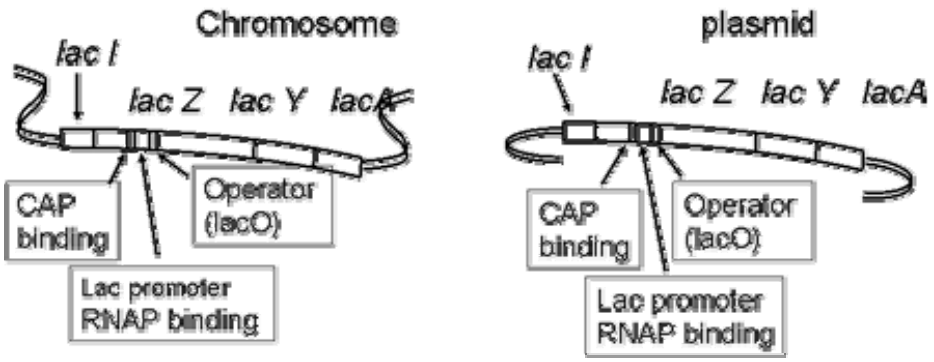
Practice Exam Questions



The following THREE questions relate to the picture above. Cells have a *lac* operon and *lacI* gene on the chromosome and a single plasmid with a *lac* operon and a *lacI* gene. The questions indicate whether there are mutations in the operons and the carbon source in the medium. For each question, choose the best alternative that describes whether LacZ is being made; if so at high level or basal levels and which operon encodes the LacZ protein that is being made. Note that the term "wild type" means the genes have 'normal function'.

1. The chromosomal *lac* operon and *lacI* gene are wild type. The plasmid *lac* operon is missing only the *lacO* region. The cells are growing on lactose and glucose.

A. The cells have no LacZ at all.
B. The cells have a basal level of LacZ and the protein is derived from both operons.
C. The cells have a high level of LacZ and the protein is derived from both operons.
D. The cells have a basal level of LacZ and the protein is derived only from the operon on the plasmid.
E. The cells have a high level of LacZ and the protein is derived only from the operon on the plasmid.

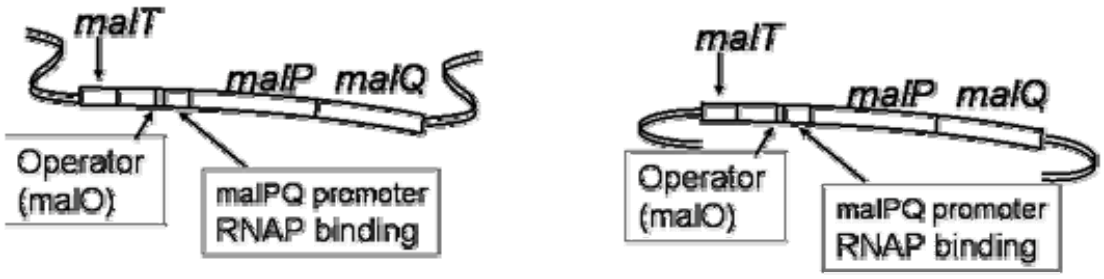
2. The chromosomal *lac* operon has a mutation that eliminates the *lacZ* gene but the rest of the operon and the *lacI* gene are wild type. The plasmid *lac* operon has a mutation that eliminates *lacY* but the rest of the operon and the *lacI* gene are wild type. The cells are growing on lactose.

A. The cells have no LacZ at all.
B. The cells have a basal level of LacZ and the protein is derived from both operons.

C. The cells have a high level of LacZ and the protein is derived from both operons.
D. The cells have a basal level of LacZ and the protein is derived only from the operon on the plasmid.
E. The cells have a high level of LacZ and the protein is derived only from the operon on the plasmid.

3. The chromosomal *lac* operon is missing the promoter sequences but the rest of the operon and *lacI* gene are wild type. The plasmid *lac* operon is missing the *lacZ* gene but the rest of the operon and *lacI* gene are wild type. The cells are growing on lactose.

A. The cells have no LacZ at all.
B. The cells have a basal level of LacZ and the protein is derived from both operons.
C. The cells have a high level of LacZ and the protein is derived from both operons.
D. The cells have a basal level of LacZ and the protein is derived only from the operon on the plasmid.
E. The cells have a high level of LacZ and the protein is derived only from the operon on the chromosome.



