

NAME (Last, First) Gomes, Lucas GSI Name Emily Valadao

(PRINT CLEARLY, LAST, then First)

Your participation in the course requires that you follow examination policies.

Instructions: To prevent cheating, **nothing** may be on your desk but a pencil and eraser.

Nothing may be on the empty seats: everything must be under your own seat, and out of sight. This includes:

- Water bottles, drinks, cups
- Phones
- Books and notes
- Hats and jackets
- etc.

All watches must be removed and put away inside backpacks. All cell phones must be turned off AND put inside backpacks.

Keep your exams and answer sheets **flat on your desk**; do not lift them up to your face to read them, as others will be able to see your answers too.

When there are 10 minutes left, stay in your seats until the exam is finished. We will also not answer any questions during the last 10 minutes to avoid disturbing others.

Your SID must be written on your answer sheet **and** bubbled in. If your SID is only 8 digits, fill the last two spaces in with zeroes and bubble those in too. Failure to do this may result in a 5 point deduction

SID (start on the left, write & bubble in 00 in the last two red boxes if you have an 8 digit SID)

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Section Number

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Please follow the directions on the exam questions sheet. Fill in the entire circle that corresponds to your answer. Use a number 2 pencil. Erase undesired responses completely. Do not cross them out.

This exam is 50 minutes long. When the timer goes off, you must stop working. If you continue to work, we may not accept your exam. This includes filling in your name, SID and answers on the answer sheet; this needs to be done before the timer goes off.

Do not begin until instructed to do so. Each question is worth 2 points unless indicated otherwise. (Version of the exam is always worth 0 points, but very important).

There is always only one best answer.

1) Atomic oxygen (O) is highly reactive and will receive how many electrons to fill-up its outermost orbital (valence shell)?

- A) None, O is an inert gas
- B) One
- C) Two
- D) Three
- E) Four

2) Water as a molecule is

- A) Twice positively charged (++, full positive charges)
- B) Twice negatively charged (--, full negative charges)
- C) A dipole molecule
- D) Highly lipophilic
- E) All of the above

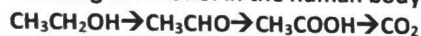
3) Water molecules, when in the liquid phase, make the following bonds between themselves

- A) Hydrogen bonds
- B) Van Der Waals bonds
- C) Covalent bonds
- D) Electrostatic bonds
- E) Lipophilic bonds

4) (1 pt) Hydroxyl groups are abundant in biological compounds. Identify the hydroxyl group among the choices.

- A) -C=O
- B) -OH
- C) -CH₃
- D) -SH
- E) -NH₂

5) The processing of ethanol in the human body follows the below set of reactions:



The molecule that potentially causes cancer is

- A) CH₃CH₂OH
- B) CH₃COOH
- C) CH₃CHO
- D) A and B
- E) B and C

6) The -SH sulfhydryl group is an integral component of what amino acid?

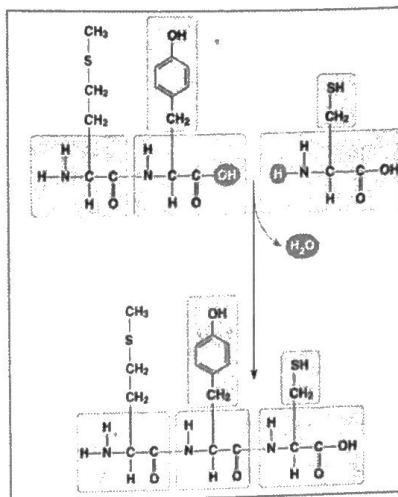
- A) Serine
- B) Cysteine
- C) Asparagine
- D) Methionine
- E) Glutamine

7) The α -carbon of amino acids binds the following chemical group(s)

- A) Imidazole
- B) Amino and carboxyl
- C) Sulfhydryl
- D) Hydroxyl
- E) Aldehyde

(1 pt) Identify the bond formed as shown in the reaction to the right.

