Genetics – Exam 2B – Key

MONDAY 13 NOVEMBER 2006

NAME (PRINT) *(SIGNATURE)* *TUTORIAL SECTION*

INSTRUCTIONS:

- fill out the scantron card with a #2 pencil
- PRINT your name, date and lab section in the spaces provided
- TO RECEIVE A GRADE you must print your student number, fill in corresponding bubbles in the spaces provided on the card & indicate that you have taken EXAM 2B
- read ALL questions carefully before answering any of them
- if a question has more than one correct answer, chose the one that is MOST correct
- circle answers on the exam pages BEFORE filling marking answers on the scantron
- mark only ONE answer for each question on the scantron card
- mark all answers carefully – dark and only within the bubbles for each question
- you MUST sign the sheet at the front of the room when handing in your exam to receive a grade

1. The one gene – one enzyme hypothesis postulates that

   A) gene sequences are conserved in all species
   B) genes are translated into mRNA
   C) genes are units of heredity
   D) genes encode protein structure
   E) genes are transcribed into polypeptides

2. A rare 3-arm starfish was found off the coast of North Korea after a recent nuclear test. When this unusual creature was bred with the wild-type 5-arm variety, their F_1 progeny all had 4 arms (you scored many, and are confident that the 3-arm parent was a homozygote). Crosses among these F_1 produced 25 3-arm, 49 4-arm, and 25 5-arm F_2. The likely inheritance pattern for arm number represented by the data is one gene with

   A) incomplete dominance of the wild-type 5-arm allele (*A*) over the new 3-arm allele (*a*)
   B) the wild-type 5-arm allele (*a*) being recessive to the new 3-arm allele (*A*)
   C) no dominance
   D) the new 3-arm allele (*a*) being recessive to the wild-type 5-arm allele (*A*)
   E) co-dominance of the 5-arm (A^1) & 3-arm (A^2) alleles

3. If a mutation is recessive,

   A) a heterozygote has at least 50% function of the normal gene product
   B) the wild-type allele is haplo<u>in</u>sufficient
   C) a heterozygote has less than 50% function of the normal gene product
   D) the mutant allele is haplosufficient
   E) none of the above

4. Three recessive mutant alleles in mice were isolated in a screen for albino coat color. Before using them in any further experiments, it is important to

   A) identify additional pleiotropic phenotypes such as PKU and Cretinism
   B) map the mutant alleles
   C) sequence the mutant alleles
   D) show that each is true breeding
   E) test for complementation with all other mutant alleles

5. In a complementation test among the 3 albino mutant strains (in #4), one of the three crosses gave rise to only albino offsping, indicating that the mutant alleles contributed by each of the parents were

   A) alleles of three different genes that can be separated by recombination
   B) alleles of the same gene
   C) alleles of two different genes that function in a common cellular process
   D) alleles of two epistatic genes
   E) alleles of two linked genes

6. The other two crosses among albino mutant mice strains (in #4) both gave wild type offspring, indicating that the three mutant albino alleles represent

   A) this test does not tell you anything about how many genes affect coat color in mice
   B) an unknown number of genes
   C) 1 gene
   D) 2 genes
   E) 3 genes

7. When the F_1 (from one of the crosses in #6) were bred among themselves, they produced 55 black, 25 albino and 19 brown mice, implying that alleles contributed by each of the mutant parents represent

   A) two linked duplicate recessive genes
   B) one gene with a series of three linked alleles
   C) two unlinked genes with recessive epistasis
   D) two linked genes with dominant epistasis
   E) two unlinked duplicate dominant genes

8. Using a simple χ^2 test of your hypothesis (from #7), the calculated χ^2 =

   A) 52.961, with $P > 0.001$, you reject the hypothesis
   B) 52.267, with $P < 0.001$, you reject the hypothesis
   C) 3.050, with $0.25 > P > 0.10$, you do not reject the hypothesis
   D) 2.307, with $0.50 > P > 0.25$, you do not reject the hypothesis
   E) 0.303, with $0.90 > P > 0.75$, you do not reject the hypothesis

9. A series of biochemical reactions results in red pigment in the feathers of scarlet macaws in Costa Rica. Isolated populations of yellow, green and blue birds were found. Supplementing the diets of all alternative variants with coconut early in life results in red plumage. Feeding pineapple to green and blue birds results in yellow plumage, while feeding bananas turns green to blue. The pathway that explains these observations is

BONUS QUESTION

A) red –↺→ (banana) green –↺→ (pineapple) blue –↺→ (coconut) yellow

B) green –↺→ (coconut) blue –↺→ (pineapple) yellow –↺→ (banana) red

C) green –↺→ (banana) blue –↺→ (pineapple) yellow –↺→ (coconut) red

THIS IS STILL CORRECT… BUT MORE COMPLICATED.

