Medical Biochemistry Examination III
December 15, 1999
Kresge Auditorium

Please follow these directions:

1. Do not begin the exam until all students have received a copy of the exam. You will be instructed as to when to break the seal.

2. The exam consists of 81 questions on 17 pages, with this title page considered page 1. There are 150 points on this exam. The point value for each question is indicated by the question. For multiple answer questions without a defined number of answers 0.25 points will be deducted for each incorrect answer, although the lowest point value assigned for a question is 0. **No multiple answer question will have more than 4 correct answers. If a question has a defined number of answers, there is no penalty for guessing.**

3. Place your ID number on every page of the exam booklet and on the answer sheet you will hand in. Also, print your name on the line provided on the answer sheet.

4. There is one answer sheet for this exam. **One question (Number 81 on page 17) should be answered within the exam booklet itself. Use a No. 2 pencil only.** Fill in the circle for the correct answer(s) completely. If you believe that a question has more than one correct answer fill in all answers for that question completely. If you wish to change an answer, be sure to erase cleanly. **Make sure that you use your biochemistry ID number to fill in the ID box. You should use the three leftmost boxes to insert your number.**

5. When you are finished with the exam, return both the test booklet and the answer sheets. The test booklet will be returned to you when the grading is complete. **You will receive your next installment of the course syllabus in your mailbox the second week of February.**

6. Questions will not be allowed during the exam. If you believe there is a typographical error do the best you can with the information available. Do not spend extra time on the question. If it is determined that the information presented is ambiguous, or in error, then the question will not be counted in the final scoring.

7. Following the last page of the exam are two blank pages for your use, and a third page which can be used by you to list your answers. You can take this sheet with you from the exam, and use it to check your answers against the posted answers (outside of room 3109 MSB). **You will not be given extra time to fill out this answer sheet.** Answers will be posted on December 16th, at noon, assuming that all students attend the exam at its scheduled time.

8. You will have **3.0 hours (until 11:30 am)** to complete this exam. Good luck.
1. (2 points) A newborn female infant was found to produce elevated levels of both phenylalanine and phenylpyruvate in her urine. This finding suggests an enzyme deficiency. Which TWO of the following enzymes, or processes, when defective, may lead to this condition?
   A. Tyrosine hydroxylase
   B. Phenylalanine hydroxylase
   C. Phenylalanine transaminase
   D. Regeneration of tetrahydrofolate
   E. Regeneration of tetrahydrobiopterin
   F. Regeneration of tetrahydroniacin

2. (2 points) The reaction which converts serine to pyruvate is initiated by a beta-elimination of the serine hydroxyl. The required cofactor for this reaction is which ONE of the following?
   A. Vitamin B1
   B. Vitamin B2
   C. Vitamin B6
   D. Vitamin B12
   E. Biotin
   F. Folic acid
   G. Biopterin
   H. Thioredoxin

3. (2 points) An elderly patient presents to you with evidence of amino acid deficiencies. Your history of the patient reveals that the patient has been forgetting to eat, and when he does eat, only consumes diet pepsi and romaine lettuce. Which TWO of the following amino acids would you expect this patient to be deficient in?
   A. The amino acid designated by the letter N.
   B. The amino acid designated by the letter P.
   C. The amino acid designated by the letter H.
   D. The amino acid designated by the letter S.
   E. The amino acid designated by the letter Q.
   F. The amino acid designated by the letter T.

4. (2 points) A defect in an amino acid transporter can lead to Hartnup’s disease, which results in the formation of kidney stones. These stones are composed primarily of which ONE of the following compounds?
   A. Uric acid
   B. Leucine
   C. Xanthine
   D. Cystine
   E. Lysine
   F. Methionine
Questions 5 and 6 (2 points each) refer to the case described below. A patient presents with feelings of lethargy and nausea. These feelings are more pronounced after eating a high protein meal. Laboratory tests indicate elevated levels of methylmalonic acid in the blood and urine.

5. This metabolic defect is most likely caused by a deficiency of which ONE of the following?
   A. Vitamin B1
   B. Vitamin B2
   C. Vitamin B6
   D. Vitamin B12
   E. Biotin
   F. Folic acid
   G. Biopterin
   H. Thioredoxin

6. The ingestion of which TWO of the following amino acids would be expected to exacerbate the metabolic problem?
   A. The amino acid designated by the letter R.
   B. The amino acid designated by the letter H.
   C. The amino acid designated by the letter M.
   D. The amino acid designated by the letter L.
   E. The amino acid designated by the letter K.
   F. The amino acid designated by the letter V.
   G. The amino acid designated by the letter S.

7. (2 points) During the intestinal digestion of proteins the products of trypsin cleavage can be further degraded from their carboxy terminus by which ONE of the following enzymes?
   A. Carboxypeptidase A
   B. Carboxypeptidase B
   C. Carboxypeptidase C
   D. Elastase
   E. Chymotrypsin
   F. Pepsin
Questions 8 and 9 (2 points each) are based on the case scenario presented below. A 30 year old female comes to your office for a consultation. She had previously given birth to a child with anencephaly (a neural tube defect), and was considering getting pregnant again. However, she was very concerned that she would have another child with a neural tube defect, and wanted to know if there were any tests which could be done to determine her risk of having another child with such a defect.

