3310

90+3 = 93/100 +2 ⇒ 95

BIOL 4620 Molecular Biology
Exam 3: April 16, 2010

Name [redacted]

PLEASE WRITE LEGIBLY. **IF THE GRADER CANNOT READ YOUR ANSWER IT WILL BE MARKED WRONG.**

There are 12 multiple choice questions below. Each question is worth 1 point. **Please write the letter for the correct answer in the appropriate space in the table. 5 points will be deducted for blank table.**

1. C D	2. A	3. C	4. D
5. B	6. C	7. A	8. B
9. B	10. C	11. A	12. C

1. How is DNA packaged in the E coil cell?
a. it is packaged into nucleosome complexes containing histone proteins
b. it is packaged into nucleoid structures containing histone proteins
c. it is the packaged into nucleosome complexes containing DNA gyrase and DNA topoisomerase
d. it is supercoiled by DNA gyrase and DNA topoisomerase

2. The core histones provide the structural basis for the:
a. nucleosome b. centromere c. heterochromatin d. euchromatin

3. Which of the following is able to prevent gene expression when inserted between a gene and its regulatory sequences?
a. functional domain
b. structural domain
c. insulator region
d. locus control region

4. Which is true regarding transcription initiation in prokaryotes and eukaryotes?
a. Both prokaryotic and eukaryotic RNA polymerases interact directly with promoter sequences.
b. Both prokaryotic and eukaryotic RNA polymerases interact indirectly via transcription factors
c. In prokaryotes RNA polymerase interacts indirectly via transcription factors but in eukaryotes, RNA polymerase binds directly to promoter sequences.
d. In prokaryotes, RNA polymerase binds directly to promoter sequences but in eukaryotes RNA polymerase interacts indirectly via transcription factors

5. What is the most important control point for regulation of genome expression?
a. processing of transcripts
b. transcription initiation
c. translation initiation
d. degradation of proteins and RNA molecules

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6. pre rRNA is synthesized:
a. by RNA pol I in the nucleus
b. by RNA pol III in the nucleus
c. by RNA pol I in the nucleolus
d. by RNA pol III in the nucleolus

7. The primary function of basal (general) transcription factors in eukaryotic transcription is
a. to assist in associating RNA polymerase with the promoter element
b. to activate transcription in a tissue specific manner
c. to repress transcription in a tissue specific manner
d. to activate transcription via sequence specific binding of enhancer elements

8. Association of DNA with core histones
a. is stable and occurs only in a sequence specific manner
b. requires energy to alter structure and exclude nucleosomes at promoter
c. rapidly changes in response to an increased concentration of sequence DNA binding protein
d. occurs completely at random

9. Methylation of eukaryotic DNA
a. occurs randomly in genomic DNA
b. occurs on the 5 position of C in CG dinucleotides and is correlated with gene inactivation
c. occurs on the 5 position of C in CG dinucleotides and is correlated with gene activation
d. occurs only on the maternal allele

10. Splice sites in pre-mRNA are marked by two universally conserved sequences contained
a. at the ends of the exons
b. in the middle of the exon
c. at the ends of the introns
d. in the middle of the intron

11. Alternative splicing may be regulated by sequence specific RNA binding proteins that
a. sterically blocks the use of a splice site
b. competes for binding at the Sm binding site
c. binds to single stranded region of U1 snRNA
d. targets mRNA for degradation

12. rRNA base modifications are determined by
a. interactions with U snRNA
b. specific rRNA maturases
c. interactions with snoRNA
d. specific rRNA methylases

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13 (3pts) Identify the components of a nucleosome in 30 nm fiber?

in a 30nm fiber there is a core histone octamer that has 2 H2a / H2b dimers and one H3/H4 tetramer that form the histone which DNA wraps around it twice. Then H1 associates w/ the complex and acts as a linker histone. Then this "string on a bead formation" forms a parallel complex that wraps around itself to form a solenoid. This loop formation forms this 30nm fiber. The fiber can then attach w/ SAR to further condense.