- A) Peptide bond
- B) Lipophilic bond
- C) Esterification bond
- D) Dehydration bond
- E) van der Waals bond



9) A newly synthesized polypeptide attains its secondary structure when

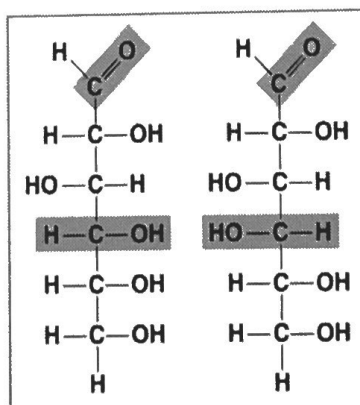
- A) It becomes denatured
- B) α -helices and β -sheets form
- C) The -COOH end of the protein is cleaved
- D) It is phosphorylated prior to processing
- E) Co-factors are attached to the protein

10) The following conditions can cause a protein to denature (fully unfolded)

- A) Low temperature
- B) High temperature
- C) Phosphorylation of one of its amino acids
- D) Interaction with reactants
- E) Interaction with products

11) The molecules shown to the right are

- A) Disaccharides
- B) Hexoses
- C) Esterified compounds
- D) Isomers of each other
- E) Both B and D above



12) The difference between amylopectin and glycogen is primarily the

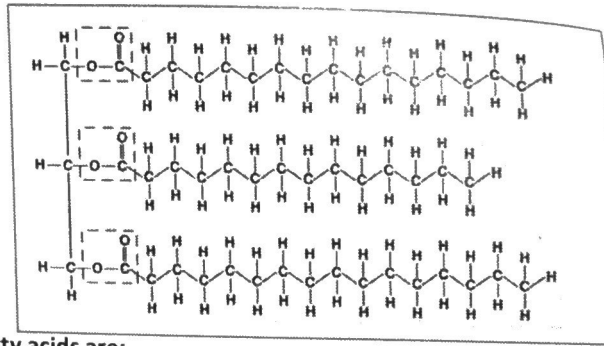
- A) Length of the polysaccharide
- B) Frequency of branching
- C) Molecular weight size
- D) *Cis* versus *trans* form
- E) Participation in DNA versus RNA formation

13) The difference between amylose and cellulose is primarily the

- A) Frequency of branching
- B) Length of the polysaccharide
- C) Molecular weight size
- D) *Cis* versus *trans* form
- E) Participation in DNA versus RNA formation

14) The molecule pictured to the right shows:

- A) Fatty acids esterified to glycerol
- B) A triglyceride
- C) Contains saturated fatty acids
- D) *Cis* versus *trans* form
- E) A, B, and C

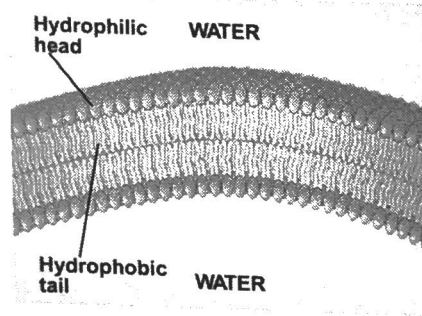


15) Triglycerides with saturated versus unsaturated fatty acids are:

- A) More rigid
- B) Melt at a higher temperature
- C) Have a greater hydrogen-to-carbon (H:C) ratio
- D) Are linear versus angular
- E) All of the above

16) Given the below lipid bilayer structure of the biological membrane, which one of the following molecules would most easily diffuse through?

- A) Propanol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$)
- B) Methanol (CH_3OH)
- C) Protons (H^+)
- D) Water (H_2O)
- E) Sodium cations (Na^+)



17) The DNA double helix structure shown to the right is primarily stabilized because of:

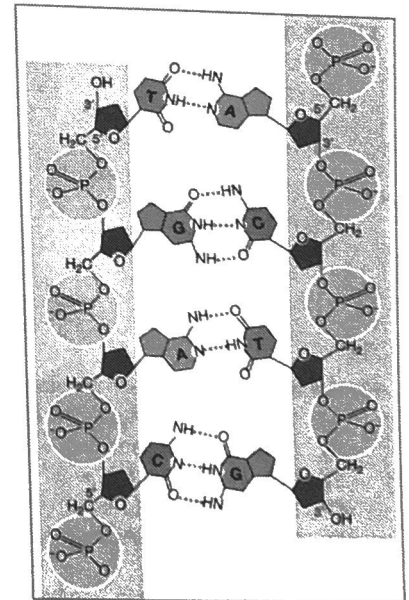
- A) Peptide bonds
- B) Hydrogen bonds
- C) Covalent interactions
- D) Hydrophobicity
- E) Histone proteins

