DURATION: 3 hours

TOTAL MARKS: 120

Internal Examiner: Prof. S. Schmidt
External Examiner: Dr. F.M. Swalaha

CANDIDATES ARE REQUESTED TO WRITE LEGIBLY

INSTRUCTIONS: This exam paper comprises 2 sections, A and B. For section A mark your answers to these questions on the MCQ answer sheet provided. For section B, write your answers in the green answer book provided. The MCQ paper and answer sheet must be submitted with your written answer book(s). This papers consists of 8 pages, please make sure you have them all.

Section A – Multiple choice
(Σ=64 marks, 2 marks per answer)

MCQ's (not supplied)
1. The class delta-Proteobacteria comprises a number of predator species which undergo intricate lifecycles. Myxococcus xanthus is a well-known representative.
   a. Outline the life cycle of this bacterial species (highlight different stages, identify their function and activity, specify inducing factors). (8)
   b. The hunting strategy of Myxococcus xanthus is frequently compared to that of which well-known mammalian predator? Explain why. (2)
   c. Describe briefly (and/or add a clearly labelled illustration) which experimental strategy you would use to isolate such bacterial predators from the environment. (4)
   d. Which lifecycle stage of myxobacteria can be observed in the environment without a microscope? (1)

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2. A number of Desulfovibrio species can utilize chlorinated compounds such as 2-chlorophenol in anoxic polluted sediments; preferentially in the absence of nitrate, thiosulfate and sulfate.
   a. What is the role of 2-chlorophenol in their metabolism? (1)
   b. Which chemical compound is formed in Desulfovibrio spp. cultures utilizing 2-chlorophenol under anoxic conditions? (1)
   c. Why do these organisms require the presence of simple organic compounds such as acetate or lactate to catabolize 2-chlorophenol? (2)
   d. For several Desulfovibrio spp. it was established that their protein yield increased by a factor of two when 2-chlorophenol was replaced in experiments by equimolar quantities of 2,6-dichlorophenol. Explain why this might be the case. (3)
   e. Which term was coined in the literature to describe this type of bacterial metabolism? (1)

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3. The prokaryote Nanoarchaeum equitans is typically found in association with Ignicoccus hospitalis.
   a. Which term would best characterize the relationship of these two prokaryotes? Explain your answer. (3)
   b. What is the role of Ignicoccus hospitalis in this relationship? (1)
   c. Suggest an experiment and the principle behind it which you would run in the laboratory to confirm the type of relationship you specified above under (3a). (3)

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4. Microbially induced corrosion is a serious problem as it causes damage to essential infrastructure.
   a. Outline (you can use a clearly labelled figure) which groups of bacteria involved in sulfur metabolism can contribute to sewer corrosion and how this takes place. (5)
   b. Select two examples to illustrate and explain why our modern life style has increased the sewer corrosion caused by microbial metabolism. (4)
   c. Explain how the so called SRB can drive anodic iron dissolution. (2)

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5. Many heterotrophic *Proteobacteria* can catabolize aromatic compounds under aerobic conditions.
   a. Outline the underlying catabolic sequence starting with the substrate benzene until
      the first noncyclic intermediate is produced. Therefore put the numbers representing
      the correct compounds (select from the compounds shown below) into the correct
      sequence. In addition, name the enzymes catalyzing the individual reactions. (7)
   b. Identify the two co-substrates required by the enzyme performing the first reaction
      in the sequence. (2)
   c. You recently isolated a strain of the genus *Sphingopyxis* mineralizing naphthalene-
      2-ol (C_{10}H_{10}O) completely to H₂O and CO₂. Calculate the amount of oxygen (in mg)
      that is consumed when an amount of 1400 mg of this aliphatic hydrocarbon is
      completely mineralized. In addition, calculate the quantity of CO₂ (in mg) that is
      produced. (6)