D) yellow –↺→ (banana) blue –↺→ (pineapple) green –↺→ (coconut) red

E) red –↺→ (coconut) yellow –↺→ (pineapple) blue –↺→ (banana) green

GREEN = *b p c*
BLUE = b^+ *p c*
YELLOW = b^+ p^+ *c*

10. Assuming that all macaws (in #9) are homozygous (and diploid of course) for plumage pigmentation genes, a cross between the green and blue variants should give rise to birds with

BONUS QUESTION

A) turquoise feathers
B) yellow feathers
C) green feathers
D) blue feathers
E) red feathers

GREEN x BLUE
b p c / b p c x b^+ *p c* / b^+ *p c*
|
BLUE
b p c / b^+ *p c*

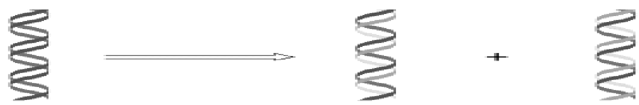
11. Differential labeling of phage T2 coat protein and DNA demonstrated that

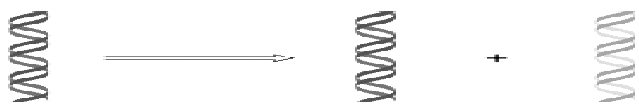
A) only protein enters the infected cell
B) phage coat protein directs synthesis of new progeny phage
C) the entire virus enters the infected cell
D) phage genetic material is most probably DNA
E) a chromosome is composed of 2 chromatids each containing a single DNA molecule

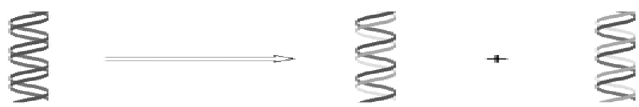
12. Paired nitrogenous bases in DNA are held together by

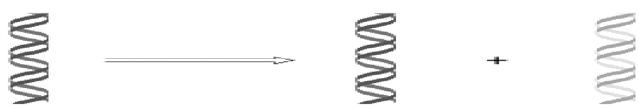
A) hydrogen bonds
B) covalent bonds
C) van der Waal's forces
D) phosphodiester bonds
E) peptide bonds

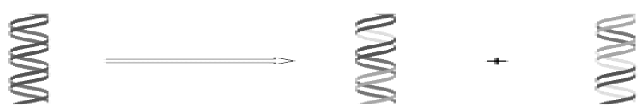
13. The accepted model of DNA replication is

A) conservative


B) conservative


C) semiconservative


D) semiconservative


E) distributive


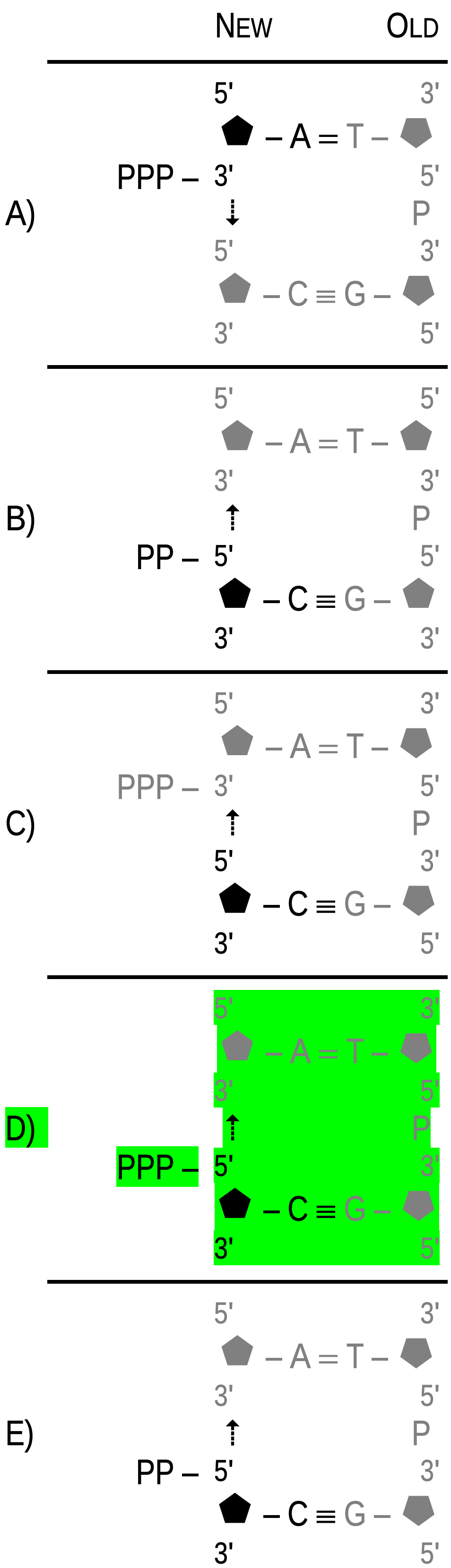
14. Chargaff established rules about DNA nucleotides, stating that amounts of