The following TWO questions relate to the picture above. Cells have a *malPQ* operon and *malT* gene on the chromosome and a single plasmid with a *malPQ* operon and a *malT* gene. The questions indicate whether there are mutations in the operons and the carbon source in the medium. For each question, choose the best alternative that describes whether MalP is being made; if so at high level or basal levels and which operon encodes the MalP protein that is being made. Note that the term “wild type” means the genes have 'normal function'.

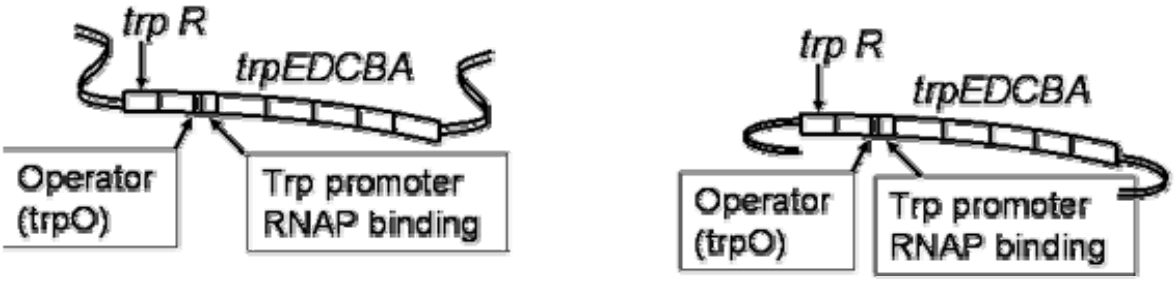
4. The chromosomal *malPQ* operon is wild type but the *malT* gene is missing. The plasmid *malPQ* operon is missing only the *malPQ* operator region. The *malT* gene on the plasmid is wild type. The cells are growing on glucose.

A. The cells have no MalP at all.
B. The cells have a basal level of MalP and the protein is derived from both operons.

C. The cells have a high level of MalP and the protein is derived from both operons.
D. The cells have a basal level of MalP and the protein is derived only from the operon on the plasmid.
E. The cells have a high level of MalP and the protein is derived only from the operon on the chromosome.

5. The chromosomal *malPQ* operon is missing the *malP* gene. Otherwise it and the *malT* gene are wild type. The plasmid *malPQ* operon is missing only the *malPQ* operator region. The *malT* gene on the plasmid is wild type. The cells are growing on maltose.

A. The cells have a high level of MalP and the protein is derived from the operon on the plasmid.
B. The cells have a basal level of MalP and the protein is derived from both operons.
C. The cells have a high level of MalP and the protein is derived from both operons.
D. The cells have a basal level of MalP and the protein is derived only from the operon on the plasmid.
E. The cells have a high level of MalP and the protein is derived only from the operon on the chromosome.



The following TWO questions relate to the picture above. Cells have a *trp* operon and *trpR* gene on the chromosome and a single plasmid with a *trp* operon and a *trpR* gene. The questions indicate whether there are mutations in the operons and whether there is tryptophan in the medium. For each question, choose the best alternative that describes whether TrpE (the first gene in the *trp* operon) is being made and which operon encodes the TrpE protein that is being made. Note that the term “wild type” means the genes have 'normal function'.

6. The chromosomal *trp* operon is wild type but the *trpR* gene is missing. The plasmid *trp* operon is missing only the *trp* operator region and everything else is wild type. The *trpR* gene on the plasmid is wild type. There is tryptophan in the media.

A. The cells have a high level of TrpE and the protein is derived from the operon on the plasmid.
B. The cells have a basal level of TrpE and the protein is derived from both operons.
C. The cells have a high level of TrpE and the protein is derived from both operons.
D. The cells have a basal level of TrpE and the protein is derived only from the operon on the plasmid.
E. The cells have a high level of TrpE and the protein is derived only from the operon on the chromosome.

7. The chromosomal *trp* operon is missing the promoter. The *trpR* gene is wild type. The plasmid *trp* operon is missing only the *trp* operator region. The *trpR* gene on the plasmid is wild type. There is tryptophan in the media.

A. The cells have a high level of TrpE and the protein is derived from the operon on the plasmid.
B. The cells have a basal level of TrpE and the protein is derived from both operons.
C. The cells have a high level of TrpE and the protein is derived from both operons.
D. The cells have a basal level of TrpE and the protein is derived only from the operon on the plasmid.
E. The cells have a high level of TrpE and the protein is derived only from the operon on the chromosome.