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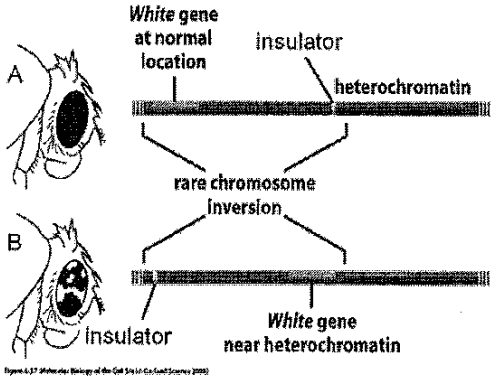
14 (2pts) Identify the components of a typical histone octamer?
a histone octamer is composed of 2 H2a/H2b dimers and one H3/H4 tetramer that DNA is wraped around twice. Then H1 acts as a linker histone & binds to the complex.

15 (2pts) Identify ONE **major** function of the centromere? _____
The centromere connects the two sister chromatids together to form a chromosome.

16 (2pts) Why is telomere replication important? _____
Telomere replication is important because telomeres provide stability to a chromosome and have inactive regions. Therefore if lost there would be shortening of active DNA which would cause major mutations or death.

17 (2pts) How are mammalian centromeres different from yeast centromeres? (for full credit your answer should address both mammalian and yeast centromeres) Mammalian centromeres have proteins bonded to them which form the kinetochore that binds to microtubules, therefore the centromere itself doesn't bind to microtubules. In yeast centromeres the microtubules bind directly to the centromere during cell division. The centromere is apart of the kinetochore in yeast while in mammalian the kinetochore is a separate protein complex.



Expression of the White gene results in red (wild type) eye color in Drosophila. The White gene in fly A and fly B is normal (nonmutant). In fly B, however expression of the white gene in fly B is nonuniform resulting in has an altered eye color (altered phenotype).

18 (2pts) This phenomenon is called _____
positional effect

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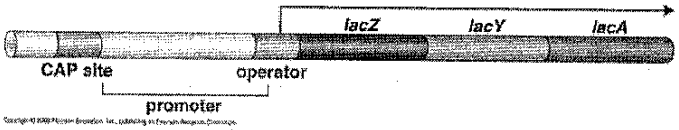
19 (2pts) What role of an insulator in heterochromatin spreading ?_____
The role of an insulator is to separate the functional domain from the heterochromatin so that the functional domain can be expressed and is not subject to being inactive

20 (2 pts) Distinguish between constitutive and facultative heterochromatin?_____
Constitutive heterochromatin is always inactive (eg. Satellite DNA) → cannot be turned into active euchromatin facultative heterochromatin can be turned into active euchromatin in specific cells at certain times & conditions (eg. X inactivation).

21 (2pts) Why are genes not transcribed in heterochromatin?_____
genes are not transcribed in heterochromatin because there is no DNAse I sensitive regions because it is tightly packed thereby making gene transcription inactive.

22-27 (2pts each) Identify the region of the **lactose operon** that is bound (if any) by each DNA binding protein under the condition indicated. Use figure of the Lac operon for reference.



22. Lac repressor in the absence of lactose? operator
23. RNA polymerase II in the absence of lactose? not bound → operons not found in eukaryotes.
24. RNA polymerase II in the presence of lactose? not bound
25. E coli RNA polymerase in the presence of lactose? promoter.
26. Gal 4 in the presence of galactose? not bound → bicoid → eukaryote.
27. CRP in the absence of glucose? CAP site.

Gal4/UAS.

operons are in prokaryotes → bicoid

RNA poly II is in eukaryotes

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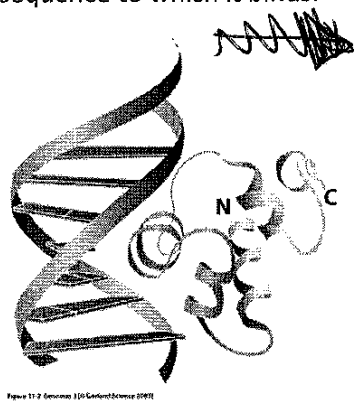
This figure shows the interaction between the E. coli bacteriophage 434 repressor and the DNA sequence to which it binds.

