1. **Describe how a plasmid can be transferred from a bacterial cell to another one in the laboratory and in nature. What is the significance of this process in nature? (10%)**

2. **How would you try to obtain as many as possible the pure cultures of a variety of bacteria from a soil sample? (10%)**

3. **Name the strategies a bacterial pathogen may use to ensure a successful infection in a human body? (10%)**

4. **Read the following paragraphs and answer the question.**

   Some plasmids carry a pair of genes, *mazEF*, with *mazF* specifying a stable toxin and *mazE* specifying an unstable but specific antitoxin. When bacteria lose the plasmid, the cells are selectively killed because the unstable antitoxin is degraded faster than is the stable and lethal toxin.

   Gene pairs homologous to *mazEF* are also found on the *E. coli* chromosome. At least one of them has been shown to be involved in bacterial suicide under stresses. Under nutritional starvation, coexpression of *mazE* and *mazF* in *E. coli* is inhibited. Because MazE is a labile protein, its cellular levels fall more rapidly than do those of MazF, leaving MazF to exert its toxic effect and kill cells.

   Furthermore, several antibiotics, such as rifampin and chloramphenicol, were found to trigger *mazEF*-mediated death in *E. coli* cells growing in vitro by inhibiting coexpression of *mazE* and *mazF*. Thus, "triggering bacterial suicide" can now be added to other well-documented modes of antibiotic action. Although this effect on triggering bacterial cell death is documented only for several *E. coli* strains, the presence of similar *mazEF* suicidal modules in *E. coli* O157:H7 as well as other microorganisms could mean that such antibiotics also can trigger suicide in these other microorganisms. Whether antibiotics that activate the *mazEF* system of *E. coli* strains in vitro also do so in vivo remains unknown.

   Design an experiment that can help you determine whether the *mazEF* system mediates killing of *E. coli* strains that harbor this system by chloramphenicol in vivo. (20%)

5. **Based on the types of viral genomes, please classify all viruses into groups and give an example for each group. (10%)**

6. **Please describe the life cycles of RNA viruses, including how they infect,**

(背面仍有題目，請繼續作答)

replicate viral genomes, and produce progeny viruses in infected cells. (10%)

7. **Please list 4 antiviral immune responses and describe how they clear viral infections. (10%)**

8. **Based on the information provided below, please draw a picture to show the interaction of VZV and MPRs, which results in the cell association or secretion of virus. (20%)**

A long-standing dilemma that has puzzled researchers of varicella zoster virus (VZV), the causative agent of chickenpox (varicella) and shingles (zoster), is how airborne virions that emerge from skin lesions are able to readily transmit to new hosts, yet when grown *in vitro*, the virus is highly cell-associated and very few infectious virions are released. A new study found a host protein — the mannose 6-phosphate receptor (MPR) — as being a key molecule in both processes.

Cell association of VZV has been attributed to the re-routing of newly assembled virions to late endosomes where they are degraded prior to exocytosis. As previous work has shown that VZV is able to interact with cation-independent MPRs via its envelope glycoproteins, it is speculated that the presence of MPRs in the membrane of vesicles used to transport the newly enveloped virions could be responsible for their re-routing to late endosomes. Furthermore, previous research also demonstrated that mannose 6-phosphate, the ligand of MPRs, inhibits the infection of host cells by free VZV particles, indicating that MPRs have a role in the infection of new cells. In a new study, the authors tested the hypothesis that the intracellular trafficking of newly assembled VZV and the infection of target cells by free virions are MPR-dependent. So the authors generated five human cell lines deficient in MPRs. Analysis of these cell lines revealed that all were resistant to infection by cell-free VZV, although the cells could be infected by cell-associated VZV. Once infected, the mutant cell lines could secrete infectious virions, thus supporting the hypothesis that both infection of naive cells by the free virus and re-routing of newly assembled VZV to late endosomes require the participation of MPRs.

Further investigation of VZV infection in human epidermis revealed that the intracellular pathway of virus in superficial epidermal cells resembled that observed with the MPR-deficient cell lines. These results support the argument that, as MPR expression is lost in maturing superficial epidermal cells of the skin and VZV can not re-route to late endosomes, the virus can be secreted to readily transmit to new hosts.