8. Which of the following statements about regulation of the lactose operon of *E. coli* is NOT correct?

A. The LacI protein binds to the operator and inhibits transcription of the *lac* operon.
B. When grown in media with glucose and lactose, *E. coli* produce very little *lac* mRNA.
C. The CAP protein binds to DNA only if has bound cAMP.
D. When both glucose and lactose are in the culture medium, the cells don't metabolize the lactose.
E. When cells are grown in medium that contains lactose but not glucose, neither CAP nor LacI will be bound near the promoter for the *lac* operon.

9. There is a well known mutant of *E. coli* where the sequence of DNA that includes the operator of the *lac* operon up to and including the transcription terminator of the lacI gene (which is immediately upstream of the *lac* operon) has been deleted. Which of the following statements describes what will happen in this mutant?

A. The cells will be unable to use lactose to grow.
B. The cells will contain an unusually high level of LacZ and LacY but only when grown in medium lacking glucose but containing lactose.
C. The cells will contain LacZ, LacY and LacA even if there is no lactose in the medium.
D. The presence of glucose will prevent the expression of the *lac* operon.
E. The mutation will have no effect at all on the regulation of the lac operon.

10. Which of the following statements describes what the *E. coli* TrpR protein does to regulate the expression of the *trp* operon?

A. TrpR binds to RNA polymerase and prevents the polymerase from interacting with the DNA.
B. TrpR binds to the ribosome preventing translation of the message, but only when tryptophan is present.
C. TrpR binds to the *trp* operator sequence and prevents RNA polymerase binding to the promoter, but only when tryptophan is present.
D. TrpR binds to the mRNA as it is made and prevents translation.
E. TrpR binds to the DNA sequence near the initiation of translation of the *trpE* gene, blocking translation when tryptophan is present.

11. The fundamental differences in the regulatory proteins LacI, MalT and TrpR can be stated as: When the signal molecule that binds to the proteins *is present,*

A. LacI and MalT bind DNA efficiently but TrpR does not.
B. TrpR and MalT bind DNA efficiently, LacI does not.
C. LacI and TrpR bind DNA efficiently, but MalT does not.
D. LacI and TrpR block the binding of RNA polymerases to the promoter, but MalTdoes not.
E. LacI and MalT bind upstream of the promoter whereas TrpR binds downstream of the promoter.

For the Questions 12, 13, 14 below mark:

A) if you think the regulation of synthesis of the enzymes would be regulated like the lac operon
B) if you think the regulation of synthesis of the enzymes would be regulated like the trp operon
C) if you think the regulation of synthesis of the enzymes would be regulated like the mal option
D) if you think the regulation of synthesis of the enzymes would be different than either the lac operon , mal operon or trp operon

E) could be either like mal or lac

12. Enzymes for synthesis of guanine (part of GTP).
13. Enzymes for the degradation of phenylalanine.
14. Enzymes for the conversion of glucose to ribose.

15. Consider the *lac* operon of *E. coli.* The role lactose is to:

A. bind to the promoter region and decrease the affinity of RNA polymerase for the promoter.
B. bind to the operator region and decrease the affinity of RNA polymerase for the promoter.
C. increase production of an inactive form of the LacI repressor protein.
D. bind to the repressor protein and inactivate it.
E. bind to the repressor protein and activate it.

16. A certain mutation in *E. coli* causes production of a faulty repressor protein used in the control of tryptophan synthesis. As a result of this mutation it is possible that:

- the cell will continue to make tryptophan regardless of tryptophan concentration.
- the ability of the RNA polymerase to bind to the operator will increase.
- the ability of the RNA polymerase to bind to the operator will decrease.
- the cell may not be able to synthesize tryptophan regardless of tryptophan concentration.

A. one of the statements could be true.
B. two of the statements could be true.
C. three of the statements could be true.
D. none of the statements could be true.
E. all of the statements could be true.

17. The basic difference between positive regulation and negative regulation is based on

A. The direction of transcription.
B. Whether the presence of small signalling molecule involved promotes transcription of inhibits transcription
C. Whether the regulatory protein involved promotes transcription or inhibits transcription
D. Whether cAMP is involved.
E. Whether transcription goes up or goes down.

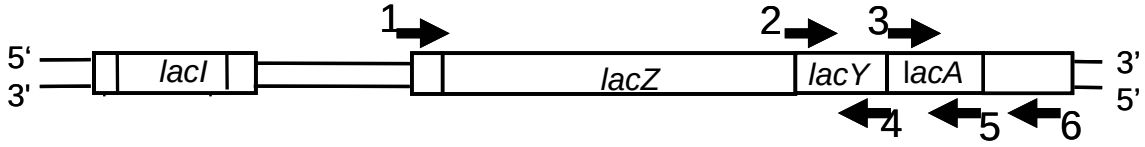
18. If an intron isn't correctly removed, the most probable result is

A. the polyA tail won't be added properly.
B. insertional inactivation of the protein.
C. replication of the lagging strand will cease.
D. a substitution mutation.
E. that there will be no effect on gene expression.