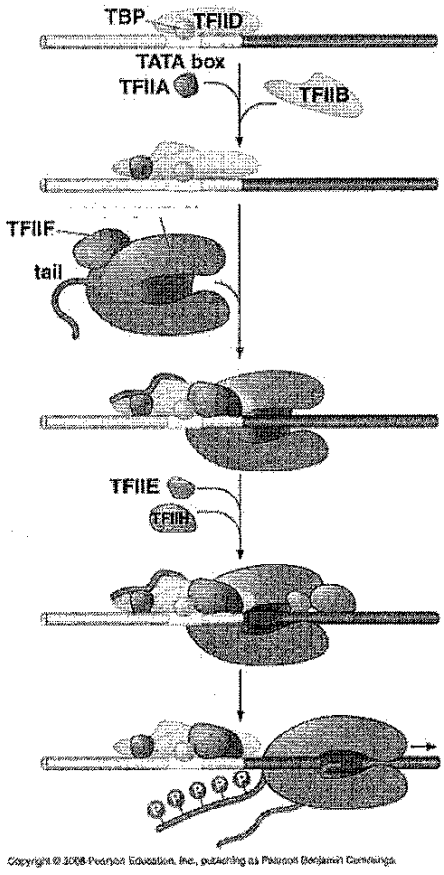


28 (2pts) Identify the DNA binding motif shown in the figure

helix turn helix

29 (2pts) How does the DNA binding domain shown in the figure interact with DNA?

the helix (#2) of the binding domain interacts w/ the major groove of the DNA.



30 (2pts) Which RNA polymerase initiates transcription in the manner shown in the figure (be specific)?

RNA poly II

31 (2pts) What happens when TBP binds DNA?

When TBP bind DNA at the promoter region it recruits the initiation complex in a closed complex that once completely situated & certain events take place transcription can be initiated.

32 (2pts) TFIIH has several roles in transcription.

Identify one role that TFIIH plays in transcription initiation.

TFIIH has helicase activity in where it helps to unwind the DNA. It also acts as a kinase and ⓟ the CTD region of RNA poly II.

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33 (2pts) The largest subunit of RNA polymerase II contains a distinct carboxyterminal domain (CTD) which has several roles in RNA transcription and processing. At initiation the CTD is unmodified. What change occurs in the CTD as the RNA polymerase II transitions from initiation to elongation?
CTD becomes phosphorylated by TFIIH to transition from initiation to elongation

34 (2pts) Which basal transcription factor is required for transcription initiation from all 3 eukaryotic RNA polymerases? TBP.

35 (2pts) What is the role of the basal transcription factor that is involved in transcription initiation from all eukaryotic RNA polymerases? BTF are involved in positioning & recruiting RNA polymerase to the promoter region.

36 (2pts) How is the promoter for eukaryotic tRNA genes different from promoters for most bacterial genes? The eukaryotic tRNA promoter has a recognition sequence down stream from the initiator codon while bacterial promoter have a recognition sequence upstream.

37 (2pts) How is the promoter for eukaryotic Pol II genes similar to bacterial promoters?
The promoters are similar because they contains an upstream recognition sequence from the initiation codon.

38-40 (2pts each) Use the one letter OR the 3 letter code for an amino acid that fits the description

38 Identify one amino acid that can be phophorylated tyr.

39 Identify one amino acid that can be methylated his +2 ✓ +2

40 Identify one amino acid that can be glycosylated ser.

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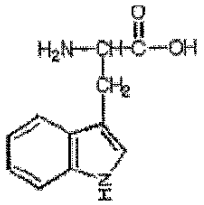
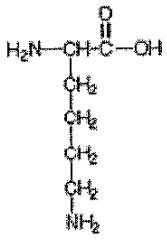
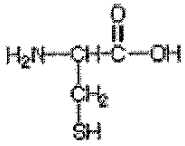
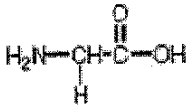
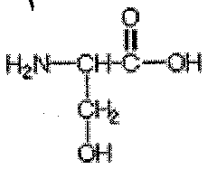
a. 
tryptophan

