Final Examination
2018/2019 Academic Session

June 2019

JIB 322 – Molecular Biology
(Biologi Molekul)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of **TWENTY FIVE (25)** pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **DUA PULUH LIMA (25)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini].*

Instructions : Answer **ALL** questions from **Section A** in the **OMR** sheet provided. Answer **THREE (3)** questions from **Section B.** All answers for **Section B** must be written in the answer booklet provided. Marks for each subquestion in **Section B** are given. You may answer **either** in Bahasa Malaysia or English.

*[**Arahan** : Jawab **SEMUA** soalan **Seksyen A** dalam borang **OMR** yang diberikan. Jawab **TIGA (3)** soalan daripada **Seksyen B.** Semua jawapan **Seksyen B** mestilah ditulis dalam buku jawapan yang disediakan. Markah untuk setiap subsoalan dalam **Seksyen B** diperlihatkan di penghujung subsoalan itu. Anda dibenarkan menjawab soalan **sama ada** dalam Bahasa Malaysia atau Bahasa Inggeris].*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai].

THE WHOLE QUESTION BOOKLET MUST BE RETURNED TO THE INVIGILATORS.

[KESELURUHAN KERTAS SOALAN INI MESTI DISERAHKAN KEMBALI KEPADA PENGAWAS PEPERIKSAAN].

…2/-

Section A - Answer ALL questions
Seksyen A - Jawab SEMUA soalan
(40 marks/*markah*)

1. The description of the lagging and leading strands of DNA are true **EXCEPT** for

   A. the strand elongates at 3' end of the primer
   B. only one of the two exposed templates can be replicated continuously as the replication fork moves
   C. on the lagging strand, the polymerase simply "chases" the moving replication fork
   D. it needs primer for the DNA synthesis
   E. it has Okazaki fragments

   *Huraian tentang bebenang susulan DNA dan bebenang pimpinan DNA adalah benar **KECUALI***

   A. bebenang memanjang pada hujung primer 3'
   B. hanya satu daripada dua templat yang terdedah boleh direplikasi secara langsung sepanjang pergerakan cabang replikasi
   C. pada bebenang pimpinan, polimerase mengejar cabang replikasi yang bergerak
   D. memerlukan primer untuk sisntesis DNA
   E. memerlukan fragmen Okazaki

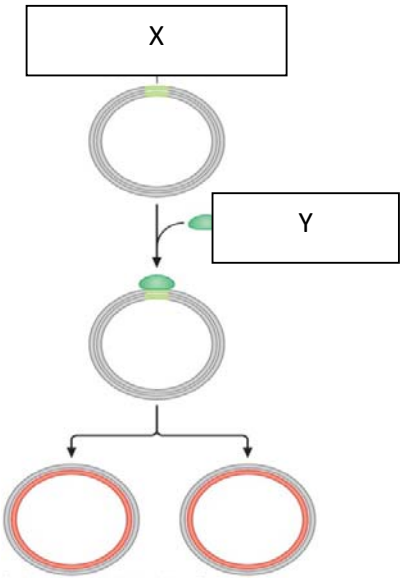

Figure 1/ *Rajah 1*

2. There are two main components for replication and initiation. Fill in the blanks X and Y(Figure 1)

   A. Transcription, Deletion
   B. Replicator, Initiator
   C. Initiator, Replicator
   D. Duplicator, Initiator
   E. Replicator, Duplicator

   Terdapat dua komponen utama untuk pereplikaan dan permulaan. Isikan tempat kosong X dan Y (Rajah 1)

   A. Transkripsi, Pelesapan
   B. Pereplika, Pemula
   C. Pemula, Pereplika
   D. Pengganda, Pemula
   E. Pereplika, Pengganda

3. There are several important sources of mutation with include

   A. inaccuracy in DNA replication
   B. radiation
   C. oxidation
   D. deamination
   E. All of the above

Terdapat beberapa punca mutasi yang penting, termasuk

A. ketidaktepatan pereplikaan DNA
B. radiasi
C. oksidasi.
D. deaminasi.
E. Semua di atas

4. An enzyme that is responsible for photoreactivation is

A. glycosylase
B. pyruvate kinase
C. photolyase
D. DNA polymerase
E. None of the above

Enzim yang bertanggungjawab dalam pemfotoreaktifan ialah

A. glikosilase
B. piruvat kinase
C. fotoliase.
D. DNA polimerase
E. Tiada di atas

5. A single base error is also called

A. point mutation
B. transversion
C. transition
D. insertion
E. None of the above

Kesalahan satu bes juga dikenali sebagai

A. mutasi titik
B. transversi
C. transisi
D. penambahan
E. Tiada di atas

6. The structure of DNA helix is composed of two polynucleotide chains _____

   i. with hydrogen bonds
   ii. involves minor groves
   iii. involves major groves
   iv. with sugar-phosphate backbones