18) A difference between DNA and mRNA molecules is:

- A) The presence of Adenine in DNA but not in mRNA
- B) DNA can be linear or circular whereas mRNA is only circular
- C) DNA has T (thymidine) versus U (uracil) in mRNA
- D) DNA has a double helix versus single stranded mRNA molecule
- E) Both C and D above

19) (1 pt) Compared to prokaryotes, eukaryotes have the following:

- A) Membrane-based intracellular compartments
- B) Endoplasmic reticulum
- C) Mitochondria
- D) Golgi apparatus
- E) All of the above



20) Which of the following observations supports the endosymbiotic bacterial origin of chloroplasts and mitochondria within eukaryotic cells?

- A) Mitochondria and chloroplasts have similarities with prokaryotic bacteria
- B) Mitochondria and chloroplasts contain free bacterial-type ribosomes
- C) Mitochondria and chloroplasts contain bacteria-type circular DNA
- D) Mitochondria and chloroplasts contain enzymes similar to those found in the cytosol (isozymes)
- E) All of the above

21) (1 pt) Diffusion is a process whereby a compound moves:

- A) Against a concentration gradient
- B) Through a biological lipid bilayer
- C) From the area of its highest concentration to the area of its lowest concentration
- D) When endowed with high energy phosphate (~P) bonds.
- E) All of the above

22) (1 pt) When red blood cells are suspended in pure water (a hypotonic solution), they will:

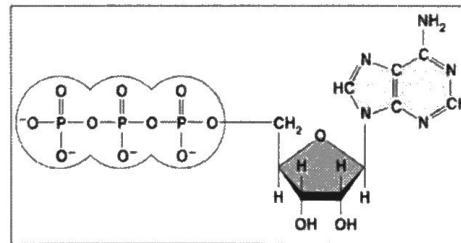
- A) Shrink
- B) Swell
- C) Acquire kinetic energy
- D) Become phosphorylated
- E) Actively efflux Na⁺ cations

23) Active movement of Na⁺ cations from the cell interior to the extra-cellular environment requires:

- A) Cell swelling
- B) Cell shrinking
- C) Cell rotation
- D) Import of amino acids
- E) Consumption of ATP energy

24) The molecule shown to the right is

- A) a DNA nucleotide base
- B) a phosphorylated amino acid
- C) a monosaccharide
- D) adenosine triphosphate
- E) NAD⁺

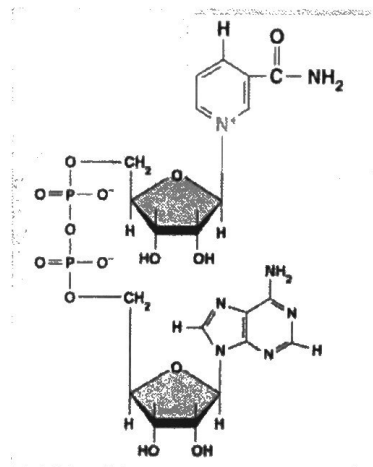


25) Coupling of endergonic and exergonic reactions enables:

- A) Product generation in a multistep process where at least one step is endergonic
- B) An overall exergonic process
- C) May entail use of high energy phosphate (~P) bonds
- D) May entail consumption of ATP energy
- E) All of the above

26) The molecule shown to the right is:

- A) NAD⁺
- B) Adenosine triphosphate
- C) Monosaccharide
- D) DNA nucleotide base
- E) RNA nucleotide base



27) The hydrolysis of sucrose to glucose and fructose is shown below. The delta G of this reaction ($\Delta G^\circ = -29.3 \text{ kJ/mol}$). It should be a spontaneously occurring forward reaction. However, sucrose in an aqueous solution is stable. Why?



