Chapter 5
Later Passages

Passage I

In an experimental device known as a cloud chamber, energetic protons and neutrons pass through a vapor of condensed alcohol, causing the ionization (acquired charge) of some of the alcohol molecules. The ionized alcohol molecules begin as condensation nuclei around which the alcohol vapor continues to condense until a high-energy mist is formed. When the mist has acquired enough charge, energetic particles passing through the vapor form tracks visible to the naked eye. These tracks can be accelerated by the application of a magnetic force, under which positively and negatively charged ions will travel in opposite directions.

Two studies using cloud chambers were done at a research center in a temperate climate, using supercooled gaseous ethanol as a medium. The cloud chamber temperature ranged from 0°C to –150°C.

Study 1

Four types of anions (A–D) were used. Anions of each type, when released into the cloud chamber, emit groups of electrons into the chamber with a specific distribution of charges (see Table 1).

Table 1

Anion type	Percent of groups of electrons having charges (coulombs):			
	0.1–0.5	0.6–1.0	1.1–1.5	1.6–2.0
A	70	20	8	2
B	75	10	8	7
C	80	8	7	5
D	85	7	5	3

Note: 1 coulomb is the charge of 6.24×10^{18} electrons.

A device containing all 4 types of anions was placed next to the cloud chamber. A computer in the device determined when to release anions, which type of anion to release, and how many anions to release to generate 10, 100, 1,000, or 10,000 condensation nuclei per cm^3 within the chamber. The average number of tracks produced by each type of anion and at each concentration of condensation nuclei is shown in Figure 1.

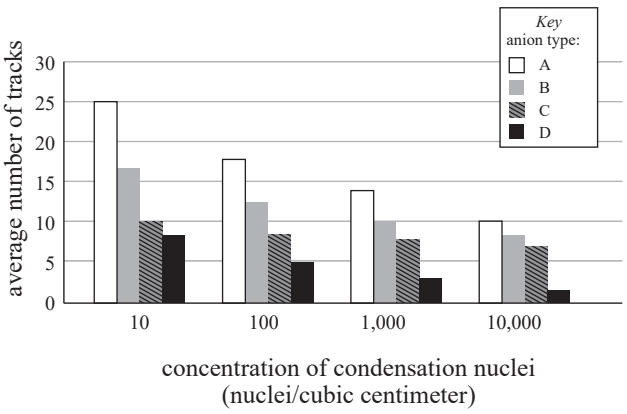

Figure 1

Study 2

The magnetic force required to make each track accelerate away from a straight line was recorded over an hour following the release of the four types of anions into two types of cloud chambers: one with ethanol vapor and one with water vapor. The averaged results for both types of cloud chambers are shown in Figure 2.

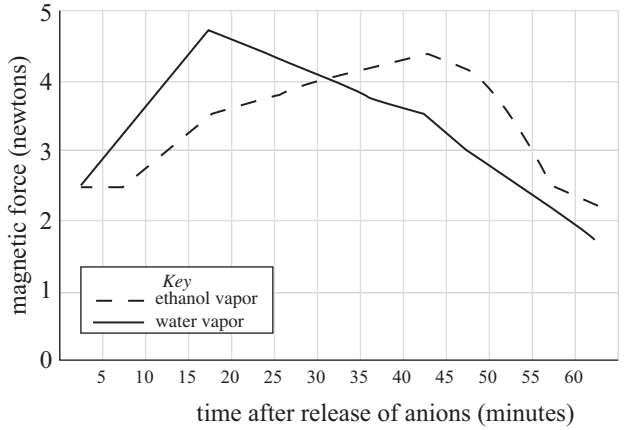

Figure 2

1. According to the results of Study 1, as the condensation nuclei concentration increased, the average number of tracks generated:

- **A.** increased for all 4 types of anions.
- **B.** increased for anion types A and B but decreased for anion types C and D.
- **C.** decreased for all 4 types of anions.
- **D.** decreased for anion types A and B but increased for anion types C and D.

2. Based on the passage, what is the correct order of tracks, high-energy mist, and condensation nuclei, according to the stage of development, from earliest to latest?

- **F.** High-energy mist, tracks, condensation nuclei
- **G.** Condensation nuclei, high-energy mist, tracks
- **H.** Tracks, high-energy mist, condensation nuclei
- **J.** Tracks, condensation nuclei, high-energy mist

3. According to the results of Study 2, how did the magnetic force required in the cloud chamber with ethanol vapor differ from the magnetic force required in the cloud chamber with water vapor, with respect to their maximum strength?

- **A.** It took more time for the magnetic force in the ethanol vapor to reach a maximum strength, and it reached a greater maximum strength.
- **B.** It took less time for the magnetic force in the ethanol vapor to reach a maximum strength, and it reached a greater maximum strength.
- **C.** It took more time for the magnetic force in the ethanol vapor to reach a maximum strength, and it reached a lesser maximum strength.
- **D.** It took less time for the magnetic force in the ethanol vapor to reach a maximum strength, and it reached a lesser maximum strength.

4. The design of Study 1 differed from the design of Study 2 in that Study 1, the:

- **F.** tracks of condensation nuclei were analyzed, whereas in Study 2, the concentration of condensation nuclei was analyzed.
- **G.** strength of magnetic fields was measured, whereas in Study 2, the concentration of condensation nuclei was analyzed.
- **H.** tracks of condensation nuclei were analyzed, whereas in Study 2, the strength of magnetic fields was analyzed.
- **J.** strength of magnetic fields was analyzed, whereas in Study 2, tracks of condensation nuclei were analyzed.

5. Which of the following statements gives the most likely reason that data from the cloud chamber was not recorded below a temperature of –150ºC? Below –150ºC, there would be present:

- **A.** only water vapor.
- **B.** only alcohol vapor.
- **C.** ice crystals but little water vapor.
- **D.** solidified alcohol but little alcohol vapor.

