KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN BIOCHEMISTRY AND BIOTECHNOLOGY

SBC 409: FERMENTATION TECHNOLOGY

DATE: MONDAY, 26TH MARCH 2012 TIME: 4.30 P.M. – 6.30 P.M.

INSTRUCTIONS

SECTION A: ASNWER ALL QUESTIONS. (20 MARKS)

1. In fermentation, which of the following feeding strategies does not require accurate monitoring and operator control?

A) Variable feeding regime

B) Continuous feeding regime

C) Intermittent feeding regime

D) Incremental feeding regime

E) Batch feeding regime

2. The following is an advantage of the fed-batch fermentation process

A) Detailed knowledge of the organism's growth and product formation pattern is required.

B) Deficiency of reliable online sensors for accurate substrate determination in near real time.

C) Without feedback control, the feed is predetermined and therefore little fluctuations within the bioprocess.

D) The process operator must be fully trained and highly skilled.

E) There is increased production of non-growth related secondary metabolites

3. Which among the following is not a strategy to keep the volume of the fed batch fermentation process fixed?

A) Limiting the substrate

B) Feeding growth-limiting substrate in undiluted form

C) Adding the substrate by dialysis

D) Irradiation of the fermentation

E) None of the above

4. During the continuous culture fermentation

A) Productivity and growth rate can be optimised by changing the feed flow rate during production

B) All primary and secondary products are produced optimally

C) Non-growth-associated products are optimally produced

D) Culture mutation rarely occur in the microorganism

E) Back mutation that is common in fermentation does occur

5. The following fermentation configuration is not associated with continuous cultures

A) Plug flow

B) Fixed volume

C) Chemostat

D) Turbidostat

E) Auxostat

6. Under which culture conditions will the specific growth rate of a bacteria culture (R) and substrate concentration (S) become the maximum specific growth rate and limiting substrate concentration respectively

A) When specific growth rate is half the volumetric growth rate

B) When the substrate concentration is far much greater than the saturation constant

C) When the substrate concentration is far smaller than the saturation constant

D) When the substrate concentration is equal to the saturation constant

E) When the growth mechanism exhibit zero order kinetics

7. Among the known fermentation culture processes, which one prolongs the exponential phase of growth?

    A) Batch culture process

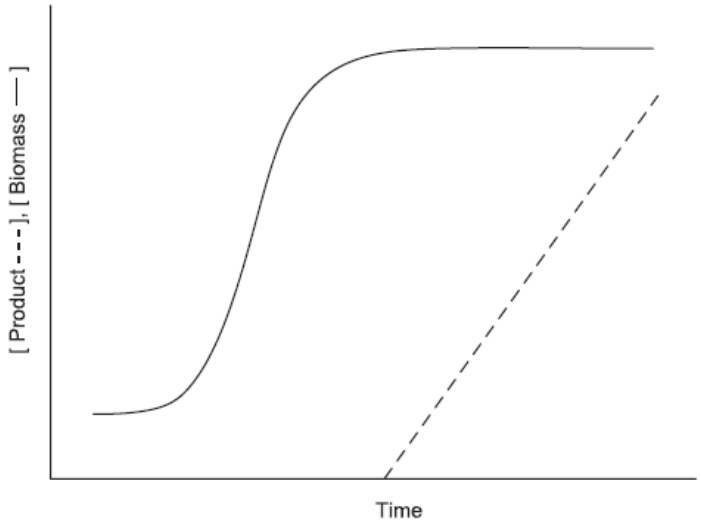
    B) Continuous culture process

    C) Fed-Batch culture process

    D) The stirred tank reactor process

    E) The open culture fermentation process

8. During a fermentation process to make penicillin, the kinetics results were plotted as shown in the graph below (solid line is for cell biomass and dotted line for penicillin). What statement is true about penicillin production via fermentation?