   A. i and ii
   B. ii and iii
   C. iii and iv
   D. i, ii, and iii
   E. All of the above

   Struktur DNA heliks terdiri daripada dua rantai polinukleotida _____

   i. dengan ikatan hidrogen
   ii. melibatkan kumpulan minor
   iii. melibatkan kumpulan major
   iv. dengan tulang belakang gula-fosfat

   A. i and ii
   B. ii and iii
   C. iii and iv
   D. i, ii, and iii
   E. Semua di atas

7. RNA contains _____, whereas DNA contains _____

   A. deoxyribose sugar, a ribose sugar
   B. nucleotides, nucleic acids
   C. uracil, thymine
   D. cytosine, guanine
   E. adenine, guanine

   RNA mengandungi _____, sedangkan DNA mengandungi _____

   A. gula deoksiribosa, gula ribosa
   B. nukleotida, asid nukleik
   C. urasil, timina
   D. sitosina, guanina
   E. adenina, guanina

8. If one strand of a DNA double helix has the sequence GTCCAT, what is the sequence of the other strand?

   A. ACTTGC
   B. TGAACG
   C. CAGGTA
   D. CAGGUA
   E. CUGGTU

   Jika satu bebenang heliks dubel DNA mempunyai turutan GTCCAT, apakah turutan bebenang yang satu lagi?

   A. ACTTGC
   B. TGAACG
   C. CAGGTA
   D. CAGGUA
   E. CUGGTU

9. Major types of RNA include _____

   i. transfer RNA
   ii. ribosomal RNA
   iii. messenger RNA
   iv. short hairpin RNA

   A. i and ii
   B. ii and iii
   C. iii and iv
   D. i, ii, and iii
   E. All of the above

   Jenis utama RNA termasuk _____

   i. RNA permindah
   ii. RNA ribosom
   iii. RNA pengutus
   iv. RNA pin rambut pendek

   A. i dan ii
   B. ii dan iii
   C. iii dan iv
   D. i, ii, dan iii
   E. Semua di atas

10. The structure of protein can contain _____

    i. non-polar amino acids sequences
    ii. positive charge amino acids sequences
    iii. polar amino acids sequences
    iv. negative charge amino acids sequences

    A. i, ii and iii
    B. i, iii and iv
    C. ii, iii and iv
    D. All of the above
    E. None of the above

    Struktur protein boleh mengandungi _____

    i. jujukan asid amino tidak polar
    ii. jujukan asid amino yang bercas positif
    iii. jujukan asid amino polar
    iv. jujukan asid amino yang bercas negatif

    A. i, ii dan iii
    B. i, iii dan iv
    C. ii, iii dan iv
    D. Semua di atas
    E. Tiada di atas

11. DNA recombination can be _____

    i. a new combinations of DNA sequences during DNA mutation
    ii. an exchange of nucleotide sequences between two identical DNA molecules during mitosis
    iii. an exchange of nucleotide sequences between two identical DNA molecules during meiosis
    iv. an exchange of nucleotide sequences involved in the DNA repair double-strand breaks

    A. i, ii and iii
    B. i, iii and iv
    C. ii, iii and iv
    D. All of the above
    E. None of the above

Penggabungan DNA boleh terjadi apabila _____

i. gabungan baru turutan DNA boleh berlaku semasa mutasi DNA
ii. satu pertukaran turutan nukleotida antara dua molekul DNA yang sama semasa mitosis
iii. satu pertukaran turutan nukleotida antara dua molekul DNA yang sama semasa meiosis
iv. pertukaran rangkaian nukleotida yang melibatkan pemulihan dua jujukan DNA yang terputus