b. 
lysine

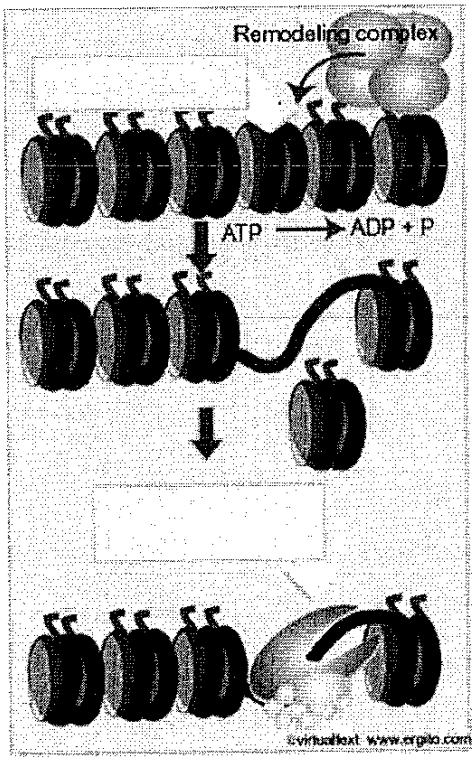
c. 
cysteine

d. 
glycine

e. 
serine

41 (2pts) Write the letter of the structure of serine E

42 (2pts) Write the letter of the structure of lysine B



43 (2pts) What is nucleosome remodeling?

It is an ATP dependent process in which nucleosomes are either modified, translocated or removed to allow for the DNA associated w it originally to because loosened thereby making it DNAse I sensitive.

44 (2pts) Nucleosome remodeling complexes such as SWI/SNF and NURF contain ATPases but do not contain proteins that bind DNA in a sequence specific manner. How are nucleosome remodeling complexes able to alter gene expression of a specific gene?

SWI/SNF and NURF act catalytically by associating w the C terminal domain of RNA poly II & catalyzes this region thereby allowing for transcription to occur. -2

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45 (2 pts) The Sin3 complex includes two histone deacetylases (HDAC1 and HDAC2). How would you expect this to effect gene expression?

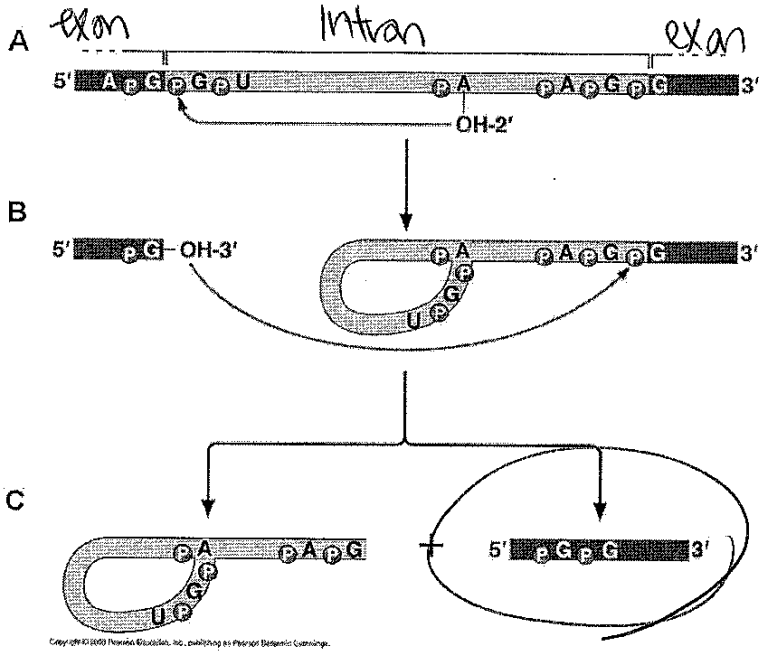
histone deacetylases affects gene expression by decreasing it. Decreases gene expression.