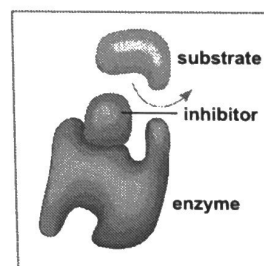
- A) Reactants need to be dissolved in a hydrophobic solvent for the reaction to go forward.
- B) Reactants are not in close proximity
- C) D) Reactants need activation energy
- D) C) Reactants need to be boiled
- E) Both B and D above

28) Enzymes have

- A) High affinity for their co-factors
- B) Low affinity for reactants and low affinity for the products of the reaction they catalyze
- C) High affinity for reactants and low affinity for the products of the reaction they catalyze
- D) High affinity for reactants and high affinity for the products of the reaction they catalyze
- E) Both A and C above

29) The schematic to the right illustrates

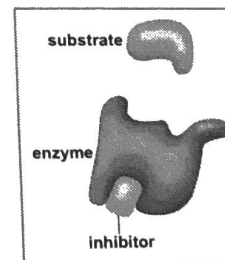
- A) A compound competes with the reactant for binding in the active site
- B) High temperature causing enzyme denaturation
- C) An enzymatic catalysis product of the reaction that accumulates
- D) An allosteric effect that changes the enzyme conformation
- E) All of the above



30) 0 pts. Mark B as you have version B of the exam.

31) The schematic to the right illustrates

- A) An allosteric effect that changes the enzyme conformation
- B) A situation that always causes enzyme denaturation
- C) An enzymatic catalysis product of the reaction that accumulates
- D) An inhibitor that binds in an allosteric site causing enzyme inhibition
- E) Both A and D above



32) Feedback inhibition of metabolic pathways is when

- A) The end product competitively inhibits the activity of an enzyme functioning early in the pathway
- B) The end product non-competitively inhibits the activity of an enzyme functioning early in the pathway
- C) The primary reactant / substrate inhibits the activity of the last (terminal) enzyme in the pathway
- D) End-product accumulation shuts down the pathway
- E) Both B and D

33) The end-product(s) of glycolysis is/are

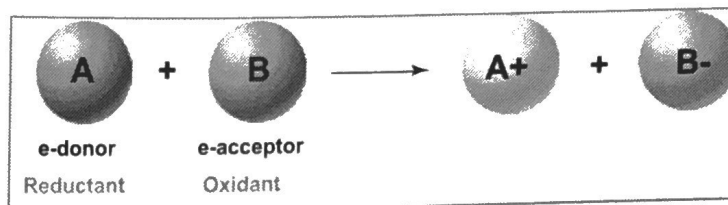
- A) Sucrose and fructose
- B) ATP, CO_2 , H_2O and pyruvate
- C) ATP, NADH, H_2O , and pyruvate
- D) Glucose and fructose
- E) Acetic acid

34) Under anaerobic fermentation conditions, pyruvate is processed further to ethanol (e.g. beer and wine). The reactant and products of this specific metabolic step are:

- | | |
|---|---|
| A) <u>Reactants</u> : Sucrose; | <u>Products</u> : Lactate and NAD ⁺ |
| B) <u>Reactants</u> : Pyruvate; | <u>Products</u> : Ethanol, ATP, and NADH |
| C) <u>Reactants</u> : Pyruvate and NADH; | <u>Products</u> : Ethanol, CO ₂ , and NAD ⁺ |
| D) <u>Reactants</u> : 1,6 Fructose bis-phosphate; | <u>Products</u> : Ethanol and inorganic phosphate. |
| E) <u>Reactants</u> : Glucose; | <u>Products</u> : ATP, CO ₂ , and H ₂ O |

35) In the redox reaction shown to the right:

- A) A is oxidized, B is reduced
 B) A is oxidized, B is oxidized
 C) A is reduced, B is reduced
 D) A is reduced, B is oxidized



36) Enzyme co-factors could be:

- A) Metal cations
 B) Chlorophylls, hemes, quinones, carotenoids, flavins
 C) Small proteins: fatty acid (acyl)-carrier protein
 D) Coenzyme-A; Pantothenic acid; Vitamins
 E) All of the above

37) Substrate phosphorylation means:

- A) A redox reaction has occurred
 B) The kinetic energy of the substrate has diminished
 C) Substrate has attained a higher level of energy due to the addition of a phosphate (~P) group.
 D) Substrate has attained a lower level of energy due to the addition of a phosphate (~P) group.
 E) Substrate has been stabilized

38) In chloroplasts and mitochondria, ATP synthesis from ADP and Pi is an endergonic reaction powered by

- A) The fatty acid composition of the membrane lipid bilayer
 B) The carbon reactions of photosynthesis
 C) The ΔpH across the chloroplast and mitochondrial bioenergetic membrane.
 D) Vitamin cofactors in the ATP synthase
 E) Glycolysis in the cytosol of the cell.