A. i, ii and iii
B. i, iii and iv
C. ii, iii and iv
D. Semua di atas
E. Tiada di atas

12. Types of genetic recombination involve _____

i. homologous recombination
ii. site-specific recombination
iii. transposition of DNA element
iv. transcription

A. i, ii and iii
B. i, iii and iv
C. ii, iii and iv
D. All of the above
E. None of the above

Jenis penggabungan genetik melibatkan _____

i. rekombinasi homologi
ii. penggabungan semula tapak-spesifik
iii. tranposisi elemen DNA
iv. transkripsi

A. i, ii and iii
B. i, iii and iv
C. ii, iii and iv
D. Semua di atas
E. Tiada di atas

13. The current model of DNA homologous recombination are _____

    i. Holiday double-strand invasion
    ii. single-strand invasion
    iii. DNA double strands break
    iv. translation

    A. i, ii and iii
    B. i, iii and iv
    C. ii, iii and iv
    D. All of the above
    E. None of the above

    Model semasa penggabungan homolog DNA melibatkan _____

    i. serangan dua hala Holiday
    ii. serangan tunggal
    iii. pemulihan dua jujukan DNA yang terputus
    iv. terjemahan

    A. i, ii and iii
    B. i, iii and iv
    C. ii, iii and iv
    D. Semua di atas
    E. Tiada di atas

14. Techniques in Western blotting _____

    i. can determine the size and amount of protein in a given sample
    ii. can diagnose a disease by specific antibody against virus or bacteria in a serum sample
    iii. is the confirmatory test for HIV which detects anti-HIV antibody in serum from a patient
    iv. is a useful method to detect defective proteins, for example in Prions disease

    A. i and ii
    B. ii and iii
    C. iii and iv
    D. i, ii, and iii
    E. All of the above

Teknik dalam serapan Western _____

i. boleh menentukan saiz dan jumlah protein dalam sampel yang diberi
ii. digunakan untuk diagnosis penyakit dengan mengesan antibodi spesifik terhadap virus atau bakteria dalam sampel serum
iii. adalah ujian pengesahan untuk HIV dimana ia mengesan antibodi anti-HIV dalam serum pesakit
iv. kaedah berguna untuk mengesan protein yang rosak contohnya dalam penyakit Prions.

A. i dan ii
B. ii dan iii
C. iii dan iv
D. i, ii, dan iii
E. Semua di atas

15. The process of making multiple copies of a gene by inserting it into a host genome and culturing the host is called _____

A. gene cloning
B. industrial genetic engineering
C. gene amplification
D. gene magnification
E. gene pharming

Proses membuat banyak salinan gen dengan memasukkan ke dalam genom perumah dan pengkulturan perumah disebut _____

A. pengklonan gen
B. kejuruteraan genetik perindustrian
C. amplifikasi gen
D. magnifikasi gen
E. farmasi gen

16. The machineries for the gene translation are

i. mRNA
ii. tRNA
iii. aminoacyl-tRNA synthetase
iv. ribosome

A. i and ii
B. ii and iii
C. iii and iv
D. ii and iv
E. All of the above

Jentera untuk translasi gen ialah

i. mRNA
ii. tRNA
iii. aminoasil-tRNA sintetase
iv. ribosom

A. i dan ii
B. ii dan iii
C. iii dan iv
D. ii dan iv
E. Semua di atas

17. Principle steps of translation are

i. initiation
ii. elongation
iii. addition
iv. termination

A. i and ii
B. ii and iii
C. i, ii and iii
D. ii, iii and iv
E. i, ii and iv

Langkah utama translasi ialah

i. pemulaan
ii. pemanjangan
iii. penambahan
iv. penamatan

A. i dan ii
B. ii dan iii
C. i, ii dan iii
D. ii, iii dan iv
E. i, ii dan iv

18. Eukaryotic cells always use _____ as the start codon during translation

A. 5'-AUG-3'
B. 5'-GUG-3'
C. 5'-UUG-3'
D. 5'-GUU-3'
E. 5'-UGU-3'

Sel eukariot sentiasa menggunakan _____ sebagai kodon pemula ketika proses translasi

A. 5'-AUG-3'
B. 5'-GUG-3'
C. 5'-UUG-3'
D. 5'-GUU-3'
E. 5'-UGU-3'

19. The three binding sites in ribosomes are known as

i. A site
ii. B site
iii. D site
iv. E site
v. P site

A. i, ii and iii
B. i, iv and v
C. ii, iii and iv
D. iii, iv and v
E. i, ii and v

Tiga tapak pengikatan pada ribosom dikenali sebagai

i. tapak A
ii. tapak B
iii. tapak D
iv. tapak E
v. tapak P

A. i, ii dan iii
B. i, iv dan v
C. ii, iii dan iv
D. iii, iv dan v
E. i, ii dan v

Questions 20 - 23 refer to Figure 2.
Soalan 20 - 23 merujuk kepada Rajah 2.