    A) Penicillin is a primary metabolite that is affected by the accumulating biomass of the culture
    B) Penicillin is essential for the growth of the culture
    C) Penicillin overproduction is achievable under the conditions
    D) Penicillin is formed from the growth substrate by cell activity
    E) Production of penicillin occurs during the slow growth and the stationery growth phase

9. When carrying out routine checks on an on-going fermentation, a technician found the cells to be dividing close to maximum, the nutrients depleting rapidly and heat was generated in the bioreactor. At what stage was the fermentation process?

    A) The log phase

    B) The lag phase

    C) The late log-phase

D) The early log phase

E) The de-acceleration phase

10. Which of the following component is not part of a glass jacketed bioreactor?

A) Water chamber

B) Impellor

C) Baffle

D) Head plate

E) Sight glass

11. When configuring a bioreactor vessel,

A) Mammalian culture reactors are fitted with Rushton impellors and baffles

B) Bacterial cultures are fitted with Rushton impellors and baffles

C) Deep sea microorganisms' cultures are grown with high speed mixing

D) Halophiles and acidophiles are cultured in stainless steel vessels

E) A covering tinfoil and light source are used for organisms that require light at a particular wavelength

12. One of the following procedures is not correct in making a starter culture

A) Isolate culture, identify, propagate in small volume, propagate in large volume, package, freeze and store

B) Stock culture, confirm purity, propagate in small volume, propagate in large volume, lyophilize, package, freeze and store

C) Stock culture, confirm identify, propagate in small volume, propagate in large volume, concentrate, suspend in carrier medium, package, freeze and store

D) Isolate culture, confirm purity, propagate in small volume, propagate in large volume, add cryoprotectant, package, freeze and store

E) Culture collection, confirm identity, propagate in small volume, propagate in large volume, concentrate, add cryoprotectant, lyophilize, package, freeze and store.

13. When selecting microorganisms for production of a secondary metabolite by fermentation, an anaerobic condition with glucose as the substrate were preferred. The preeminent metabolic pathway(s) suitable for the selection is(are)

A) Embden-Meyerhof-Parnas pathway alone

B) Embden-Meyerhof-Parnas and Entner-Duodoroff pathways

C) Entner-Duodoroff pathway alone

D) Embden-Meyerhof-Parnas and the pentose phosphate pathways

E) The phosphoketolase pathway alone

14. Which of the following microorganism will produce the highest amounts of secondary metabolites via the shikimate pathway under aerobic conditions with glucose as the substrate?

A) *Saccharomyces cerevisae*

B) *Penicillium chrysogenum*

C) Both *Saccharomyces cerevisae* and *Penicillium chrysogenum*

D) Acetobacter

E) All of the above

15. One of the following does not matter during sterilizing of a fermentation process

A) Volume

B) Components

C) Bioreactor

D) Cost

E) Space

16. Continuous sterilizers are

A) Used on the industrial scale for the production of media for large volume, low value products

B) An example of sterilize in place bioreactors (SIPs)

C) They can dry out if insufficient care is taken.

D) Useful in emergencies.

E) They have automated cycle times

17. Which among the following bioreactors is aerated by gas sparging?

A) Airlift fermentors

B) Hollow fibre chambers

C) Tower fermentors

D) Perfusion bioreactors

E) Stirred tank bioreactors

18. When sterilizing bioreactors, stainless steel steam in place systems use high atmospheric pressure that also

A) Allows *in situ* sterilization

B) Enhances oxygen transfer rate

C) Allows the need for a large autoclave

D) Reduces the need for man handling

E) Allows for automation

19. When establishing a microbial fermentation, one MUST at least provide all of the following except

A) A nitrogen source

B) A carbon source

C) An energy source

D) Suitable photochemical condition

E) A viable inoculums

20. Filtration is one of the techniques used for sterilization of fermentation media. What filter pore is required to successfully remove bacteria?