39) Identify the metabolic process that will proceed only in the presence of oxygen

- A) Oxidative phosphorylation
 B) Krebs cycle
 C) Glycolysis
 D) Both A and B
 E) Both B and C

40) Mitochondria process pyruvate from glycolysis to the following FINAL products:

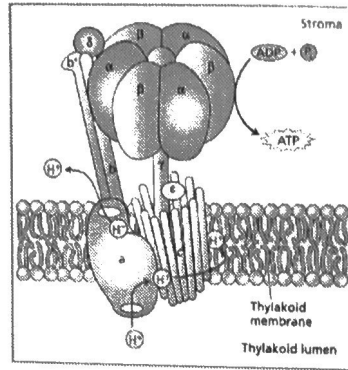
- A) Glucose
 B) Fructose
 C) CO₂, H₂O, and ATP
 D) NADH and CO₂
 E) Both A and C above

41) Consider the complete catabolism of one mole each of glucose (C₆H₁₂O₆), stearic fatty acid (CH₃[CH₂]₁₆COOH), and acetic acid (C₂H₄O₂) to CO₂ and H₂O. The descending order (from more to less) of ATP produced is:

- A) Glucose>Stearic acid>Acetic acid
 B) Stearic acid> Glucose>Acetic acid
 C) Glucose >Acetic acid>Stearic acid
 D) Stearic acid>Acetic acid> Glucose
 E) Acetic acid>Stearic acid> Glucose

42) The functional model of the ATP synthase stipulates rotation of the catalytic peripheral portion of the enzyme by 120° for each proton (H^+) passing through. If the operational H^+/ATP ratio is 3:1, how many ATPs will be generated in a full cycle of the rotor?

- A) Five
- B) Four
- C) Three
- D) Two
- E) One



43) Electron transport in the mitochondrial cristae:

- A) Releases energy that is stored in H_2O
- B) Is an endergonic reaction
- C) Releases energy that generates a ΔpH
- D) Releases energy that is eventually captured as ATP
- E) Both C and D above

44) The substrate level ATP synthesis and the chemiosmotic mechanism of ATP synthesis have the following common characteristics

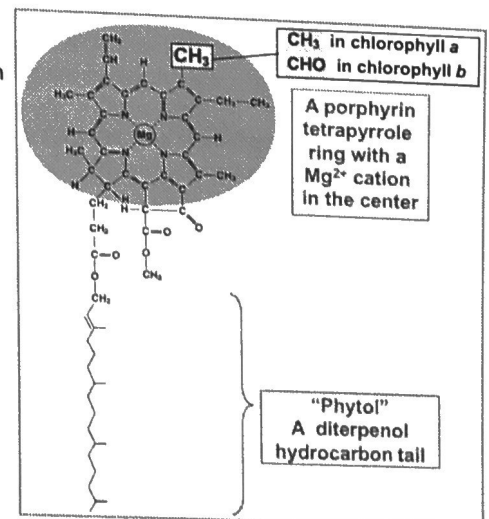
- A) They both use ADP and inorganic phosphate (P_i) as reactants.
- B) They both use the ATP synthase enzyme to make ATP
- C) They both occur in the mitochondrial cristae
- D) They both require glucose as a reaction substrate.
- E) Both A and B above.

45) (1 pt) The visible light of the solar spectrum has the following wavelength range:

- A) 200-320 nm
- B) 320-400 nm
- C) 400-700 nm
- D) 700-900 nm
- E) 900-2,000 nm

46) The photochemistry part of photosynthesis

- A) Utilizes the energy of absorbed photons to drive an endergonic redox reaction
- B) Is the step where a transition from physics to chemistry takes place
- C) Occurs between two tetrapyrroles
- D) Results in one tetrapyrrole being oxidized and the other reduced
- E) All of the above



47) The structure of chlorophyll is shown to the right.

Light is absorbed by what part of its molecular structure?