19. Which of the following *correctly* describes one way in which typical bacterial and human mRNAs are different?

A. Human mRNAs have 5' untranslated regions, but bacterial mRNAs do not.
B. Human mRNAs have several open reading frames, but bacterial mRNAs have only one.
C. Human mRNAs are spliced before translation but bacterial mRNAs are not.
D. Bacterial mRNAs are all made by one RNA polymerase, whereas human mRNAs are made by three RNA polymerases.
E. Human mRNAs can accommodate several ribosomes, but bacterial mRNAs cannot.

20. Here's a diagram of the lac operon. Shown on the diagram are arrows that are numbered. Assume these are primers for PCR amplication. If you want to amplify the coding region for only the *lacY* gene, which pair of primer would you use?



A. Primers 1 and 5
B. Primers 3 and 5
C. Primers 2 and 4
D. Primers 2 and 5
E. Primers 2 and 6

21. In the human genome, the repeated sequences called SINES depend on the repeat elements called LINES to expand in number because of which one of the following:

A. SINE sequences always are found inside LINES and so need to have LINES to be in the genome.
B. SINES do not encode their own reverse transcriptase.
C. The transcription of a SINE by RNA polymerase II starts at a promoter in a neighbouring LINE.
D. The process of "retrotransposition" by a short SINE sequence must take place at the same time as the retrotransposition of a long LINE sequence to be stable.
E. SINE sequences are found in the same quarter of the DNA as LINE sequences.

22. Which of the following statements is NOT true about the RNA polymerase I, II and III of Eukaryotes?

A. The three enzymes are found in within the nucleus.
B. The three enzymes all transcribe mRNA sometimes.
C. The three enzymes share some common subunits but not all the subunits are the same.
D. The three enzymes transcribe along the template in the 3' to 5' orientation
E. RNA polymerase I, but not RNA polymerase II and III transcribes ribosomal RNA

23. Which of the following is accurate concerning the properties of an intron?

A. Introns are commonly found in prokaryotes and eukaryotes.
B. In eukaryotes, the fraction of a transcription unit that is introns can vary dramatically and over 90%.
C. Translation of introns is used to general different proteins from one gene.
D. In multicellular organisms, the different cells in the organism may differ in which introns are in their genes.
E. Introns are the coding parts of the gene and they are interrupted by exons in eukaryotes. .

24. A group of 6 bodies are found buried in the forest: three males, a female and two children. The police suspect that they may be a missing family. They extract DNA from bones and examine the STRs from two genes *A* and *B*. The results are shown below, where the numbers indicate the number of copies of a STRs for the genes..

	Gene *A*	Gene *B*
Male 1	7, 10	7, 7
Male 2	6, 8	5, 5
Male 3	8, 9	5, 7
Woman	8, 8	3, 5
Child 1	7, 8	5, 7
Child 2	8, 8	3, 7

Looking at the data, which of the following is a reasonable conclusion.

A. The woman cannot be the mother of the children and none of the males is the father.
B. The woman cannot be the mother of the children but male 2 or 3 could be the father.
C. The woman could be the mother of the children, and none of the males can be the father
D. The woman could be the mother of the children and any of the males could be father
E. The woman could be the mother of the children, and none of the males can be

the fathers of both children.

25. A good rationale for why RNA is the primer used for DNA synthesis of the lagging strand is that:

A. Lagging strand synthesis must happen faster, so it needs more priming sites.
B. Lagging strand synthesis takes place in a 5' to 3' direction.
C. Lagging strand synthesis requires DNA strand separation.
D. Because the initial helix is short, DNA polymerase might make mistakes when it starts replicating.
E. Lagging strand synthesis takes place backwards so information transfer from RNA to DNA makes sense.

26. Reversion mutations are ones that change a strain with a mutation back to wild type. However, not all mutations can revert. Which if the following mutations cannot revert?

A. A missense mutation that changes a GC base pair to a CG base pair.
B. An insertion mutation that adds two TTs to the DNA sequence: that is GTTTTTCG**T**CGTCGT to GTTTTTCG**TTT**CGTCGT
C. A deletion mutation that deletes the two Cs from the sequence AGGGGG**CC**GGGGA changing it to AGGGGGGGGA
D. A missense mutation that changes a GC base pair to an AT base pair.
E. Well, none of the above can revert.

