

Please choose the most appropriate terms/phrases/statements that complete or answer the questions.
Attention: More than one of the choices provided may be correct. (2.5 points for each question)

- The high fidelity of DNA replication in *E. coli* would not be possible with
 - The high processivity of DNA polymerase III.
 - The σ subunit of DNA polymerase I.
 - The 5'-exonuclease activity of DNA polymerase I.
 - The 3'-exonuclease activity of DNA polymerase III.
 - The extremely high accuracy of the aminoacyl-tRNA synthetases.
- In glycoproteins, which amino acids in the protein part were attached by carbohydrate moieties?
 - Valine
 - Serine
 - Tryptophan
 - Asparagine
 - Alanine
- Which of the following assay can be used to detect protein-protein interaction:
 - DNA footprinting
 - Western blot
 - Yeast two-hybrid
 - Northern blot
 - Immune-precipitation
- What type of structural/functional change would be most likely in an oncogenically activated variant of the Ras protein?
 - Inability to interact with the Raf-1 protein kinase.
 - Reduced GTPase activity.
 - A point mutation in a transmembrane helix.
 - Resistance to the phosphatase PTEN.
 - An increased ability to tyrosine-phosphorylate proteins.
- Mutations in the p53 gene are the most common aberrations in spontaneous human cancers. The normal p53 protein affects the cell cycle by
 - Inducing cell cycle arrest in response to DNA damage.
 - Inducing the phosphorylation of pRb in response to mitogens.
 - Directly inhibiting Cdk inhibitors in response to cell-cell contact and other growth-inhibiting stimuli.
 - Increasing the activity of cyclin-dependent protein kinase by inducing their phosphorylation.
 - Inducing cell apoptosis in response to DNA damage.
- E. coli* Strain A (i^-Z^+/i^+Z^- diploid) was derived from Strain B (i^-Z^+) and Strain C (i^+Z^-) following a conjugation. Choose correct statements from the following.
 - The Strain A can constitutively express beta-galactosidase
 - The Strain A expresses beta-galactosidase in the presence of lactose
 - The operator of Strain A can be bound by repressor in the presence of glucose
 - The operator of Strain A can be bound by repressor in the presence of galactose
 - The operator of Strain A can be bound by repressor in the presence of lactose
- Trans*-acting factors bind to specific *cis*-elements to regulate transcription of eukaryotes. Select correct statements from the following.
 - TFIID binds to TATA box
 - Sp1 binds to CAAT box
 - Oct-1 binds to GC box
 - Fos and Jun binds to AP1 site
 - HSF binds to heat shock element

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8. What's the function of alpha-amanitin in inhibiting RNA polymerase activity. Please select correct answers.
- (A) Eukaryotic DNA-dependent RNA polymerase I is sensitive to high concentration of alpha-amanitin
 - (B) Eukaryotic DNA-dependent RNA polymerase II is sensitive to low concentration of alpha-amanitin
 - (C) Eukaryotic DNA-dependent RNA polymerase III is sensitive to low concentration of alpha-amanitin
 - (D) Eukaryotic DNA-dependent RNA polymerase III is sensitive to high concentration of alpha-amanitin
 - (E) None of above
9. Which of the following statements in regard to the processing of tRNA transcripts is/are **False**?
- (A) The 5' end of precursor tRNA can be cleaved by RNase P that possesses a ribozyme activity.
 - (B) The 5' end of precursor tRNA is added to the CCA sequence after RNase P cleavage.
 - (C) Precursor tRNAs undergo base modifications and splicing.
 - (D) The 3' end of precursor tRNA can carry specific amino acid residue for translation.
 - (E) The 3' sequence (U residue) of tRNA anticodon can complementary to the 5' sequence (G residue) of mRNA codon.
10. The substitution from codon AAA to UAA is called
- (A) Silent mutation.
 - (B) Missense mutation.
 - (C) Nonsense mutation.
 - (D) Frameshift mutation.
 - (E) Transversion mutation.
11. Which of the following techniques can be used to determine the size of a specific mRNA?
- (A) Northern blot analysis
 - (B) Southern blot analysis
 - (C) RT-PCR
 - (D) RT-real time PCR
 - (E) RNase protection assay
12. When clone DNA fragment with a pBluescript II plasmid. What are required to select clones with insert DNA?

