning, this places the protozoa, which presumably developed not long after the plants, in existence well over two billion years. Humanity, the modern variety, is generally thought to be fifty thousand years old.

4 More than fifteen thousand species of protozoa are known; the *Amoeba proteus,* one of the commonest, is an excellent example of the obscure protozoan way of life. It resembles a small, mobile, translucent blob of jelly, and can survive in any kind of freshwater, be it Lake Superior or a mud puddle. The ordinary amoeba, less than a hundredth of an inch across, moves by thrusting out one lobe of its gelatinous body and pulling or pushing the rest of itself after it. In this fashion, it has been observed to travel the distance of the diameter of its own body in one minute. Under the microscope, which magnifies motion as well as size, this does not seem like a snail's pace—the rate would amount to about one foot in twenty-four hours were the amoeba to travel in a straight line—which, incidentally, it never does. It eats fellow protozoa and one-celled plants like diatoms, both of which it captures by encirclement.

5 One theory about the amoeba's amazing ectoplasm, which elongates and retracts when needed and through which pass food, water, and refuse without leaving a hole, is that it is made of ultramicroscopic bubbles, a form of construction that would permit these phenomena. Whatever its composition, it is amazingly strong and can, when necessary, by means of two protrusions, part a paramecium (considered by microscopists to be an extremely tough little organism) with remarkable ease.

6 While science credits the amoeba with being merely a mindless, undifferentiated drop of cellular matter, its actions might well be considered intelligent. For instance, it moves away from an area into which acid has been poured; it accepts an edible object but rejects an inedible one; if it puts forth three lobes, or pseudopodia, to find something solid that it can grasp, it withdraws the groping pair when the third has successfully discovered such an object.

7 According to Roman Vishniac, the simplest answer seems to be intelligence, in the loose, ordinary sense of the word. Otherwise, how does the amoeba know enough to absorb the two arms on the other side of the body when one has fulfilled its mission? In the case of an ape, Vishniac points out, this certainly would be called intelligence. One of the most amazing sights of the microscope is watching a relatively slow-moving creature such as the amoeba catch a quick-running animal such as a ciliate of the genus *Stylonychia.* You think to yourself: Surely the amoeba must have brains. You see how, as if by magic (or intelligence), it suddenly attaches itself to this rapid ciliate. There is a fight; the ciliate seeks to tear away, the amoeba to engulf.

8 Often the victim does escape at first. Getting some distance off, it feels secure, but the amoeba pursues, creeping, and if the amoeba starts in the wrong direction, by some miracle it gets its bearings, reverses its direction, finds its prey, and in the end is usually triumphant. The amoeba is a wonderful example of the living single cell, which nature contrived billions of years ago—perhaps nature's magnificent and final creation. "For," says Vishniac, "basically, nature seems never to have got beyond this original beautiful trick; all subsequent life is formed of it. The cortex of the cerebral hemispheres of the human brain is composed of twelve billion [living single cells], and the rest of the body of trillions more, packed into layer upon layer of tissue. Other single-cell accumulations make up the hummingbird, the fiddler crab, the walrus, and the mosquito; practically all these cells are the same size as the one that forms the amoeba.

9 "Thus, here is another connection within the compass of all life. As I look at nerve cells under the microscope, working their way through and around muscle cells as they take their normal growth through tissue, I see that their movement is strikingly like an amoeba's. And as I watch the white corpuscles of blood cleaning up a hemorrhage, I see that they eat the damaged red blood cells exactly like an amoeba engulfing its prey. Never once do they approach healthy red blood cells, but with amoeboid intelligence they concentrate only on their natural prey, exactly like the amoeba at the bottom of its mud puddle."

10 Near the center of the amoeba is an almost invisible structure called the nucleus, whose functions include control of reproduction and the assimilation of food. If an amoeba is cut in two with one part containing the complete nucleus and the other part none of it, nothing

much happens at first; both sections quickly replace the outside cover and go about their business, but the nonnucleated fragment, while it can capture food, cannot digest it, and it finally dies after ten or twelve days, the period it would take an ordinary amoeba to starve if all nourishment were withheld from it. An amoeba protects the nucleus, which apparently is its vital spark, by *encysting* when its habitat dries up. By this process it produces out of its own substance a warty shell within whose confines it can lie dormant for a long time.

11 Vishniac recalls that one of these encysted amoebas was caught in the folds of the wrapper of a mummy that was brought to the British Museum. During a careful examination of the wrapper, part of which took place under the microscope, the amoeba was seen and recognized by the viewer, who put it in a little water, anxious to see what would happen. Still watching through the microscope, he saw the rough casing burst and the amoeba move off, for all the world as though it had not been dozing quietly for the last four thousand years.