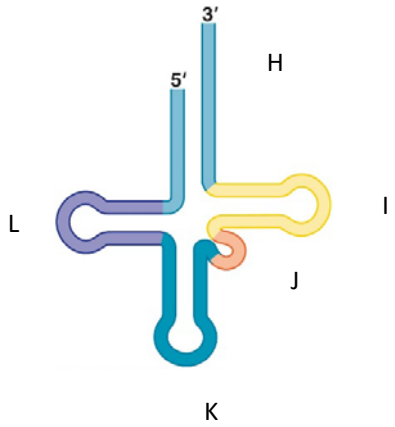

Figure 2. Cloverleaf representation of the secondary structure of tRNA
Rajah 2. Gambaran daun klover bagi struktur sekunder tRNA

A. H
B. I
C. J
D. K
E. L

20. The variable loop is
Gelung pemboleh ubah ialah

21. The ψU loop is
Gelung ψU ialah

22. The acceptor arm is
Lengan penerima ialah

23. The anticodon stem is
Batang anticodon ialah

	U		C		A		G		
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC		UCC		UAC		UGC		C
	UUA	Leu	UCA		UAA*	stop /henti	UGA*	stop /henti	A
	UUG		UCG		UAG*	stop /henti	UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	Gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	Lys	AGA	Arg	A
	AUG†	Met	ACG		AAG		AGG		G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	Glu	GGA		A
	GUG		GCG		GAG		GGG		G

Table 1. The Genetic Code
Jadual 1. Kod Genetik

24. Referring to Table 1, what would be the most likely derived peptide sequence from the nucleotide sequence below?

5' AACCGAGGTCCATGGGGGTCATTTGGGGAT 3'

A. Asn Arg Gly Pro Trp Gly Ser Phe Gly Asp
B. Gly Val Phe Thr Gly Gly Thr Trp Ser Gln
C. Thr Glu Val His Gly Gly His Leu Gly Ile
D. Ala His Val Glu Cys Trp Met Ile Arg Cys
E. Pro Ile Val Asp Ser Arg Trp Phe Tyr Lys

Merujuk kepada Jadual 1, apakah jujukan peptida yang mungkin diperolehi daripada jujukan nukleotida di bawah?

5' AACCGAGGTCCATGGGGGTCATTTGGGGAT 3'

A. Asn Arg Gly Pro Trp Gly Ser Phe Gly Asp
B. Gly Val Phe Thr Gly Gly Thr Trp Ser Gln
C. Thr Glu Val His Gly Gly His Leu Gly Ile
D. Ala His Val Glu Cys Trp Met Ile Arg Cys
E. Pro Ile Val Asp Ser Arg Trp Phe Tyr Lys

25. From the peptide sequence given below which of the following nucleotide sequences can be the template for translation?

    Trp Gly Ser Asn Phe

    A. 5’ GTTGGGAAATTACTTCT 3’
    B. 5’ CCTGGTAAATGGGCCC 3’
    C. 5’ GATGATCCTCCGTTG 3’
    D. 5’ TAGTGATAATGATAGTA 3’
    E. 5’ TGGGGTAGTAATTTT 3’

    Daripada jujukan peptida yang diberikan di bawah manakah jujukan nukleotida berikut yang boleh menjadi templat untuk terjemahan?