A) 0.45 □m

B) 0.22 □m

C) 20 nm

D) 20 □m

E) 0.22 nm

SECTION B: ANSWER ALL QUESTIONS (5 MARKS EACH)

1. (a) In a fermentation process, the r_x is 500kg/m/h, r_p 10000mg/m/h and □ is 100/h. What is the amount of biomass formed and specific product formation rate? (2 Marks)

(b) When producing SCP from methane and ammonia, the oxygen consumption is 1.35 mols per mol methane utilized. From the stoichiometric equation below, show that

$$CH_4 \square\square aO_2 \square\square bNH_3 \rightarrow cCH_{1.81}O_{0.52}N_{0.21} \square\square dCO_2 \square\square eH_2O$$

b = 0.13

c = 0.63

d = 0.37

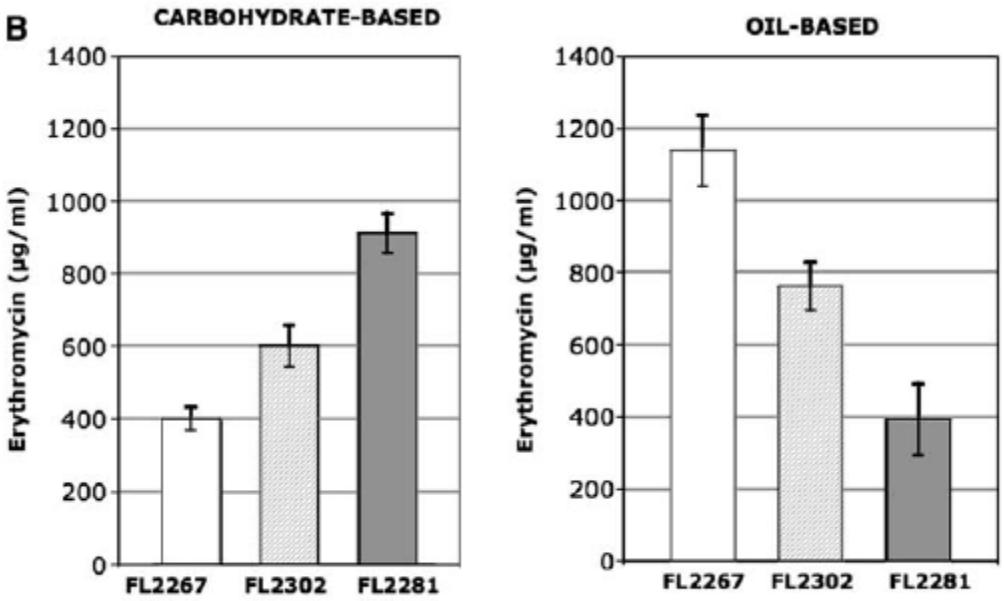
e = 1.63

(3 Marks)

2. (a) What is the doubling (generation) time of a fermentation that has a critical biomass of 600kg/m^3, limiting substrate concentration of 100kg during the zero order of growth (2 Marks)

(b) Describe the growth pattern of a microbial culture (3 Marks)

3. During genetic improvement of *Saccharopolyspora erythraea* for production of erythromycin, the wild-type strain (FL2267), non-polar *mutB* knockout strain (FL2302) and the polar *mutB* knockout strain (FL2281) gave contrasting yields on two different media as shown in the graphs below. Discuss the success of the genetic strain improvement (5 Marks)



4. List FIVE advantages and disadvantages of batch culture process (5 marks)

5. What criteria is used in choosing the raw material for a fermentation process (5 Marks)

6. Briefly discuss the efficiency of oxygen transfer in fermentation systems (5 Marks)

SECTION C: ANSWER ANY TWO QUESTIONS (10 MARKS EACH)

1. Giving examples, describe the classification of secondary metabolites according to their synthetic metabolic pathways during the process of fermentation

2. Give an account of the various media used in fermentation

3. Using the Monod growth kinetics, describe the meaning of zero order, first order and mixed order specific growth rates in relation to the substrate concentration

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