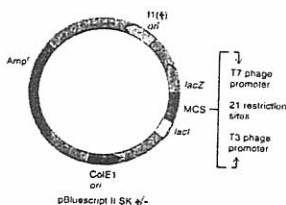


Figure 4.11 The pBluescript vector.

- (A) ampicillin
 - (B) tetracycline
 - (C) x-gal
 - (D) IPTG
 - (E) all of above
13. What is Single Nucleotide Polymorphism?
- (A) a single nucleotide in the genome differs between members of a species
 - (B) is present in at least 1% of the population
 - (C) SNPs represent about 90% of the common variation in the genome
 - (D) all SNPs can cause functional changes
 - (E) SNP maps will help scientists to identify the multiple genes associated with complex diseases
14. Which of the following amino acid substitutions would surely yield a mutant phenotype?
- (A) Pro to His
 - (B) Lys to Arg
 - (C) Ile to Thr
 - (D) Ile to Val
 - (E) Tyr to His
15. Which of the following techniques can be used to evaluate protein-DNA interaction?
- (A) Chromatin immunoprecipitation
 - (B) DNase I footprinting assay
 - (C) Electrophoretic Mobility shift assay
 - (D) Fluorescence in situ hybridization
 - (E) Microarray

16. Three researchers studying how chromosomes are protected by telomeres were awarded Nobel Prize in Physiology of Medicine last year. Which statement(s) of telomere below is/are CORRECT?
- (A) Telomeres are tandem repeats of short RNA sequences in the end of chromosomes which buffers the lost of chromosome ends during each round of DNA replication.
 - (B) Telomeres are replenished by telomerase, which is a reverse transcriptase.
 - (C) Telomerase transcribes single-stranded RNA templates to single-stranded DNA molecules.
 - (D) In human adults, telomerase only expresses in stem cells but not in terminally-differentiated cells.
 - (E) Telomerase is a highly conserved protein and can be identified in both prokaryotic and eukaryotic cells.
17. RNA interference (RNAi) is an evolutionary conserved mechanism to degrade RNA molecules in a sequence-specific manner. RNAi has an important role in defending cells against parasitic genes such as viruses and transposons. A specialized machinery of ribonucleases is required for RNAi, including Dicer and Argonaute. This ribonuclease machinery (and thus RNAi) does NOT exist in
- (A) *Homo sapiens*
 - (B) *Drosophila melanogaster*
 - (C) *Saccharomyces cerevisiae*
 - (D) *Schizosaccharomyces pombe*
 - (E) *Escherichia coli*
18. Epigenetics is a term referring to changes of phenotypes or gene expression caused by mechanisms other than changes of the underlying DNA sequences. Notable epigenetic regulations include mechanisms such as
- (A) Methylation of cytosines
 - (B) Post-translational modifications of histone tails
 - (C) Demethylation of thymidines
 - (D) ATP-dependent chromatin remodeling enzymes
 - (E) Deamination of cytosines
19. Prokaryotes and eukaryotes have acquired distinctive molecular apparatus for processing gene products during the evolutionary history. Which following features only appear in eukaryotic cells but not prokaryotic cells?
- (A) Splicing of primary mRNA transcripts
 - (B) Incorporation of N-formylmethionine into peptide chains during translation
 - (C) Addition of 5' cap to the mRNA transcript
 - (D) Acetylation of lysine residue side chains after translation
 - (E) Addition of 3' poly-adenylate tail to the mRNA transcript
20. Many transcription factors recognize different DNA sequence motifs through association with other transcription factors as heterodimers. Now you are investigating if two transcription factors A and B can form heterodimers in vivo, which experimental strategies are viable options for you to evaluate the binding between these two proteins?
- (A) Yeast one hybrid assay
 - (B) Yeast two hybrid assay
 - (C) Co-immunoprecipitation
 - (D) Tandem affinity purification followed by mass spectrometry
 - (E) Fluorescence energy resonance transfer