    Trp Gly Ser Asn Phe

    A. 5’ GTTGGGAAATTACTTCT 3’
    B. 5’ CCTGGTAAATGGGCCC 3’
    C. 5’ GATGATCCTCCGTTG 3’
    D. 5’ TAGTGATAATGATAGTA 3’
    E. 5’ TGGGGTAGTAATTTT 3’

26. The poly-A binding protein binds to

    A. the A site of ribosome
    B. the 5’ end of eukaryotic mRNA
    C. the 3’ end of eukaryotic mRNA
    D. adenine bases in DNA
    E. arginine residues in polypeptides

    Protein pengikat poli-A mengikat kepada

    A. tapak A pada ribosom
    B. hujung 5’ pada mRNA eukariot
    C. hujung 3’ pada mRNA eukariot
    D. bes adenina pada DNA
    E. residu arginina pada polipeptida

Questions 27 - 29 refer to Figure 3.
Soalan 27 - 29 merujuk kepada Rajah 3.

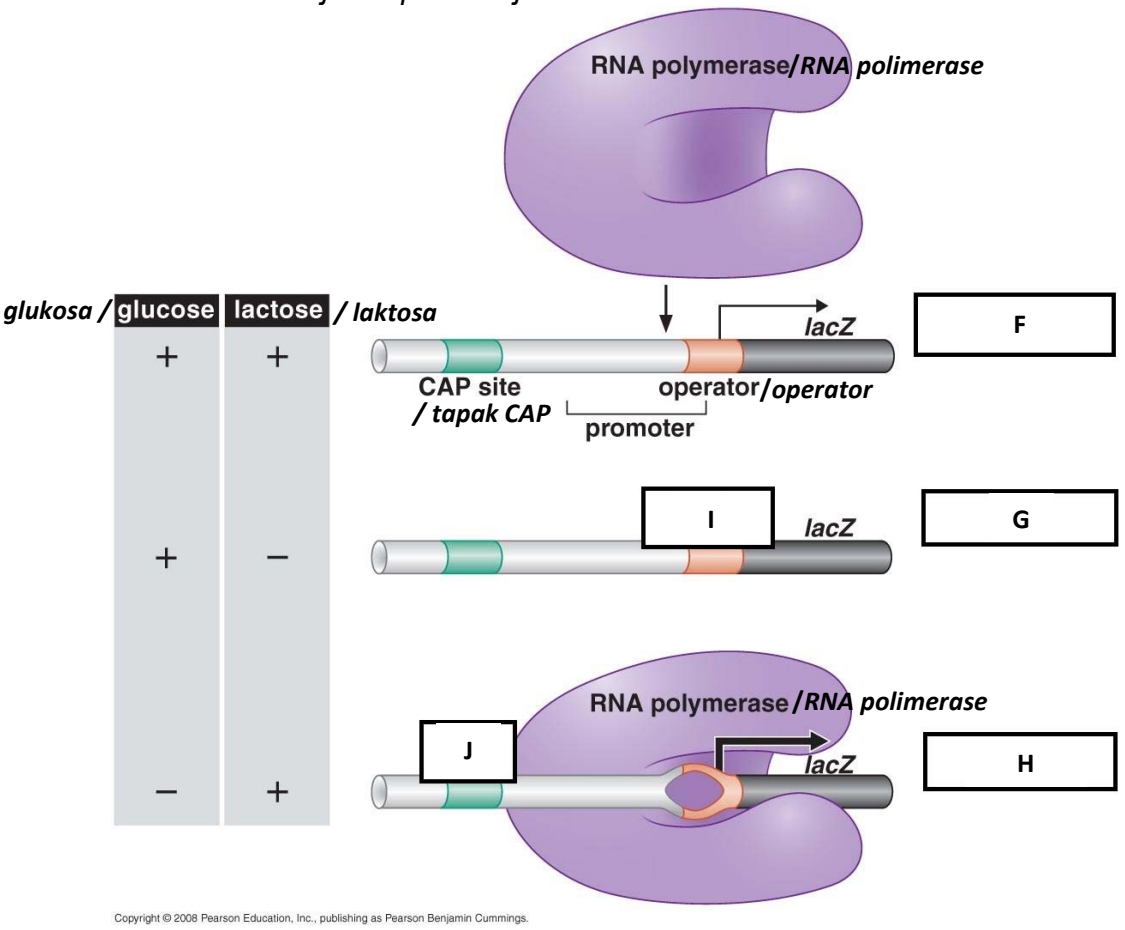

Figure 3. Activation by recruitment of RNA polymerase
Rajah 3. Pengaktifan oleh pengrekrutan RNA polimerase

27. At F, _____ occur with the presence of glucose and lactose

A. no transcription
B. basal transcription
C. activated transcription
D. moderated transcription
E. All of the above

Pada F, _____ berlaku dengan kehadiran glukosa dan laktosa

A. tiada transkripsi
B. transkripsi basal
C. transkripsi diaktifkan
D. transkripsi sederhana
E. Semua di atas

28. When the I protein binds to the operator region, what has happened to the transcription level at G?

A. No transcription
B. Basal transcription
C. Activated transcription
D. Moderated transcription
E. All of the above

Apabila protein I mengikat kawasan operator, apa yang berlaku pada tahap transkripsi G?