A) purines (C + T) = pyrimidines (A + G), A = T, and C = G
B) purines (A + G) = pyrimidines (C + T), A = T, and C = G
C) purines (A + T) = pyrimidines (C + G), A = T, and C = G
D) purines (C + G) = pyrimidines (A + T), A = G, and C = T
E) purines (A + T) = pyrimidines (C + G), A = G, and C = T

15. The non-coding strand of DNA is also called the

A) template strand
B) leading strand
C) lagging strand
D) antiparallel strand
E) parallel strand

16. The best representation of DNA synthesis (newly added nucleotide in black, ⇣ or ⇡) is



17. Chromosome replication in prokaryotes involves

A) rolling circle structures, single origins of replication, unidirectional replication forks
B) theta structures, multiple origins of replication, bidirectional replication forks
C) theta structures, single origins of replication, unidirectional replication forks
D) theta structures, single origins of replication, bidirectional replication forks
E) rolling circle structures, single origins of replication, bidirectional replication forks

18. DNA replication fork movement relative to leading and lagging strand templates is

A) 5' $\rightarrow$ 3' for both
B) 5' $\rightarrow$ 3' and 3' $\rightarrow$ 5', respectively
C) 3' $\rightarrow$ 5' and 5' $\rightarrow$ 3', respectively
D) 3' $\rightarrow$ 5' for both
E) all directions of replication fork movement are possible

19. During DNA replication, helicase enzyme is important for

A) excision of DNA
B) unwinding of DNA
C) excision of RNA
D) addition of small nuclear proteins
E) synthesis of RNA

20. RNA is transcribed in a

A) 5' $\rightarrow$ 3' direction from the template DNA strand,with the transcription bubble moving along the template strand in a 3' $\rightarrow$ 5' direction
B) 3' $\rightarrow$ 5' direction from the coding DNA strand,with the transcription bubble moving along the coding strand in a in a 5' $\rightarrow$ 3' direction
C) 5' $\rightarrow$ 3' direction from the template DNA strand,with the transcription bubble moving along the template strand in a 5' $\rightarrow$ 3' direction
D) 5' $\rightarrow$ 3' direction from the coding DNA strand,with the transcription bubble moving along the coding strand in a 3' $\rightarrow$ 5' direction
E) 3' $\rightarrow$ 5' direction from the template DNA strand,with the transcription bubble moving along the template strand in a 5' $\rightarrow$ 3' direction

21. RNA polymerase II catalyzes the synthesis of

A) polycistronic mRNA in eukaryotes
B) monocistronic mRNA in eukaryotes
C) polycistronic rRNA in prokaryotes
D) monocistronic mRNA in prokaryotes
E) monocistronic tRNA in eukaryotes

22. Introns are not found in

A) bacteria
B) humans
C) animals
D) yeast
E) plants

23. Alternative RNA splicing

A) is found in prokaryotes only
B) takes place in the cytoplasm immediately prior to translation
C) begins only when the primary transcript has been completed
D) only removes the introns from a primary transcript
E) can produce different mRNAs from the same primary transcript

24. An exclusively posttransciptional mRNA processing event in eukaryotes is

A) cleavage down stream from a AAUAAA consensus sequence by endonuclease
B) 7-methylguanosine cap addition to the 5' end of mRNA by guanyltransferase
C) introns spliced out of mRNA
D) poly(A) tail addition to the 3' end of mRNA by poly(A) polymerase
E) GTF binding to the TATA sequence

25. The degree of degeneracy (redundancy) for a given amino acid is determined by the

A) size, shape, and pH of the R-groups on the amino acid
B) position of the anti-codon sites relative to the DHU and TψC loops on the tRNA
C) importance of the amino acid in biological processes
D) likelihood that single base pair changes will result in a stop codon
E) number of isoaccepting tRNA molecules for the amino acid + wobble

26. The codon(s) and amino acid(s) that correspond to a tRNA with the anticodon sequence 3'-GGU-5' are

A) 5'-CCA-3' & 5'-CCG-3'; proline (Pro)
B) 3'-ACC-5'; threonine (Thr)
C) 5'-CCG-3'; proline (Pro)
D) 3'-ACC-5' & 3'-GCC-5'; threonine (Thr) & alanine (Ala)
E) 5'-CCA-3'; proline (Pro)