27. DNA polymerase and RNA polymerase can make base pairing errors. Unlike DNA polymerase, however, RNA polymerase has no proof-reading function. If an error is made by RNA polymerase during the transcription of a gene encoding a ribosomal RNA molecule, what would be the LIKELY consequence to the cell in which the error occurred?

A. The genotype of the cell would be changed.
B. The cell would die.
C. The cell would live but its phenotype would be changed.
D. There would be no significant consequence to the cell.
E. The cell would have additional requirements of nutrients for growth.

28. The following nucleotide sequence encodes the C terminus of a protein. .

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5'-GCCTCTAAAATCAGGAGAACACACGCCGCCATGTAA-3'
3'-CGGAGATTTTAGTCCTCTTGTGTGCGGCGGTACATT-5'
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What would be the consequence of a mutation that changed the CODING strand sequence 5'-GCCTCTAA-'3 to 5'-GCCTCTTA-3'?

A. The mutation would result in a shorter protein.
B. The mutation would result in a different amino acid being inserted into the protein.
C. The mutation would result in a longer protein.
D. The mutation would be silent, i.e., the amino acid sequence of the protein would not change.
E. NONE of the above.

29. It is common to use 37 C and 42 C as two growth temperatures to find temperature sensitive mutations. The phenotype of a strain of bacteria with a mutation in *trpB* such that the protein would unfold at 42C which of the following?

A. The cell would be wild type at 37 C but it wouldn't grow under any conditions at 42 C.
B. The cell would not grow at either 37 C or 42 C under any conditions.
C. The cell would be wild type 37 C; at 42 C it would grow only if tryptophan is in the growth medium.
D. The cell would require tryptophan at both 37 C and 42 C, but it would require more tryptophan at 42C.

30. If we wanted to find a mutant *E. coli* with a mutation in either *lacZ* or *lacY*. Which of the following would be useful to include in the medium?

1. lactose
2. glucose
3. X-gal
4. cAMP

A. All 4
B. 1, 2, 3 only
C. 1, 2 only
D. 1, 3 only
E. Only 3

31. If we use media with X-gal, lactose and glucose for our growth of parents and mutant cells. Which of these mutants will we be able to find?

1. mutants in *lacI* such that the protein is inactive.
2. Mutants in the gene for the enzyme that makes cAMP such that the enzyme is inactive.
3. Mutants where the *lac ZYA* promoter is closer to consensus.
4. Mutants in the gene for CAP such that the enzyme is inactive

A. All of the 4 types
B. Type 3 and 4 only
C. Types 2 and 3 only
D. Type 4 only
E. Type 3, and maybe type 1

32. The *nif* gene encodes the enzyme Nitrogenase that catalyzes the reaction $N_2 \rightarrow NH_4^+$. *Azotobacter* and *Anabaena* are two species of bacteria capable of N_2 fixation to NH_4^+.

In the lab, when cells of a competent Nif^- *Azotobacter* mutant are mixed with wild-type (Nif^+) *Azotobacter* DNA, the Nif^- *Azotobacter* mutants are transformed to the wild-type (Nif^+) phenotype. However, using DNA from a Nif^+ *Anabaena* strain, Nif^+ *Azotobacter* transformants are not obtained. Which one of the following is a potential explanation for the latter result?

A. The *Anabaena* strain was cultivated in the presence of fixed nitrogen before its DNA was prepared.
B. *Azotobacter* DNA and *Anabaena* DNA may have very different ratios of A+T to G+C.
C. The *Anabaena* strain may not have been competent when its DNA was prepared for the experiment.
D. The method used for preparation of the DNA may have failed to convert it from dsDNA to ssDNA.
E. NONE of the above is a potential explanation for the result.

33. Transformation and homologous recombination allow for the formation of heteroduplex DNA (i.e., areas where there may not be complementary base pairing between the two strands). Considering only the region of the DNA that contains the heteroduplex, which of the following would occur after errorless DNA replication of this molecule**?**

A. One daughter DNA would have two strands that are complementary to the donor DNA molecule while the other daughter DNA would have two strands complementary to the recipient DNA molecule.
B. Both daughter DNA molecules would have two strands complementary to the donor DNA molecule.
C. Both daughter DNA molecules would have two strands complementary to the recipient DNA molecule.
D. Both daughters DNA would have one strand that is complementary to the donor DNA molecule and one strand is complementary to the recipient DNA molecule
E. None of the above is correct.