A. Tiada transkripsi
B. Transkripsi basal
C. Transkripsi diaktifkan
D. Transkripsi sederhana
E. Semua di atas

29. When the J protein binds to the CAP region, what has happened to the transcription level at H?

A. No transcription
B. Basal transcription
C. Activated transcription
D. Moderated transcription
E. All of the above

Apabila protein J mengikat kawasan CAP, apa yang berlaku pada tahap transkripsi H?

A. Tiada transkripsi
B. Transkripsi basal
C. Transkripsi diaktifkan
D. Transkripsi sederhana
E. Semua di atas

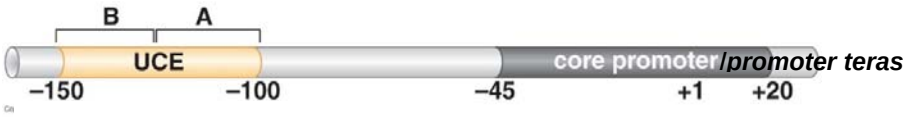

Figure 4. Eukaryotic class I gene promoter
Rajah 4. Promoter gen kelas I eukariot

30. Figure 4 shows a typical eukaryotic class I gene promoter. Which of the following factors will bind to the core promoter?

A. TBP
B. SL1
C. UBF
D. SPT6
E. TFIIS

Rajah 4 menunjukkan promoter gen kelas I eukariot yang tipikal. Manakah antara faktor berikut yang mengikat pada promoter teras?

A. TBP
B. SL1
C. UBF
D. SPT6
E. TFIIS

31. Which of the following is **NOT** a method of gene expression control in eukaryotes?

A. Transcriptional
B. Replicational
C. Post transcriptional
D. Translational
E. Post translational

*Manakah **BUKAN** cara pengawalan ekspresi gen di dalam sel eukariot?*

A. Transkripsi
B. Pereplikaan
C. Pos transkripsi
D. Terjemahan
E. Pos terjemahan

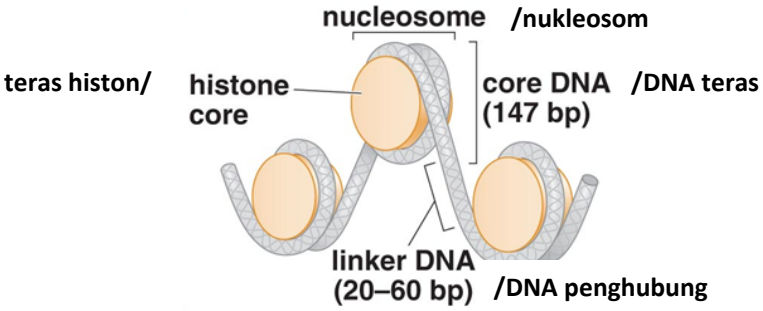

Figure 5 / *Rajah 5*

32. Figure 5 shows the packaging of DNA in a chromosome. The histone core consists of _____subunits

A. 4
B. 6
C. 8
D. 10
E. 12

Rajah 5 menunjukkan pembungkusan DNA pada kromosom. Teras histon terdiri daripada _____ subunit

A. 4
B. 6
C. 8
D. 10
E. 12

33. During eukaryotic gene transcription, _____ can block the transcription activation by the activators that are bound to enhancer

A. insulator
B. promoter
C. histone
D. leucine zipper motif
E. RNA polymerase

Semasa transkripsi gen eukariot, _____ boleh menghalang pengaktifan transkripsi oleh pengaktif yang mengikat pada penggalak

A. penebat
B. promoter
C. histon
D. motif zip leusina
E. RNA polimerase

34. The enzyme that removes the formyl group from amino acids in the polypeptide during translation is called

A. deacetylase
B. deformylase
C. deaminase
D. depeptidase
E. decarboxylase

Enzim yang menyingkirkan kumpulan formil daripada asid amino dalam polipeptida ketika terjemahan dipanggil

