Passage IV

To grow on a *medium* (a nutrient system) that lacks *arginine* (an amino acid), the bacterium *E. coli* must synthesize arginine from the medium. Figure 1 shows a portion of the reaction pathway for the synthesis of arginine in *E. coli*. Each of these reactions is catalyzed by an enzyme (E1–E4). In the first reaction, acetylornithine is the precursor, ornithine is the product, and E1 is the enzyme. In the second reaction, ornithine is the precursor, citrulline is the product, and E2 is the enzyme.

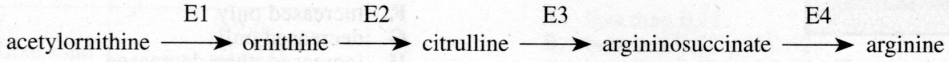

Figure 1

Figure 1 adapted from Ursula Goodenough, *Genetics*, 3rd ed. ©1984 by CBS College Publishing.

Table 1 lists the *E. coli* genes that normally code for the enzymes in Figure 1.

Table 1	
Gene	Enzyme
arg1	E1
arg2	E2
arg3	E3
arg4	E4

Sometimes a gene that normally codes for an enzyme is damaged in such a way that the enzyme is not produced. The pathway then shuts down at the reaction catalyzed by that enzyme. As a result, the precursor increases in concentration and the product is not produced. An undamaged gene is labeled with a plus sign (for example, $arg1^+$). A damaged gene that cannot code for its enzyme is labeled with a minus sign (for example, $arg1^-$).

Experiment

A biologist grew *wild-type* (naturally occurring) *E. coli* on *minimal medium* (MM), a medium that lacks arginine.

To induce genetic damage, the biologist exposed wild-type *E. coli* to radiation. She then identified those *E. coli* that could no longer synthesize arginine from MM. She tested these *E. coli* on various media, classifying them into 5 types depending on the media on which they grew (see Table 2).

In Table 2, an "×" indicates that a given type could grow on a given medium and thus could synthesize arginine from that medium.

Table 2					
Medium	Type: 1	2	3	4	5
MM					
MM + acetylornithine					×
MM + ornithine	×				×
MM + citrulline	×	×			×
MM + argininosuccinate	×	×	×		×

Table 2 adapted from Anthony J. F. Griffiths et al., *Genetic Analysis*, 5th ed. ©1993 by W. H. Freeman and Company.

17. One of the media listed in Table 2 acted as a control to provide evidence for the biologist's belief that each of the 5 types of *E. coli* listed in Table 2 had some genetic damage. This medium was:

A. MM.
B. MM + acetylornithine.
C. MM + citrulline.
D. MM + argininosuccinate.

18. For each of the 5 types of *E. coli* listed in Table 2, if a given type was able to grow on MM + citrulline, it was also able to grow on:

F. MM.
G. MM + acetylornithine.
H. MM + ornithine.
J. MM + argininosuccinate.

19. Which of the following statements best describes the relationships between argininosuccinate, citrulline, and ornithine as shown in the reaction pathway represented in Figure 1 ?

A. Ornithine is a precursor of argininosuccinate, and argininosuccinate is a precursor of citrulline.
B. Ornithine is a precursor of citrulline, and citrulline is a precursor of argininosuccinate.
C. Argininosuccinate is a precursor of citrulline, and citrulline is a precursor of ornithine.
D. Argininosuccinate is a precursor of ornithine, and ornithine is a precursor of citrulline.

20. According to the information provided, *E. coli* that are $arg1^+$ $arg2^-$ $arg3^+$ $arg4^-$ CANNOT produce:

F. E1 and E2.
G. E1 and E3.
H. E2 and E4.
J. E3 and E4.

21. Based on the information presented, the highest concentration of argininosuccinate would most likely be found in which of the following *E. coli* ?

A. *E. coli* that cannot produce E1
B. *E. coli* that cannot produce E2
C. *E. coli* that cannot produce E3
D. *E. coli* that cannot produce E4

22. Type 1 *E. coli* were most likely NOT capable of converting:

F. acetylornithine into ornithine.
G. ornithine into citrulline.
H. citrulline into argininosuccinate.
J. argininosuccinate into arginine.