46 (2pts) A partial sequence of the N terminal end of histone H3 is shown. Which amino acid is modified by histone acetyl transferase? NH_2------Arg_8, Lys_9 Ser_{10},Thr_{11}----------COOH

lys 9.

47 (2pts) What effect (if any) does histone acetylation have on gene expression of the nearby gene?

histone acetylation increases gene expression.



48 (3pts)

Label intron(s) and exon(s) in panel A.

49 (2pts)

Circle the structure in panel C that remains in the mRNA after the splicing reaction is completed

50 (2pts) What component of the spliceosome binds to 5′ splice site? U1 snRNP

51 (2pts) What spliceosomal component attaches to branch point? U2 snRNP

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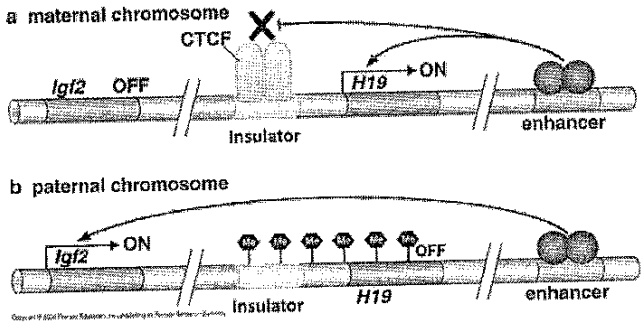
52 (2pts) How is tRNA splicing different from mRNA splicing? tRNA splicing deals w/ introns that get spliced by endo and exonucleases. mRNA splicing deals w/ introns that get spliced by a spliceosome & transesterification rxns.

The sexual development of female Drosophila results from a cascade of alternative splicing events.

Functional Tra which produced only in female flies is an SR protein.

53 (2pts) What is an SR protein? An SR protein is an RNA binding protein that is rich in serine and arginine that forms protein protein interactions that influence alternative splicing.

54 (2pts) What epigenetic phenomenon is illustrated in the figure below? genetic imprinting



55 (2pts) Why is the maternal copy of Igf2 not expressed? It is not expressed because the insulator blocks the Igf2 of the maternal copy to be expressed by an enhancer. Since the gene is normally off it will not turn on because activation by an enhancer is blocked by the insulator

56 (2pts) Why is the methylated (paternal) copy of H19 not expressed? Methylation causes gene inactivation, the more methyls the less likely to be transcribed. Therefore since its promoter region is highly methylated and normally off it can not be activated by an enhancer.

2 Bonus questions on reverse side

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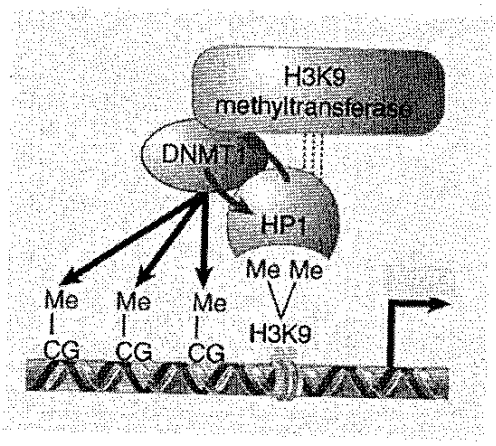
Bonus 1 (2pts) Segment identity is determined by homeotic selector genes. Only one homeotic gene is expressed in a given segment. What is the role of **polycomb** in this process?

polycomb is recruited to PRE of genes that are already silenced in order to induce heterochromatic formation. Therefore polycomb is recruited to all regions besides the expressed gene in the region.



Bonus2 (1pt) How does DNA and histone methylation this affect the expression of the gene shown in the figure?

Methylation causes the gene H3K9 to recruit HP1 which becomes methylated & recruits H3K9 methyltransferase to methylate all of the promoter and gene region which is the CpG islands to become methylated thereby silencing their activity.

+3