34. Two closely related bacterial species, *B. subtilis* and *B. cereus*, are both competent and capable of being transformed by DNA from their own species. If DNA is extracted from wild-type *B. subtilis*, it cannot transform a *B. cereus* trp^- to trp^+. At what stage might the transformation process fail?

1. The binding of DNA at the cell surface.
2. The transfer of DNA through the cell membrane.
3. RecA dependent strand displacement.
4. Ligation of the single strand to the chromosome.

A. 1 or 2
B. 2 or 3
C. 3 or 4
D. 1
E. 4

35. Assume that you have a culture of *lacZ*$^-$ *Streptococcus (and the regulation of the lac operon in this organism is the same as discussed in class*. These cells can be transformed. You grow the cells so they are in the state of competence, and you add DNA from *lacZ*$^+$, *lacY*$^-$ *Streptococcus*. Which of the choices correctly describes what type of media could you use to recover cells with a *lacZ*$^+$ phenotype, and what would the colonies look like?

A. Media containing ampicillin and lactose; wild-type cells will grow into colonies.
B. Media containing glucose and X-gal; look for blue colonies.
C. Media containing glucose and X-gal; look for white colonies.
D. Media containing glucose and lactose; wild-type cells will grow into colonies.
E. Media containing only lactose; wild-type cells will grow into colonies.

36. Suppose you were working in a lab and found that your strain of *E. coli* was suddenly a *lac*$^-$ mutant because it no longer is blue when grown on lactose plus X-gal. Which of the following would be a useful approach to finding out whether the mutation was caused by a transposon or not.

1. Check to see if glucose affects expression of the operon.
2. Check to see whether the cell has a plasmid or not.
3. Check to see if it's possible to revert the *lac*$^-$ mutation to *lac*$^+$
4. Use PCR to see if either the *lacZ* or *lacY* gene is larger in size than wildtype.

A. 1, 2, only would be useful
B. 2, 3, only would be useful
C. 3, 4 only would be useful
D. 3 only would be useful
E. 4 only would be useful

37. In the process of transposition in bacteria, which of the following would be true?

A. The process overall depends on the recombination enzyme RecA.
B. The overall process is not dependent on DNA synthesis.
C. The overall process requires that the transposition donor site and the target site must have similar DNA sequences.
D. The overall process depends a plasmid DNA in the cell.
E. The overall process depends on the endonuclease and ligation properties of the transposase.

38. Which of the following is the best rationale for why conjugation is thought to be responsible for DNA transfer between unrelated bacteria.

A. Conjugative plasmids do not require recombination into the chromosome for survival in the recipient.
B. The transfer of both strands of the DNA protects the DNA from restriction enzymes.
C. The strand of DNA being transferred is nicked into pieces by enzymes in the donor.
D. The recipient must have a surface receptor protein for the pilus.
E. All cells use DNA as their genetic material.

39. Assume a bacterium contains a conjugative plasmid (call it plasmid pC). The same bacterium contains a second plasmid (call it plasmid pM) that can be mobilized by pC. Which of the following statements would be TRUE about these two plasmids?

1. Plasmid pM contains a *tra* operon.
2. Proteins encoded on plasmid pC are required to transfer plasmid pM.
3. The nickase encoded on plasmid pC would also nick the oriT site on plasmid pM.
4. Plasmid pM has a gene for a nickase.
5. Plasmid pM could be transferred to a recipient that contains another plasmid.

A. Statements 2, 3, 4, 5 are true.
B. Statements 1, 2, 3, 4 are true.
C. Only statements 1 and 4 are true.
D. Only statements 3 and 4 are true.
E. Statements 2, 4 and 5 are true.

40. The conjugative plasmid pR100 has a copy number of 5. This means there are 5 copies of the plasmid in each cell. Consider the DNA transfer between a single donor *E. coli* containing pR100, and a single recipient cell and indicate which of the following describes what is going on. *Immediately after* the transfer is completed:

A. The donor will contain 4 copies of pR100 and the recipient will contain one copy.
B. The donor will contain 5 copies of pR100 and the recipient will contain one copy.
C. The donor will contain 4 copies of pR100 and the recipient will have a single strand of pR100 DNA.
D. The donor will contain 5 copies of pR100 and the recipient will have a single strand of pR100 DNA.
E. The donor will contain 4 double stranded copies of pR100, and one single strand of pR100 DNA and the recipient will have a single copy of pR100 DNA.