A. deasetilase
B. deformilase
C. deaminase
D. depeptidase
E. dekarboksilase

35. Epigenetic regulation can be defined as the inheritance of gene expression patterns,

A. in the absence of both mutation and initiating signal
B. with the presence of both mutation and initiating signal
C. in the absence of initiating signal only
D. in the absence of mutation only
E. in the presence of initiating signal only

Pengawal epigenetik boleh ditakrifkan sebagai pewarisan corak ekspresi gen,

A. tanpa kehadiran mutasi dan isyarat pemula
B. dengan kehadiran mutasi dan isyarat pemula
C. tanpa kehadiran isyarat pemula sahaja
D. tanpa kehadiran mutasi sahaja
E. dengan kehadiran isyarat pemula sahaja

Questions number 36 - 37 refer to Figure 6.
Soalan nombor 36 - 37 merujuk kepada Rajah 6.

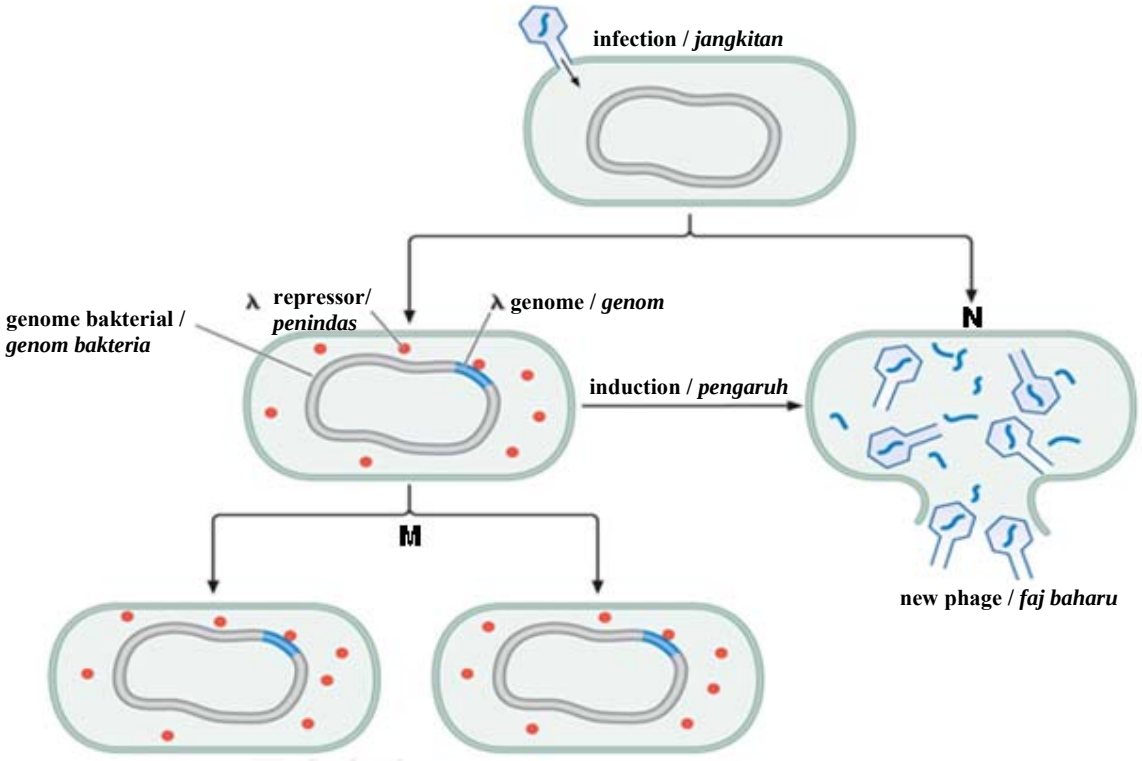

Figure 6. Growth and induction of λ lysogen
Rajah 6. Pertumbuhan dan induksi λ lysogen

36. What is M?

A. Lysis growth
B. Lysogenic growth
C. Lytic growth
D. Lysolytic growth
E. Lysozyme growth

Apakah M?

