Sample: Microbiology - Microbial Growth

Microbiology

1. A-1.B – in the separate pdf-file.

1.C.

Lag phase is a period when bacterial culture adapts to the new conditions of the environment. Cell divisions occur at the low rate. Enzymes required to metabolize the nutrients present in the culture medium are produced.

Exponential phase is characterized by the high rate of growth. Bacteria divide rapidly and the rate of reproduction is the highest. Bacterial population doubles with each new generation. Death rate is low. There are plenty of nutrients.

Stationary phase is when bacterial culture reproduces at that rate that is required to overcome the death rate. Culture growth is not observed. Nutrients are exhausted. Secondary metabolites are produced. Toxic materials, such as wastes, are released and cause death.

Death phase is when bacterial culture dies. Reproduction rate is much lower than death rate. Wastes are accumulated.

1.D. in the separate pdf file. Generation time is period required by the bacterial culture to double. It is measured during the exponential phase when the growth rate is the highest.

1.E. **$k = (\log N_t - \log N_0)/0.3t$** **$k = 1/g$**

k - mean growth rate constant

g - mean generation time

N_0 - the initial population number

N_t - the population at time t

k = (log 4000000 – log29)/0.3*11 = (6.6-1.46)/3.3 = 5.14/3.3 = 1.557 generations/hour

g = 1/k = 1/1.557 = 0.64 hr/gen. = 38 min/gen.

2. Every bacterial species has its optimal conditions for growth and reproduction. Optimal conditions for cultivation in the laboratory are determined by the natural habitat of the microorganism. *Staphylococcus epidermidis* is a human symbiotic bacterium. It usually colonizes the skin surface where the temperature is likely to be 37°C and pH is about neutral. Thus, such conditions are optimal for its growth within the laboratory. Any changes in the cultivation conditions can lead to changes in the growth curve shape (Cecil A. et al., 2011).

As far as 32°C and pH 6.0 are not optimal for *Staphylococcus epidermidis*, the curve will be lower in height. It means that fewer colonies will appear. Lag phase will be longer because bacteria will require more time to adapt to the unfavourable conditions. Exponential phase will be less steep because maximum speed of population growth can't be reached under unfavourable conditions. Stationary phase will not last long and death phase will appear sooner.

3. *E.coli* is a facultative anaerobe. It can survive both in the presence and absence of oxygen. In the presence of oxygen it uses glucose as an energy source and breaks down it into carbon dioxide and water. Under the anaerobic conditions it also uses glucose but for fermentation. Thus, glucose is again the main source of energy and carbon. (Wessely F. et al., 2011). Acid is produced and it can alter pH. Monobasic (KH_2PO_4) and dibasic (K_2HPO_4) potassium phosphates phosphates are important components of the medium. They are used as a buffer system. It means that they keep pH within normal limits for *E.coli* growth. *E.coli* also uses phosphates to produce nucleic acids. Ammonia sulphate provides the cell with sulphur and nitrogen. Nitrogen is required for amino and nucleic acids synthesis. Sulphur is required for amino acids synthesis. It participates in covalent bonds formation between the sulfhydryl groups of some amino acids.

Magnesium is a cofactor in different enzymes, including DNA and RNA polymerases and reparatory systems (Joyce H. G. et al., 2010). It is present in the medium as a component of magnesium phosphate. Calcium is also required for different cellular processes. Trace elements are microelements that are required in small amounts. They contribute to enzymes functioning because mostly serve as cofactors.

4. A. The components of the medium for *Thiobacillus* are rather similar to those ones require by *E.coli.* However, different amounts are required and glucose is not needed by *Thiobacillus thioparus.* Culture medium composition reflects the biochemical specificities of the microorganism. Components of the buffer system are present in lower amounts in the culture medium for *Thiobacillus thioparus.* It means that is produces less acids than *E.coli. Thiobacillus thioparus* obtains energy from sulphide and thiosulphate oxidation (J. De Zwart et al., 1997). Those substances are transformed into sulphate then. Thus, sulphate is the waste product. It must inhibit *Thiobacillus thioparus* metabolism and therefore, less sulphates are added to the medium. The same amount of trace elements is present in cultivation medium for *Thiobacillus thioparus* and *E.coli.*

B. *Thiobacillus thioparus* obtains energy from thiosulphate oxidation of from the medium. Thiosulphate is used as an electrons donor. Electrons are accepted by the electron transport chain and their transfer along the chain results in proton gradient creation and ATP synthesis. Thiosulphate is converted into sulphate after it has donated the electrons. Carbon-containing substances are not present in the culture medium. Thus, the microorganism must use carbon

from the atmosphere in the form of carbon dioxide. Therefore, it must produce its own organic molecules via carbon dioxide fixation. Thus, it must be autotrophic.

C. *Thiobacillus thioparus* is chemolitoautotrophic. Chemotrophic means that it obtains energy with the help of chemical reactions (oxidation of sulphur containing substances into sulphates). Litotrophic means that it obtains electrons from inorganic substances (thiosulphate). Autotrophic means that *Thiobacillus thioparus* can produce its own organic molecules from carbon dioxide present in the atmosphere.

References

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