21. Which of the following is the correct combination of histone proteins reconstituted into a nucleosome:

- (A) One each of H2A, H2B, H3 and H4
- (B) A pair of H2A, H2B, H3 and H4
- (C) An H3/H4 tetramer and two H2A/H2B dimers
- (D) An H3/H4 dimer and an H2A/H2B tetramer
- (E) None of above

22. Which of the following amino acids contains uncharged polar R groups:

- (A) S
- (B) L
- (C) H
- (D) Y
- (E) C

23. Which of the following description is correct for the general definition of “promoter” in transcription:

- (A) A protein that stimulates transcription
- (B) A DNA region that encodes a protein
- (C) The regulatory DNA sequences upstream of the transcriptional start site of a given gene
- (D) The 3'-untranslated region of a given gene
- (E) The 5'-untranslated region of a given gene.

24. Which of the following assay(s) can be used to detect the “in vivo” function of a given gene:

- (A) RNA interference
- (B) Gene knock-in mice
- (C) Gel shift assay
- (D) Pull-down assay by a GST-fusion protein
- (E) Immuno-precipitation by a GST-fusion protein

25. RNA interference (RNAi) is a mechanism whereby a double-stranded RNA (dsRNA) can interfere with the expression of a specific target gene. In some eukaryotes (such as plants and worms), an enzyme is involved in an siRNA amplification mechanism that substantially augments the potency of RNAi-based surveillance. Please indicate what this enzyme is.

- (A) DNA-dependent RNA polymerase
- (B) RNA-dependent RNA polymerase
- (C) RNA-dependent DNA polymerase
- (D) RNA ligase
- (E) Terminal nucleotidyl transferase

26. It has been known for a long time that there are 20 genetically encoded amino acids. Now, there are two new amino acids, selenocysteine and pyrrolysine, found to be also co-translationally inserted into polypeptide. Indicate which codons that are most likely used for decoding these two

amino acids.

- (A) AUG (Initiation and methionine)
- (B) UAG and UGA (stop)
- (C) AAA and AAG (lysine)
- (D) UGU and UGC (cysteine)
- (E) New beyond 64 codons

27. Please indicate which RNA may have enzymatic activity (ribozyme)

- (A) Telomerase RNA
- (B) Ribosomal RNA
- (C) Micro RNA
- (D) U1 small nuclear RNA
- (E) Hammer-head RNA

28. Which of the followings are the property of the mammalian signal recognition particle (SRP)?

- (A) It targets nascent secretory polypeptides to the rough ER
- (B) It temporarily arrests translation
- (C) It binds to the signal sequence of secretory proteins
- (D) It contains both RNA and several polypeptides
- (E) It contains a signal peptidase activity

29. John intended to purify plasmid DNA from *E. coli*. He fractionated bacterial cell lysate through a CsCl/ethidium bromide gradient. After centrifugation for an appropriate time, he observed two major bands by UV light (see the figure). The lower band is supercoiled plasmid. Please indicate what the upper one could be.

- (A) mRNA
- (B) Chromosomal DNA fragment
- (C) Ribosomal RNA
- (D) tRNA
- (E) Nicked plasmid

30. Indicate which of the multicomponent complexes contain RNA

- (A) Bacterial RNA polymerase holoenzyme
- (B) RNA-induced silencing complex
- (C) Polyadenylation stimulation factors
- (D) Nucleosome
- (E) Telomerase

31. Which of the following statements about G protein coupled protein receptor are correct?

- (A) All G protein coupled receptors contain seven transmembrane α -helical regions
- (B) All G protein coupled receptors have same orientation in the plasma membrane
- (C) G protein coupled receptor activates exchange of GTP for GDP on the β -subunit of a trimeric G protein

