

QUESTION	YOUR SCORE	FULL SCORE
I		40
II		40
III		40
IV		40
V		40
TOTAL		200

YOUR NAME: _____
 (Please PRINT your name in ink on this line as legibly as possible.)

YOUR SIGNATURE: _____
 (Please SIGN your name in ink on this line.)

YOUR STUDENT ID NUMBER: _____

YOUR LAB ROOM / TA (circle one): Dale Aromdee Jane Klimenko Jesse Patterson

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QUESTION I. Multiple Choice. Please CIRCLE clearly the letter that corresponds to the most correct conclusion to each of the following statements or queries. [40 points total]

(1) An organism whose cells contain two copies of each and every chromosome is called: [4 points]

- (a) Homozygous
- (b) Heterozygous
- (c) Homogeneous
- (d) Diploid

(2) All of the following terms are appropriate descriptions for the growth and duplication of a yeast cell in liquid medium, EXCEPT: [4 points]

- (a) Vegetative multiplication
- (b) Mitotic proliferation
- (c) Meiotic progression
- (d) Cell cycling

(3) The most appropriate definition for the genetic term "allele" is: [4 points]

- (a) one of a series of possible alternative forms of a given gene
- (b) alternative genes at two different genetic loci
- (c) one of two different forms of a specific chromosome
- (d) sequences that encode each of the domains of a bifunctional gene product

(4) In a eukaryotic cell, like budding yeast (*Saccharomyces cerevisiae*), transcription and translation take place: [4 points]

- (a) In the cell nucleus and the cytoplasm, respectively
- (b) In the nucleolar compartment of the nucleus and the cytoplasm, respectively
- (c) In the cell nucleus and the cytoplasm, respectively, as well as inside the mitochondrion
- (d) In the nucleolus and on the surface of the rough endoplasmic reticulum, respectively

(5) For propagation of *Saccharomyces cerevisiae*, it is essential that all of the following nutrients be present in the growth medium, EXCEPT: [4 points]

- (a) Oxygen
- (b) Ammonia
- (c) Sulfate
- (d) Phosphate

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(6) The degree of relatedness (in percent sequence identity) between an *Saccharomyces cerevisiae* gene product and its clearly homologous counterpart in a mammalian cell is usually in the range of: [4 points]

- (a) 20-40%
- (b) 40-60%
- (c) 60-80%
- (d) 80-100%

(7) If a mutation in one gene in *MATa* cell masks the phenotypic effect of a mutation in a different gene, this genetic behavior is called: [4 points]

- (a) Haploinsufficiency
- (b) Synthetic lethality
- (c) Dominance
- (d) Epistasis

(8) Each of the following conditions listed can be used to counter-select (i.e. provides a positive selection) for loss-of-function mutations in the indicate marker genes, EXCEPT [4 points]

- (a) addition of the toxic arginine analog, canavanine, to isolate *can1* (Arg permease-minus) mutants.
- (b) addition of the toxic pyrimidine analog, 5-fluoro-orotic acid (plus Ura), to isolate *ura3* mutants.
- (c) addition of the toxic histidine analog, 3-amino-triazole (plus His), to isolate *his3* mutants.
- (d) addition of the toxic lysine precursor, *alpha*-amino adipic acid (plus Lys), to isolate *lys2* mutants.

(9) To occur efficiently, all of the following events require DNA sequence homology, EXCEPT: [4 points]

- (a) Site-specific mutagenesis
- (b) Meiotic recombination
- (c) Gene transplacement
- (d) Plasmid integration

(10) A standard genetic procedure to determine whether two recessive mutations that display a similar phenotype are likely located in the same gene is called: [4 points]

- (a) A dominance test
- (b) A suppression test
- (c) A loss-of-function test
- (d) A complementation test

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QUESTION II. TRUE or FALSE. Put a clear "X" mark in the box that is the most appropriate response to each of the statements on the left. [40 points total]