A. Pertumbuhan lisis
B. Pertumbuhan lisogenik
C. Pertumbuhan litik
D. Pertumbuhan lisolitik
E. Pertumbuhan lisozim

37. What is N?

A. Lysis growth
B. Lysogenic growth
C. Lytic growth
D. Lysolytic growth
E. Lysozyme growth

Apakah N?

A. Pertumbuhan lisis
B. Pertumbuhan lisogenik
C. Pertumbuhan litik
D. Pertumbuhan lisolitik
E. Pertumbuhan lisozim

38. Which of the following are classes of eukaryotic regulatory proteins?

i. Homeodomain proteins
ii. Zinc finger proteins
iii. Zinc cluster proteins
iv. Leucine zipper proteins
v. Helix-loop-helix proteins

A. i, ii and iii
B. ii, iii and iv
C. iii, iv and v
D. i, iii and v
E. All of the above

Manakah yang berikut merupakan kelas protein pengawalatur eukariot?

i. Protein homeodomain
ii. Protein jari zink
iii. Protein kluster zink
iv. Protein zip leusina
v. Protein heliks-gelung-heliks

A. i, ii dan iii
B. ii, iii dan iv
C. iii, iv dan v
D. i, iii dan v
E. Semua di atas

39. Autoregulation refers to

A. the control of transcription of other genes and itself by regulatory genes
B. the control of translation by transfer RNAs
C. the control of gene expression by the nucleosomes
D. the removal of introns by RNA polymerase II
E. the addition of new gene products by the ribosomes

Autoregulasi merujuk kepada

A. kawalan transkripsi gen lain dan kendiri oleh gen pengawalatur
B. kawalan terjemahan oleh RNA pemindah
C. kawalan pengekspresan gen oleh nukleosom
D. pembuangan intron oleh RNA polimerase II
E. penambahan produk gen baharu oleh ribosom

40. Which of the following techniques can be used to find regulatory sequences in genes?

i. DNase I footprinting
ii. DNA fingerprinting
iii. Mobility shift assay
iv. DNA sequencing
iv. ChIP-Chip assay

A. i, ii and iii
B. ii, iv and v
C. i, iii and v
D. All of the above
E. None of the above

Manakah daripada teknik berikut yang boleh digunakan untuk mencari jujukan pengawalatur pada gen?

i. Jejak tapak kaki DNase I
ii. Cap jari tangan DNA
iii. Asai anjakan mobility
iv. Penjujukan DNA
v. Asai ChIP-Chip

A. i, ii dan iii
B. ii, iv dan v
C. i, iii dan v
D. Semua di atas
E. Tiada di atas

SECTION B – ESSAY QUESTIONS
SEKSYEN B – SOALAN ESEI
(60 marks/*markah*)

Answer **THREE (3)** questions.
*Jawab **TIGA (3)** soalan.*

1. Discuss **FOUR (4)** types of DNA repair systems. Provide a diagram with complete label for each of them.
   *Bincangkan **EMPAT (4)** jenis sistem pembaikan DNA. Berikan gambar rajah berserta label yang lengkap untuk setiap satu.*

   (20 marks/*markah*)

2. Discuss the DNA replication concept with the aid of diagram.
   Bincangkan konsep pereplikaan DNA dengan bantuan gambar rajah.

   (20 marks/*markah*)

3. (a). What is meant by the degeneracy of the Genetic Code?
   Apakah maksud kemerosotan Kod Genetik?

   (4 marks/*markah*)

   (b). Explain **THREE (3)** kinds of point mutations that can alter the genetic code.
   *Jelaskan **TIGA (3)** jenis mutasi titik yang boleh mengubah kod genetik.*

   (6 marks/*markah*)

   (c). Discuss the main events required for translation in prokaryotes.
   Bincangkan peristiwa utama yang perlu bagi terjemahan pada prokariot.

   (10 marks/*markah*)

4. (a). Give **TWO (2)** examples to explain the function of riboswitches.
*Berikan **DUA (2)** contoh untuk menerangkan fungsi ribosuis.*

(10 marks/*markah*)

(b). Using the *lac* operon as a model, explain the roles of activator, repressor and effector in the regulation of gene expression in bacteria.
Dengan menggunakan operon lac sebagai model, terangkan peranan pengaktif, penindas dan efektor dalam pengawalan pengekspresan gen dalam bakteria.

(10 marks/*markah*)

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