HOW WELL DID YOU READ?

Did you see the writer's purpose?

1. **The origin of the earth is treated in this selection because it**
   - **A** is the author's own theory
   - **B** explains the origin of the protozoa
   - **C** gives the reader information that is needed to read the rest of the selection with comprehension
   - **D** serves as a dramatic introduction

What did you learn about the subject?

2. **The amoeba uses its ability to project pseudopodia to**
   - **A** propel itself
   - **B** engulf its prey
   - **C** camouflage itself
   - **D** all of the above

3. **A nonnucleated amoeba is unable to**
   - **A** avoid negative stimuli
   - **B** digest food
   - **C** capture food
   - **D** live for a short length of time

Did you note the important details?

Decide whether these statements are true, false, or not included in the selection. Write **T, F,** or **NI.**

4. Protozoa were the first form of life on earth.
5. The soft-bodiedness of the protozoa has made any dating of its beginning impossible.
6. The composition of the amoeba's ectoplasm has never been definitely determined.
7. The human brain contains cells that might be likened to the amoeba.

Can you evaluate the evidence?

8. **The writer relates Roman Vishniac's theory of the origin of life in a way that implies that he**
   - **A** reluctantly accepts it
   - **B** disagrees with it
   - **C** is impartial because of his lack of firsthand knowledge
   - **D** is not vitally interested in it

9. **What the writer calls "amoeboid intelligence" is intelligence in the sense that it is**
   - **A** ability to learn through experience
   - **B** mental acuteness
   - **C** ability to deal with various situations
   - **D** creative to some degree

10. **The prevailing tone of the selection can most accurately be described as one of**
    - **A** admiration
    - **B** scientific detachment
    - **C** absorption
    - **D** condescension

LEARN ABOUT WORDS

A. Often you can tell the meaning of a word from its context—the words around it.

Directions: Find the word in the paragraph that means

1. front side *(1)*
2. establishes; decrees *(3)*
3. letting light through *(4)*
4. outer layer of a cell *(5)*
5. stretches *(5)*
6. projecting parts *(5)*
7. not distinguished *(6)*
8. false feet *(6)*
9. absorption *(10)*
10. lumpy *(10)*

B. A word may have more than one meaning. Its meaning depends on the way it is used.

Directions: Decide which meaning fits the word as it is used in the paragraph. Write the letter that stands before the meaning you choose.

11. platforms *(2)*
- **A** stages
- **B** raised surfaces
- **C** statements of principle

12. mobile *(4)*
- **A** fluid
- **B** showing changes
- **C** moving

13. bearings *(8)*
- **A** applications
- **B** manners
- **C** sense of position

14. compass *(9)*
- **A** circumference
- **B** scope
- **C** circuit

15. vital *(10)*
- **A** essential to life
- **B** of greatest importance
- **C** full of vigor

C. Some **roots** which appear in many English words are

pneum, pne (breath; wind)
ether (air)
aer (air)

Pneum, pne comes from the Greek *pnein,* meaning "to breathe." *Ether* comes from the Latin *aethir,* meaning "upper air" *Aer* comes from a similar word. *aer,* which existed in both Latin and Greek.

Directions: The words in column II are based on these roots. Write the word from column II that fits each meaning in column I.

I	II
16. by means of air pressure	pneumatics
17. unsubstantial; airy	pneumonia
18. disease of the lungs	pneumatically
19. science of art of making and flying aircraft	aerophobia
	aeronautics
20. anesthetic gas	ethereal
21. expose to air; cause air to enter	ether
	aerate
22. fear of air, especially drafts	aerospace
23. of earth's atmosphere and the space about it	
24. branch of physics dealing with air and gases	

D. Synonyms are words that have the same or nearly the same meaning. **Antonyms** are words that have opposite or nearly opposite meanings.

Directions: In each line below are five words. From them, select the two pairs that are either synonyms or antonyms. If both pairs are synonyms, write **S;** if both pairs are antonyms, write **A.** If tnere is one pair of synonyms and one pair of antonyms, write **M,** mixed.

25. approximate, elucidate, estimate, delineate, enumerate

26. components, exponents, constituents, transients, proponents

27. substantial, imaginary, short-lived, ephemeral, wavering

28. presumably, naturally, probably, subsequently, consequently

29. relatively, absolutely, partially, superficially, basically

30. prey, quarry, quay, canyon, dock

31. occasionally, fundamentally, customarily, accidentally, intentionally

32. concentrate, contemplate, consolidate, permeate, penetrate

33. dormant, savage, dramatic, inactive, ferocious