	TRUE	FALSE
(1) All yeasts are fungi. [4 points]	X	
(2) All plasmids are episomes. [4 points]	X	
(3) Extragenic suppressors of nonsense mutations are often mutant tRNA genes. [4 points]	X	
(4) Most prokaryotic (<i>E. coli</i>) genes cannot function in yeast, and vice-versa. [4 points]	X	
(5) A dominant-negative mutation interferes with the function of the wild-type version of the same gene. [4 points]	X	
(6) A dosage suppressor must be overexpressed in order to manifest its phenotypic effect. [4 points]	X	
(7) Genetics can be used to infer what residues are critically involved in the biological function of protein-coding genes, i.e. polypeptides. [4 points]	X	
(8) These terms— data, bacteria, spectra, media, maxima, criteria, and optima —are all plural words. [4 points]	X	
(9) The cell wall of <i>Saccharomyces cerevisiae</i> is very thick and made up of the same complex protein- and polysaccharide-containing polymers (peptidoglycan) as the prokaryotes (Gram-positive bacteria) that also have very thick cell walls. [4 points]		X
(10) Lactose is Gal(β 1 \rightarrow 4)Glc, whereas melibiose is Gal(α 1 \rightarrow 6)Glc. [4 points]	X	

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III. Fill in the blank with the LETTER corresponding to the most appropriate term, phrase, word or abbreviation from the column on the right. [40 points total]

(1) This compound is added to a suspension of yeast cells to aid in elevating the effective concentration of plasmids during DNA-mediated transformation [4 points] _____ **P** _____

(2) This genetic element represents the sequence in a yeast chromosome that is a site where DNA synthesis initiates when chromosomes are replicated. [4 points] _____ **A** _____

(3) This type of vector is often referred to as a YAC, for "artificial yeast chromosome." [4 points] _____ **L** _____

(4) This kind of vector is typically present in a copy number of only one per cell in the transformants that carry it. [4 points] _____ **I (or C)** _____

(5) This kind of mutation of a gene is defined as a base-pair change in the coding sequence that results in the substitution of another amino acid for the residue normally present in the wild-type protein. [4 points] _____ **Q** _____

(6) This genetic element is responsible for placing regulation of the expression of a yeast gene under the control of some stimulus or condition. [4 points] _____ **V (or M)** _____

(7) This sugar is metabolized as a carbon source for the growth of *Saccharomyces cerevisiae* only under conditions where glucose has been exhausted. [4 points] _____ **H (or X)** _____

(8) This compound avidly chelates heavy metal divalent cations and helps protect purified DNA from inadvertent oxidative damage and nucleolytic degradation. [4 points] _____ **Y** _____

(9) This genetic element represents the codon responsible for the start of translation of essential every protein made by a yeast cell. [4 points] _____ **W** _____

(10) It is impossible to obtain authentic intragenic revertants for this kind of mutation. [4 points] _____ **D** _____

- | | |
|----|---------------------|
| A. | ARS |
| B. | Citrate |
| C. | YCp24 |
| D. | Deletion mutation |
| E. | YEpl3 |
| F. | Frameshift mutation |
| G. | Glucose |
| H. | Galactose |
| I. | Ylp5 |
| J. | Terminator |
| K. | YRp7 |
| L. | YLp100 |
| M. | UAS |
| N. | Nonsense mutation |
| O. | Ori |
| P. | PEG |
| Q. | Point mutation |
| R. | Replicon |
| S. | Sorbitol |
| T. | TEL |
| U. | Operator |
| V. | Promoter |
| W. | AUG |
| X. | Glycerol |
| Y. | EDTA |
| Z. | RNA |

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IV. Fill in the blank with the LETTER corresponding to the most appropriate genetic convention, nomenclature term, or abbreviation from the column on the right. [40 points total]

(1) Designates an insertion mutation that prevents catabolism of the carbon source, galactose. [4 points] _____ **B** _____

(2) Designates a dominant allele that permits constitutive expression of the genes that encode the enzymes necessary for catabolism of galactose. [4 points] _____ **X** _____

(3) Designates the product of a wild-type gene. [4 points] _____ **Q** _____

(4) Designates a chimeric polypeptide in which a yeast protein has been fused to another protein sequence. [4 points] _____ **U** _____

(5) Designates a double mutation at the indicated locus. [4 points] _____ **V** _____

