Unit 12 · Viruses, and Biotechnology in Microbiology

ANSWER KEY · FOR TEACHERS

Full marks 39

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. capsid
2. capsomeres
3. virion
4. bacteriophages
5. lysozyme
6. lytic
7. bioremediation
8. GMO

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. head (capsid)
2. tail fibers
3. DNA
4. collar
5. tail (sheath)
6. baseplate

K · 3

Each carries 0.5 mark.

3 Multiple choice

i. **a.** They require a living host to multiply. K · 1

An **obligate** parasite can live (multiply) **only** as a parasite. A virus has no ribosomes or energy-releasing enzymes, so it multiplies only inside a **living host cell**.

ii. **d.** proteins, and RNA or DNA K · 1

Every virus has a **protein** coat and **one** kind of nucleic acid, **DNA or RNA**, never both. "DNA and protein" describes only the DNA viruses.

iii. **c.** it has no machinery of its own to make proteins or energy, so it multiplies only inside living cells U · 1

A virus is an **obligate parasite**: with no ribosomes and no energy-releasing enzymes, it can't use the food in a broth. Virologists grow viruses in living cells: in cultures of animal cells, in fertilized hens' eggs (as for many flu vaccines), or, for bacteriophages, in a culture of their host bacteria.

iv. **c.** rabies U · 1

Rabies is caused by the rabies virus, spread by the bite of an infected dog or other mammal. Typhoid, tuberculosis and cholera are caused by **bacteria** (*Salmonella* Typhi, *Mycobacterium tuberculosis*, *Vibrio cholerae*), so they can be treated with antibiotics; antibiotics don't work on viruses.

v. **c.** the bacteria form root nodules and fix nitrogen from the air for the plant A · 1

Rhizobium enters the roots of legumes such as lentil and forms **nodules**, where it **fixes the air's nitrogen** into ammonia for the plant. Dissolving phosphate is the work of other microbes such as *Penicillium bilaiae*; resistance to caterpillars comes from Bt genes.

4 Very short answers

a. MARKING SCHEME K · 1

✓ Wendell Stanley, 1935.

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b. MARKING SCHEME K · 1

✓ Streptomycin, from Streptomyces griseus.

c. MARKING SCHEME U · 1

✓ Soap destroys the virus's fatty envelope.

5 Short answers

a. MARKING SCHEME U · 2

✓ Prokaryotes and eukaryotes are cells with membrane, cytoplasm, ribosomes, DNA and RNA.

✓ A virus is acellular: none of these, one nucleic acid only.

b. MARKING SCHEME U · 2

✓ A cold is viral; antibiotics act on bacterial parts viruses lack.

✓ Needless use helps antibiotic-resistant bacteria spread.

c. MARKING SCHEME A · 2

✓ The virus carries a healthy (therapeutic) gene into the patient's cells as a vector.

✓ Its harmful genes are removed first.

d. MARKING SCHEME U · 3

✓ The human insulin gene is cut out and joined into a plasmid.

✓ The plasmid is put into E. coli.

✓ The bacteria multiply in a fermenter and make insulin, which is purified.

6 Numerical problems

ANSWER A · 4

i. $1{,}000 \div 30 \approx$ **33** polioviruses.

ii. 1 cm = 10,000,000 nm; $10{,}000{,}000 \div 30 \approx$ **330,000** (over 300,000).

iii. $100 \times 100 \times 100 =$ **1,000,000** phages.

iv. A light microscope can't show anything smaller than about **200 nm**; the poliovirus, at 30 nm, is far smaller.

MARKING SCHEME

✓ About 33.

✓ About 330,000.

✓ 1,000,000 phages.

✓ The light microscope's limit is about 200 nm.

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7 Long answers

a. ANSWER U · 4

Like living things, viruses:

a. contain genetic material (DNA or RNA) and **replicate** (multiply) inside host cells;
b. pass on their characters to their offspring (heredity);
c. undergo **mutation** and evolve;
d. are **infectious**, causing diseases, with an incubation period;
e. are **host specific**.

Like non-living things, viruses:

a. have **no cell** (acellular), no protoplasm, no cell membrane;
b. can be **crystallized** and stored like chemicals, remaining **inert** outside a host;
c. show **no metabolism**: no respiration, nutrition, excretion or growth; they have no enzymes to make ATP;
d. **can't multiply on their own**, outside a living cell.

Because they show living characters only inside a host cell and non-living ones outside it, they are placed at the borderline between living and non-living.

MARKING SCHEME

✓ Living: contain DNA or RNA and replicate inside host cells; heredity.
✓ Living: mutate, infectious with an incubation period, host specific.
✓ Non-living: acellular, crystallizable, inert outside a host.
✓ Non-living: no metabolism, no enzymes, can't multiply on their own.

b. ANSWER A · 4

Biofertilizers are living microbes that make nutrients available **slowly, as plants need them**; they cause **no runoff** or algal blooms, **improve soil life** so fertility lasts, are **cheap and renewable**, but act more slowly and only for certain crops.
Chemical fertilizers (urea, DAP) act **fast and predictably**, but much is **washed away**, polluting rivers and causing **algal blooms**; heavy use makes soil **acidic**; they are **expensive** and urea takes much energy to make.
For **lentils**: *Rhizobium*, which fixes nitrogen in their root nodules. For **rice**: the cyanobacteria *Anabaena* and *Nostoc*, and *Azotobacter*; for both, the phosphate-dissolving fungus *Penicillium bilaiae*.

MARKING SCHEME

✓ Biofertilizers: slow, natural, no pollution, lasting soil fertility, cheap.
✓ Chemical fertilizers: fast, but runoff, algal blooms, acid soil, costly.
✓ Rhizobium for lentils.
✓ Anabaena, Nostoc (or Azotobacter) for rice; or a phosphate-dissolving fungus.

8 Think

ANSWER HA · 3

The gene makes a **protein poisonous to the caterpillars** (bollworms) that bore into the cotton; a caterpillar that eats the plant dies.
Benefit: farmers spray **far less insecticide**, so less pesticide pollutes rivers and coastal waters. Risk, any one: genes may **spread to wild relatives**, it may **harm insects that weren't the target**, or **resistant pests** may appear.
Pests that resist the Bt poison appeared where farmers **did not follow the rules for its use**, so farmers must follow those rules for it to keep working.

MARKING SCHEME

✓ The gene makes a protein poisonous to the bollworm.
✓ One benefit (less insecticide) and one risk (gene spread, non-target harm, resistance).
✓ Follow the rules for its use, or resistant pests appear.

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9 Activity: Microbes in your kitchen

(not marked)

WHAT STUDENTS SHOULD FIND

Curd and gundruk: lactic acid bacteria, which make lactic acid; bread: yeast, whose carbon dioxide makes dough rise; jaand and raksi: the yeasts and molds of murcha, which turn starch into sugar and alcohol; kinema: *Bacillus subtilis*; vinegar: *Acetobacter*. Making curd, bread and alcohol with microbes is the oldest biotechnology: people used microbes in a controlled way for useful products thousands of years before anyone knew microbes existed.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	11	14	11	3	**39**

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