- A) The $-CH_3$ (in Chl *a*) or $-CHO$ (in Chl *b*) groups
- B) The tetrapyrrole ring
- C) The Mg^{++} cation in the center of the molecule
- D) The conserved phytol tail
- E) All of the above

48) The products of the electron transport process in chloroplast thylakoids are:

- A) Phosphoglyceric acid and glyceraldehyde-3-phosphate
- B) Fructose 1,6-bis phosphate
- C) ATP, CO_2 , and H_2O
- D) Reduced CO_2 , sulfates and nitrates
- E) Reduced ferredoxin, NADPH, ATP and O_2

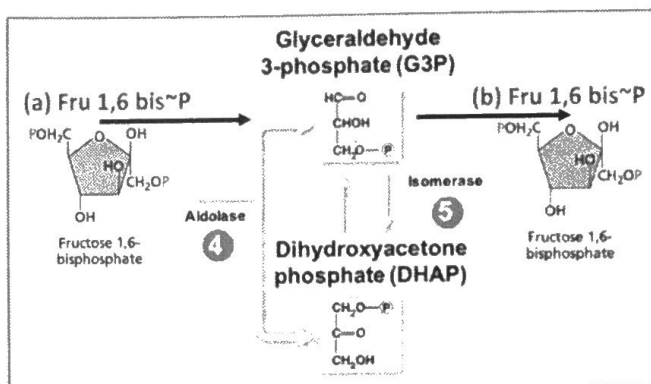
EXAM CONTINUES

49) The carboxylation reaction of photosynthesis

- A) Converts CO_2 to bicarbonate ($-\text{HCO}_3^-$).
- B) Adds CO_2 to ribulose bis-phosphate (RuBP) to make 3-phosphoglyceric acid (3-PGA)
- C) Adds NH_3 to glutamic acid to make glutamine
- D) Employs carboxylic acid to absorb sunlight
- E) Converts 3-phosphoglyceric acid (3-PGA) to glyceraldehyde 3-phosphate (G3P)

50) Reaction (a) of Fru 1,6 bis~P to G3P and DHAP (please see schematic below) also proceeds in the opposite direction, as in (b), where G3P and DHAP combine to form Fru 1,6 bis~P. However, these two opposite-direction reactions occur in different cellular compartments which are, respectively:

- A) The cytosol and the nucleus
- B) The mitochondrial matrix and the peroxisome
- C) The cytosol and the endoplasmic reticulum
- D) The cytosol and the chloroplast
- E) The Golgi apparatus and the ribosomes



51) C_4 photosynthesis (maize, sugar cane) can occur at rates faster than C_3 photosynthesis (spinach, tobacco) because

- A) C_3 photosynthesis is limited by the low (0.04%) CO_2 concentration in the atmosphere
- B) C_3 photosynthesis is handicapped because of losses due to photorespiration
- C) C_4 photosynthesis makes use of both CO_2 and the more abundant HCO_3^- , as inorganic C-sources
- D) C_4 photosynthesis is not subject to losses due to photorespiration
- E) All of the above

52) The following two transmembrane complexes are encountered in both thylakoid membranes and cristae

- A) NADH dehydrogenase and cytochrome oxidase
- B) FADH_2 dehydrogenase and photosystem-II
- C) cytochrome complex and ATP-synthase
- D) photosystem-I and cytochrome oxidase
- E) photosystem-II and photosystem-I

53) In mitotic cells division facilitated by the Centrosomes, sister chromatids move along the kinetosome microtubules toward opposite ends of the cell. What is the fate of the microtubules as the kinetosome-chromosome complex moves toward opposite ends of the cell?

- A) The cells retain the full length of these microtubules to serve as "girders" in retaining the cell shape.
- B) The microtubules disassemble by depolymerizing into the constituent tubulin monomer subunits, as the kinetosome-chromosome complex passes by.
- C) The cells store these microtubules in the nucleus for the next cell division.
- D) The full-length microtubules of the mitotic spindle are then used to make the cilia of the newly formed daughter cells.
- E) Both C and D.

54) Which of the following is improperly matched?

- A) metaphase: chromosomes are arranged in a plane through the middle of the cell
- B) anaphase: nuclear envelopes reform
- C) prophase: nuclear envelopes fragment
- D) interphase: DNA duplicates
- E) prometaphase: kinetochores attach to spindle fibers

END OF THE EXAM