(6) Designates a mutation in a mitochondrial gene. [4 points] _____ **J** _____

(7) Designates a fusion of a native yeast promoter to a reporter gene. [4 points] _____ **N** _____

(8) Designates an antibiotic-resistance phenotype. [4 points] _____ **F** _____

(9) Designates a null (deletion) allele and not a deletion-insertion allele. [4 points] _____ **H** _____

(10) Designates the heterozygous condition at a particular locus in a diploid [4 points] _____ **D** _____

A.	<i>leu2</i>
B.	<i>gal7::HIS3</i>
C.	<i>his1-24^{ts}</i>
D.	<i>ade2-1/ADE2</i>
E.	Ade ⁺
F.	Cyh ^R
G.	<i>gal80Δ::LEU2</i>
H.	<i>his3-Δ200</i>
I.	Ade ⁻
J.	[<i>cox3</i>]
K.	Psi ⁺
L.	<i>LEU2</i>
M.	[<i>KIL-k1</i>]
N.	<i>P_{GAL1}-lacZ</i>
O.	<i>ARG4</i>
P.	p[<i>LYS2</i>]
Q.	His3
R.	<i>GAL80^d</i>
S.	<i>hisG::URA3::hisG</i>
T.	<i>trp1-64^{am}</i>
U.	Cdc12-myc
V.	<i>leu2-3,-112</i>
W.	<i>P_{UAS GAL}-GFP</i>
X.	<i>GAL4-5</i>
Y.	<i>TRP1</i>
Z.	<i>URA3</i>

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QUESTION V. Complete the sentence, phrase, paragraph or thought, with the most appropriate word, term, concept, reaction, or subject that you are able to provide. [40 points total]

(1) Access to the codon for translation initiation downstream of the 5'-end of eukaryotic mRNAs, which is called the 5'-untranslated region (or 5'-UTR), is almost always blocked by rather extensive secondary and tertiary structures [4 points] in the RNA itself. The eukaryotic translation initiation factor most responsible for dealing with this specific problem is termed eIF4A [4 points]. This protein is able to alleviate this problem because it possesses a catalytic function known as RNA helicase activity [4 points].

(2) The eukaryotic translation initiation factor, termed eIF4G [4 points], is considered a platform that organizes the entire process of translation initiation because it is able to associate physically and directly with the the mRNA itself, as well as with the factor discussed in part (1) immediately above, and also with the following additional components that are all essential for efficient initiation of translation: the factor known as eIF4E [4 points] that binds to the extreme 5'-end of the mRNA; a factor that binds to mature 3'-end of the mRNA, termed PABP [4 points]; and, a factor that is necessary to recruit the 40S subunit of ribosomes, known as eIF3 [4 points].

(3) Using DNA-mediated transformation of a *MATa/MAT α his3/his3* diploid cell, you replace the chromosomal copy of *GENEX* on chromosome V with a *geneX Δ ::HIS3* construct by selecting for His⁺ transformants. As a control, you transform the same strain with just *HIS3* DNA and select the resulting His⁺ transformants. You subject both the *MATa/MAT α his3/his3 geneX Δ ::HIS3/GENEX* and the *MATa/MAT α his3/HIS3* diploids to sporulation. You then dissect the meiotic products on a rich medium (YPD). You find that from each ascus of the *MATa/MAT α his3/his3 geneX Δ ::HIS3/GENEX* diploid strain only two of the spores of each tetrad are able to grow (and all are His⁻), whereas all four spores are viable in every acus examined from the control *MATa/MAT α his3/HIS3* diploid. What does this result tell you about the function of *GENEX* in the physiology of the yeast cell? Explain your reasoning. [12 points]

This segregation pattern of 2 live spores-to-2 dead spores (abbreviated 2 live:2 dead) is the hallmark of a loss-of-function mutation in an essential gene (i.e. one that is required for the yeast cell to grow under any condition). Moreover, since the function of this gene is essential, even on rich medium (where all of the small molecules required for yeast growth are being supplied), the product of GENE X most likely has a role in macromolecular synthesis, cell structure, energy generation, or some other essential aspect of cell physiology that cannot be satisfied by low molecular weight nutrients, vitamins, trace minerals or other metabolites.