41. You have a bacterial strain that is resistant to the antibiotic tetracycline. You know it carries a conjugative plasmid (pRP1). However, you mixed your strain with a recipient and did not see transfer of tetracycline resistance.

You continued to grow your strain for many generations and tested it again. This time there was transfer of the resistance phenotype by conjugation. Which of the following is a possible explanation for this observation?

A. A transposon carrying the resistance gene moved to pRP1.
B. An IS element inserted upstream of the resistance gene.
C. Your strain became diploid.
D. Your strain was infected by a generalized transducing phage.
E. The plasmid acquired a point mutation that results in tetracycline resistance.

42. In old textbooks on microbiology, you might read that in conjugation the DNA goes through the pilus. This is not correct. It can be shown by finding which one of the mutants that fails to transfer DNA**?**

A. A mutant that doesn't make a pilus.
B. A mutant that makes a pilus but it can't attach to a recipient.
C. A mutant that makes a pilus that attaches to the recipient, but doesn't form close contact mating pairs.
D. A mutant that makes mating pairs but doesn't transfer DNA.
E. A mutant that transfers single strand DNA but doesn't ligate it into a circle in the recipient.

43. Which one of the following is not necessary in the process of conjugation?

A. Synthesis of a pilus extending from the donor.
B. Synthesis of a receptor molecule on the surface of the recipient.
C. Formation of close contact between the the donor and recipient.
D. Formation of a channel between the donor and recipient.
E. Expression of plasmid genes in the recipient.

44. Which of the conditions below must be satisfied in a bacterial conjugation in order for a recipient to become a donor?

A. The DNA being transferred must include a conjugative plasmid.
B. The DNA being transferred must encode and antibiotic resistance gene so selection can be carried out.
C. The DNA being transferred must include a transposon.
D. The DNA being transferred must include a mobilizable plasmid.

E. The DNA being transferred must be nearly the same in sequence to the recipient genome.

45. Which of the following are *essential* characteristics of a plasmid in Bacteria**?**

1. It must contain transposons.
2. It must contain genes that encode antibiotic resistances.
3. It must contain a gene for a nickase.
4. It must contain sequences that permit the cell to replicate it.
5. It must contain sequences that encode a DNA polymerase.

A. All five statements apply
B. Statements 2, 3, 4 apply
C. Statements 1, 3, 5 apply
D. Statement 3 only applies
E. Statements 4 only applies

46. A *trpA*$^{-}$ *E. coli* cell is treated so that it can be used as a recipient in a gene transfer experiment. The DNA that is introduced into the cell is a plasmid DNA that contains a gene encoding resistance to the antibiotic ampicillin and it includes a copy of the *trp* operon that has: 1) a mutation in the *trpB* gene (*trpB*$^{-}$) and 2) a deletion of the *trpR* gene. The likely phenotype of cells that are ampicillin resistant will be which of the following?

A. Able to grow without any tryptophan in the medium.
B. Able to grow only when there tryptophan in the medium.
C. Able to grow only when there is tryptophan and ampicillin in the medium.
D. Unable to grow in any condition.

47. In the gene regulation activity you were asked to propose an explanation for the expression pattern of the dark gene in the imaginary bug. Looking at the pictures below, and assuming that expression was regulated at the level of chromatin condensation, which of the following would be true?

A. The dark gene is in condensed chromatin in the DNA of both wing vein and abdomen cells.
B. A. The dark gene is in decondensed chromatin in the DNA of both wing vein and abdomen cells.
C. The dark gene is in condensed chromatin in the DNA of wing vein cells and but in decondensed chromatin in abdomen cells
D. The dark gene is in decondensed chromatin in the DNA of wing vein cells and but not in condensed chromatin in abdomen cells.
E. There is not enough information to answer the question.

48. The mechanism of histone modification that results in changes in chromosome is described by which of the following

A. Chromosome condensation happens when charges on histones are changed from positive to neutral
B. Chromosome decondensation happens when charges on histones are changed from positive to neutral.
C.. Chromosome condensation happens when charges on histones are changed from negative to neutral
D. Chromosome decondensation happens when charges on histones are changed from negative to neutral.
E. Chromosome decondenstaion happens when charges on histones are changed from negative to positive.

49. The average size of a protein in a bacterium is around 30,000 daltons, corresponding to 300 amino acids. The average size of a protein in a human is about the same. However, genomes of humans have have repeated sequences that are found in introns and between genes equally. What is a good estimate of the ratio for the average size of a gene in bacteria to the average size of a gene in humans?
This ratio would be: (size of average gene in bacteria):(size of average gene in humans)

A. 10:1
B. 1:1
C. 1:10
D. 1:100
E. 1:1000

49. Operons allow bacteria to express genes that encode proteins with related functions quickly. Which of the following would be a good reason Eukaryotes don't employ operons?