27. Termination of translation takes place when a stop codon is decoded at the

A) A-site on the ribosome and binds an uncharged tRNA molecule
B) P-site on the ribosome and binds a release factor protein
C) A-site on the ribosome and binds an uncharged tRNA molecule
D) A-site on the ribosome and binds a release factor protein
E) P-site on the ribosome and binds a charged tRNA molecule

28. You have synthesized message codons with polynucleotide phosphorylase and ribonucleotides cytosine and guanine in a 2:1 ratio, and obtained the following ratios of amino acids

A) 1.00 Pro : 0.50 Arg : 0.50 Ala : 0.25 Gly : 0.17 Asp
B) 1.00 Pro : 0.50 Arg : 0.50 Ala : 0.25 Gly
C) 1.00 Pro : 0.33 Arg : 0.33 Ala : 0.17 Gly
D) 1.00 Ser : 0.50 Arg : 0.50 Ala : 0.25 Gly : 0.25 Gly
E) 1.00 Cys : 0.50 Glu : 0.50 Met : 0.25 Gly : 0.25 Val

29. A double-stranded DNA molecule (below) encodes, in vivo, a polypeptide composed of 5 amino acid residues. Transcription takes place from

3′	AAT	CCG	CTA	TAC	TAA	GTA	ATG	ATT	CAT	TGA	GAT	5′ coding
5′	TTA	GGC	GAT	ATG	ATT	CAT	TAC	TAA	GTA	ACT	CTA	3′ template
3′	AAU	CCG	GUA	UAC	UAA	GUA	AUG	AUU	CAU	UGA	GAU	5′ mRNA
	Stop	Ala	Ile	His	Asn	Met						← AA

A) left to right on the lower strand
B) left to right on the upper strand
C) right to left on the lower strand
D) right to left on the upper strand
E) B) and D), which both encode polypeptides of 5 amino acids

30. Assume that transcription occurs from right to left on the lower strand (of the sequence in #29). In a proflavin mutagenesis experiment, a thymine nucleotide is inserted on the coding DNA strand immediately after the first transcribed triplet of bases corresponding with the mRNA start codon. The number of amino acids in the polypeptide translated from this mutant sequence is

					▼							
3′A	ATC	CGC	TAT	ACT	AAT	GTA	ATG	ATT	CAT	TGA	GAT	5′ coding
5′T	TAG	GCG	ATA	TGA	TTA	CAT	TAC	TAA	GTA	ACT	CTA	3′ template
3′A	AUC	CGG	UAU	ACU	AAU	GUA	AUG	AUU	CAU	UGA	GAU	5′ mRNA
					STOP	MET						← AA

A) 5
B) 1
C) 8
D) 3
E) 7

31. A nonsense suppressor mutation would occur in the

A) anti-codon sequence of tRNA
B) Shine-Delgarno sequence of 16S rRNA
C) the stop anti-codon wobble base of mRNA
D) the stop codon wobble base of tRNA
E) start codon sequence of mRNA

32. Wild-type "sense" codons that can be mutated to UAA "nonsense" stop codons with single base changes are

BONUS QUESTION

A) PHE, VAL, CYS, GLU, ARG, SER
B) CYS, ARG, THR, ALA, PHE
C) ASP, LYS, HIS, MET, LEU
D) PRO, MET, TYR, ILE, LEU, TRP
E) ASN, GLN, GLU, SER, LEU, TYR… the closest one, but ASN cannot be generated

33. A trans-acting element that influences the level of *lac* operon activity is

A) *lac O*
B) *lac P*
C) *lac Z*
D) *lac I*
E) *lac Y*

34. Operon transcription can be regulated by

A) activation
B) repression
C) dual control
D) environmental signals
E) all of the above

35. In the *lac* operon, lactose will be metabolized at high levels in

A) $I^s\ P^+\ O^+\ Z^-\ Y^+\ A^+$ cells when glucose is absent
B) $I^+\ P^-\ O^+\ Z^+\ Y^+\ A^+$ cells when glucose is absent
C) $I^+\ P^+\ O^c\ Z^+\ Y^+\ A^+$ cells when glucose is present
D) $I^-\ P^+\ O^+\ Z^+\ Y^+\ A^-$ cells when glucose is absent
E) $I^+\ P^+\ O^+\ Z^+\ Y^-\ A^+$ cells when glucose is present

BONUS

36. Dr. Juli Wade from Michigan State gave a seminar on November 3rd about hormonal and genetic influences on sexual differentiation and communication in

A) zebras
B) *zebra* gene mutants in fruit flies
C) zebra fish
D) zebra finch
E) zebra muscles