6. Which of the following statements about the concentration of condensation nuclei in the 4 types of anions is supported by Table 1 ?

- **F.** For all 4 types of anions, the majority of particles belonged to the largest charge category.
- **G.** For all 4 types of anions, the majority of particles belong to the smallest charge category.
- **H.** For anion types A and B, most anions belong to the largest charge category, whereas for anion types C and D, most anions belong to the smallest charge category.
- **J.** For anion types A and B, most anions belong to the smallest charge category, whereas for anion types C and D, most anions belong to the largest charge category.

Passage II

Escherichia coli (E. coli) are commonly used in laboratories for the expression, replication, and purification of introduced circular pieces of DNA called *plasmids*. Engineered plasmids encode a gene of interest and often genes that confer resistances to select antibiotics. Antibiotic resistance may be analyzed using the *disk diffusion method*. During the disk diffusion method, bacteria from a single *colony*, or a cluster of genetically identical cells, are incubated in liquid growth media and spread on agar plates (see Figure 1). Small paper disks containing a known concentration of antibiotic are set on the agar plates, and the bacteria are allowed to grow at optimal temperatures. Laboratory strains of *E. coli* lacking plasmids containing genes of resistance to select antibiotics will be unable to grow near the disk containing that antibiotic. Only bacteria that have received the introduced plasmid containing an antibiotic resistance gene should be able to grow in the presence of the antibiotic-containing disk.

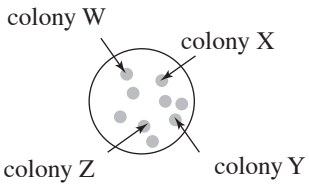

plate of
transformed colonies

Figure 1

Experiment 1

A biotech company has engineered new laboratory strains (A–E) of *E. coli* and is testing whether each strain could grow in the presence of a variety of common antibiotics—ampicillin (Amp), kanamycin (Kan), penicillin (Pen), and tetracycline (Tet). Each of the strains was incubated in a clear nutrient media containing either extra sugar (glucose) or an antibiotic at 37ºC for 24 hours. After 24 hours, the growth media was examined for *turbidity* or cloudiness, a signal of bacterial growth (see Table 1).

Table 1

Strain	Nutrient Media				
	Glu	Amp	Kan	Pen	Tet
A	+	–	+	–	–
B	+	–	–	+	–
C	+	–	–	+	+
D	+	+	+	–	–
E	+	–	+	+	–

Note: + indicates presence of turbidity;
– indicates no change in appearance

Experiment 2

The scientists at the biotech company tested Strain A for growth after *transformation*, a process of introducing engineered plasmids with antibiotic-resistance containing plasmids. Four different transformed colonies (W, X, Y, and Z) and untransformed Strain A were incubated in liquid growth media and spread on agar plates. To identify which colonies had received which resistance genes, disks containing one of each of the common antibiotics were then placed on the agar plate, and the bacteria were permitted to grow at 37ºC (see Figure 2).

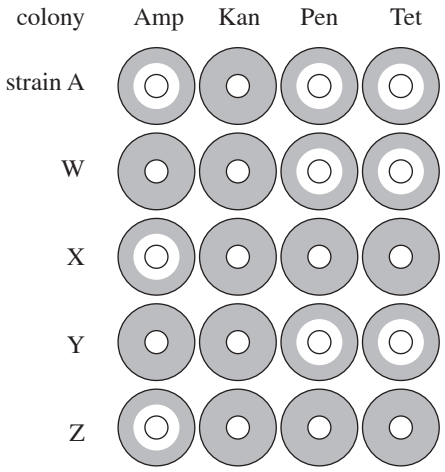

Figure 2

1. Suppose *E. coli* Strain D had been incubated on plates containing kanamycin and tetracycline (Kan^+ Tet^+) disks and growth near both disks was observed. Do the data in Table 1 support this observation?

A. Yes; the results shown in Table 1 indicate that Strain D can grow in the presence of both Kan and Tet.
B. Yes; the results shown in Table 1 indicate that Strain D cannot grow in the presence of Kan.
C. No; the results shown in Table 1 indicate that Strain D can grow in the presence of both Kan and Tet.
D. No; the results shown in Table 1 indicate that Strain D cannot grow in the presence of Tet.

2. Which of the labeled colonies shown in Figure 2 is most likely to have received a plasmid conferring resistance to tetracycline?

F. Colonies W and X
G. Colonies W and Y
H. Colonies X and Y
J. Colonies X and Z

3. According to Table 1, how many strains tested in Experiment 1 were able to grow in nutrient media containing penicillin?

A. 0
B. 1
C. 2
D. 3

4. Based on Table 1 and Figure 2, which colonies, if any, likely received a plasmid with resistance genes to ampicillin and kanamycin?

F. Colony W only
G. Colony X only
H. Colonies W and Y
J. Colonies X and Z

5. Before beginning the experiments, the scientists sprayed the lab area down with a disinfectant. The most likely reason that the disinfectant was used was to avoid contaminating:

A. the nutrient growth media with strains that were lab generated.
B. the agar plates with strains that were lab generated.
C. both the nutrient growth media and agar plates with strains that were lab generated.
D. both the nutrient growth media and agar plates with strains that were not lab generated.

6. Which of the colonies shown in Figure 2 did NOT grow in the presence of ampicillin?

F. Colony W
G. Colony X
H. Colony Y
J. None of the strains

7. One of the laboratory technicians was hospitalized for an *E. coli* infection. The infection did not respond to penicillin or tetracycline, but improved after treatment with ampicillin. The technician was most likely infected with:

A. Strain A.
B. Strain B.
C. Strain C.
D. Strain D.