

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

**Please read the following paragraph and answer questions 1 to 4.**

*Haemophilus influenzae* and *Streptococcus pneumoniae* exist together as common commensals of the healthy human nasopharynx, but both are important aetiological agents of different diseases, including the pediatric disease otitis media. It was recently shown that the formation of a multispecies biofilm of *H. influenzae* and *S. pneumoniae* is the cause of chronic forms of otitis media. However, the interactions between the two species are not clearly defined. Using a defined and kinetic analysis, our study has shown that while co-existence of the two species occurs, *S. pneumoniae* is also able to convert *H. influenzae* to a non-culturable state in a growth phase- and pH-dependent manner. To analyze the *H. influenzae*/*S. pneumoniae* interactions in more depth, we investigated the growth and transcriptional profile in a pH-defined batch culture model, as well as in a growth phase independent flow cell system. Transcriptomics has shown that there are changes in gene expression in each of the species when grown in co-culture, intriguingly inducing the *S. pneumoniae* bacteriocin transport genes, and phage-associated genes in both species. Importantly, we have shown vast changes in gene expression in a group of *S. pneumoniae* metabolic genes, including those encoding lactose utilization, glycerol utilization and sugar transport proteins, depending on the presence of *H. influenzae* and the growth system utilized. (Modified from the abstract of an article published in International Journal of Medical Microbiology, 2015)

1. Explain the following terms:

- a. Commensal (6%)
- b. Phage (6%)
- c. Bacteriocin (6%)

2. Briefly describe the morphology and pathogenicity of *Haemophilus influenzae*. (10%)

3. List the experimental results mentioned in this abstract that support the hypothesis that co-existence of different bacterial species may result in disease. (12%)

4. What experiment conducted in this study lead to the identification of genes with changed expression in a co-culture system? Briefly describe how you think this experiment is performed. (10%)

5. Please a) list three unique features of viruses comparing with bacteria.

b) describe **Baltimore classification** of viruses (list a virus for each class). (20%)

6. How do oncogenic viruses trigger cell immortalization and tumor formation? Please a) list two DNA viruses and one RNA virus and describe b) the underlying mechanism; c) what oncogenic diseases these viruses may induce. (20%)

編號：306

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7. Avian influenza viruses become one of the emerging viruses to infect human. Please a) list one avian influenza virus which may infect human and cause death; b) describe the possible reasons why avian influenza viruses can infect human. (10%)