A. Eukaryotes don't express genes with related functions
B. In eukaryotes, genes with related functions are translated from one mRNA by alternate splicing.
C. If eukaryotes used operons it could take a very long time to transcribe the genes at the 3'.
D. Translation of a coding region requires a 5'cap structure.
E. Translation and transcription take place separately in eukaryotes.

50. The fact that translation is not simultaneous with transcription in eukaryotes is primarily due to

A. The requirement that introns are spliced from eukaryotic mRNAs before translation.
B. The fact that eukaryotic mRNAs need a polyA tail.
C. The fact that eukaryotic mRNAs need a 5' cap to be translated.
D. The fact that the ribosomes are in the cytoplasm and not the nucleus.
E. The requirement that the DNA must be decondensed before transcription.

51. A mutation in the *lacI* gene such that the LacI protein cannot bind lactose, but can bind DNA will result in a strain of mutants that cannot grow on lactose. Starting with this strain, certain second (additional -not a reversion mutant) mutations would allow the cell to grow on lactose. These second mutations could be in

1. The *lac* operator
2. *lacZ*
3. the gene for CAP
4. *lacI*, but at a different place.

A. All 4 are possible
B.1, 2, 3 only
C. 2, 3, only
D. 1, 4 only
E. 1, 2, 4 only

52. A mutation in MalT that caused a change in its tertiary structure so that it could bind to the operator without binding maltose would:

A. Prevent MalPQ from ever being expressed.
B. Decrease but not eliminate the need for maltose to cause expression of MalPQ.
C. Cause expression of MalPQ all the time.
D. Increase expression of MalPQ but only when maltose is present.
E. have no effect on MalPQ expression.

53. The average rate of mutation in the DNA is 1 error per 10^9 base pairs. Remembering that the average protein is 300 amino acids long, the average rate of mutation per gene would be?

A. the same
B. 10 times bigger
C. 1000 times bigger
D. 10 times smaller
E. 1000 times smaller

54. Cousin Vinny sequenced the genome of a reversion mutant for you and found that the reversion mutation was a change of a GC base pair to an AT base pair. This means that the original mutation was:

A. Also a GC base pair changed to an AT base pair
B. an AT base pair changed to a GC base pair
C. a TA basepair changed to a GC base pair
D. a TA base pair changed to a CG base pair
E. not possible to determine.

55. It turns out that silent mutations occur with different frequencies for different amino acids. For example silent mutations in the codons for serine are 3 times more common than silent mutations at codons for phenylalanine. Which of the following would be a good reason why this is seen?

A. Serine is a more common amino acid than phenylalanine.
B. Serine is less hydrophobic that phenylalanine and so is found on protein surfaces more often.
C. There are three times more codons for serine than for phenyalanine. Would they remember this without a codon table?
D. Codons for serine have more AT base pairs than codons for phenylalanine.
E. Serines usually are not located in critical areas of the protein so changing them has little effect.

56. You are studying a strain of bacteria that has a gene encoding the BGR protein which makes the cells, and colonies bright green. You find a mutant of the strain where the colonies are white. Since you have PCR primers for this gene, you check the size of the gene in the mutants and find that it is exactly the same size as the gene in the wild type. Using this information which of the following can you eliminate as possibilities about the mutations in the white cells?

1. The mutation was caused by insertion of a transposon.
2. The mutation was caused by one form of strand slippage during replication.
3. The mutation is not in the coding region of the *bgr* gene.
4. The mutation is in the coding region of the *bgr* gene

A. You can eliminate all 4
B. You can eliminate only 1 and 2
C. You can eliminate only 1, 2, and 4
D. You can eliminate only 2, and 3
E. You can eliminate only 1 and 3

57. Mutation by strand slippage has which of the following in common with mutation caused by mispairing?

1. It is subject to repair
2. It happens during replication
3. It requires a second round of replication to be stabilized.
4. It is increased in dnaQ mutants

A. All 4
B. 1, 2, 3 only
C. 2, 3, 4 only
D. 2, 3 only
E. 1, 3 only

58. In a eukaryote, deletion of sequences in an intron is likely to:

A. cause a missense mutation
B. cause a nonsense mutation
C. cause a silent mutation
D. have a minor effect, if any effect at all.
E. All 4 of the above are possible.