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- (D) *Vibrio cholera* produces toxin that modifies G α s protein in intestinal epithelial cells into a constitutively active state
- (E) Olfactory receptors are G protein coupled receptor proteins
32. Which of the following statements about TGF- β signaling pathway are correct?
- (A) Binding of TGF- β induces the formation of receptor complexes containing two copies of RI and RII
- (B) Upon TGF- β binding, RI is phosphorylated by RII
- (C) Phosphorylated RI is an active kinase that phosphorylates Smad family proteins
- (D) TGF- β mediated Smad phosphorylations enhance the DNA binding activity but not nuclear translocation of Smad proteins
- (E) loss of TGF- β signaling plays a key role in cancer formation
33. It has been known that intracellular actin networks could regulate cell shapes. Which of the following cellular processes involve dynamic remodeling of actin networks?
- (A) Cancer cell migration
- (B) Macrophage phagocytosis
- (C) Synapse formation between two neurons
- (D) Stem cell division
- (E) Muscle contraction
34. Microtubules are polarized fibular macromolecules with (+) and (-) ends pointing away each other. Which of the following statements about microtubule are correct?
- (A) In epithelial cells, the majority of (-) ends point to microtubule organizing center (MTOC), whereas (+) ends point outwards.
- (B) In a cilium or flagellum (-) ends point to basal body, whereas (+) ends point to distal end of cilium or flagellum.
- (C) Polarized organization of microtubules ensure unidirectional movement of cargo, starting from (-) end, moving toward (+) end.
- (D) Microtubule is the only cytoskeleton involves in cargo transportation.
- (E) Even in migrating cells, microtubules are stable fibrous structures that maintain cell shapes
35. Checkpoints in cell cycle are mechanisms to ensure that each step in cell cycle proceeds only after the complete of the previous step. Which of the statements about cell cycle check points are correct?
- (A) Intra-S phase checkpoint prevents activation of cyclin A-CDK1 and cyclin B-CDK1 through inactivation of cdc25 by ATR-ChK1
- (B) In the spindle-assembly checkpoint, Mad2 and other proteins inhibit the degradation of securin mediated by APC/C
- (C) The spindle position checkpoint prevents release of the cdc14 phosphatase from nucleoli, thereby blocking activation of the APC/C
- (D) Activation of p53-p21^{CIP} pathway in DNA damage check point could arrest cell cycle in G1, S, as well as G2 phase.

(E) Inactivation of *cdc25* by ATM/R-ChK1/2 during DNA damage also arrests cell cycle progression, thus serves a check point mechanism.

36. Which of the following molecular events contribute to the diversity of immunoglobulin repertoire?

- (A) Isotype switch of heavy chain
- (B) Multiple V, D, and J segments in genome
- (C) Junctional imprecision of recombination
- (D) Somatic hypermutation
- (E) Clonal deletion of autoreactive B cell

37. Which of the mutational mechanisms promote cell transformation?

- (A) Gain of function mutation of Her2 receptor which leads to Her2 dimerization in the absence of the normal EGF-related ligands.
- (B) Any point mutation of Ras that reduces the GTPase activity of Ras.
- (C) Chromosomal translocation that fuses a part of the *c-abl* gene with a part of the *bcr* gene. The hybrid *bcr-abl* protein exhibits unregulated Abl kinase activity.
- (D) Gain of function mutation of retinoblastoma gene that enforces binding of Rb to E2f thereby prevents cell cycle progression.
- (E) Gain of function mutation of p53 allows cells to escape from contact inhibition of proliferation

38. Which of the statements describe synaptic connectivity in nerve system correctly?

- (A) The directionality of synaptic transmission is from presynaptic to postsynaptic
- (B) Synaptic vesicles loaded with neurotransmitter are part of postsynaptic structures
- (C) Influx of Ca^{2+} triggers release of neurotransmitters through binding to synaptotagmin
- (D) Reuptake and degradation of neurotransmitters are two mechanisms to prevent continued stimulation of the postsynaptic cell
- (E) Both presynaptic and postsynaptic structures are non-plastic and not subjective to activity-dependent modulations

39. Which of the following protein structures mediate cell-cell interaction?

- (A) Hemidesmosome
- (B) Gap junction
- (C) Tight junction
- (D) Adherent junction
- (E) Immunological synapse

40. How could protein could be posttranslationally modified?

- (A) Ubiquitylation
- (B) Sumoylation
- (C) Acetylation
- (D) Methylation
- (E) Palmitoylation