8. What ONE enzyme listed below would you test for a thermolabile variant?

A. Dihydrofolate reductase
B. Serine hydroxymethyl transferase
C. N\textsuperscript{5}, N\textsuperscript{10} - methylene tetrahydrofolate reductase
D. N\textsuperscript{5}, N\textsuperscript{10} - methenyl tetrahydrofolate reductase
E. Quinoid dihydrobiopterin reductase

9. If the enzyme in question 8 is found to be thermolabile, the preferred treatment for this patient would be to give high doses of which ONE of the following vitamins?

A. Vitamin B1
B. Vitamin B2
C. Vitamin B6
D. Vitamin B12
E. Biotin
F. Folic acid
G. Biopterin
H. Thioredoxin

10. (2 points) Maple syrup urine disease is a disease affecting all branched chain amino acids. The defect in this disease is in which ONE of the following enzymes?

A. Branched chain amino acid transaminase.
B. Branched chain alpha-keto acid transaminase.
C. Branched chain amino acid dehydrogenase.
D. Branched chain alpha-keto acid dehydrogenase.
E. Branched chain amino acid transporter.
F. Branched chain alpha-keto acid transporter.

11. (2 points) Folic acid donates carbons in a certain number of biochemical pathways. One of the pathways below does NOT require a folic acid carbon transfer. Indicate this ONE reaction.

A. dUMP being converted to TMP
B. Ethanolamine being converted to choline
C. Glycine being converted to serine
D. The biosynthesis of the purine ring
E. Homocysteine being converted to methionine
Questions 12-16 (2 points each) should be answered from the lettered list of structures, A-I. There is only ONE answer per question. An answer may be used once, more than once, or not at all.

12. This amino acid, when degraded, can give rise to fumarate.

13. This amino acid is thought to be essential in children, but not so in adults.

14. This amino acid, when degraded, is strictly ketogenic.

15. This amino acid, when degraded, can be both ketogenic and glucogenic.

16. This amino acid is an immediate precursor for a cellular methyl donor.

17. (2 points) A patient presents with complaints of their urine turning black after exposure to the atmosphere. This disease arises from a defect in which ONE of the following amino acid degradative pathways?

A. Methionine  
B. Isoleucine  
C. Phenylalanine  
D. Cysteine  
E. Arginine  
F. Valine
18. (2 points) Considering the hypothetical branched chain pathway shown below, the levels of B produced will be most likely regulated by which **ONE** of the following?

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A 1 → B 2 → C 3 → D 4 → E
  5 F 6 → G
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A. Inhibition of reaction 2 by E.
B. Inhibition of reaction 5 by F.
C. Inhibition of reaction 5 by G.
D. Inhibition of reaction 2 by C.
E. Inhibition of reaction 1 by a combination of E and G.
F. Inhibition of reaction 1 by a combination of C and F.

19. (2 points) A patient presents to your practice with large blisters on their arms and face, which only appear after exposure to sunlight. Analysis of the blood of this patient indicates that various chemicals, similar to heme, are present in high levels. The patient is also slightly anemic. The type of disease to suspect in this situation is which **ONE** of the following?

A. Jaundice
B. Gout
C. Lesch-Nyhan syndrome
D. Von Gierke’s disease
E. Porphyria
F. Phenylketonuria

20. (2 points) A new-born infant is found to have elevated levels of glutamine, ammonia and citrulline in their bloodstream. The most likely enzymatic defect in this patient is which **ONE** of the following?

A. Carbamoyl-phosphate synthetase I
B. Carbamoyl-phosphate synthetase II
C. Ornithine transcarbamoylase
D. Argininosuccinate synthetase
E. Argininosuccinate lyase
F. Arginase
G. N-acetylglutamate synthase
21. (1 point) Starting with ornithine labeled with $^{15}$N in the side chain nitrogen, how many nitrogens of urea will be labeled?

A. None  
B. One  
C. Two  
D. Three  

Questions 22-25 (2 points each) should be answered from the lettered list (A-F) of structures below. An answer may be used once, more than once, or not at all.

22. Redux and phen/fen acted by elevating the level of this ONE neurotransmitter.

23. Release of this ONE neurotransmitter will result in the activation of PKA in muscle.

24. This ONE neurotransmitter is produced via the B6 dependent decarboxylation of glutamate.

25. Drugs which inhibit monoamine oxidase (MAO) will lead to the elevation of which TWO of these neurotransmitters?

26. (2 points) Enzymes which can fix ammonia into an organic compound play an important role in the detoxification of ammonia. Which TWO of the following enzymes CANNOT fix ammonia into an organic molecule?

A. Glutamate dehydrogenase  
B. Carbamoyl-phosphate synthetase I  
C. Carbamoyl-phosphate synthetase II  
D. Glutamine synthetase  
E. Asparagine synthetase
27. (2 points) Glutamate plays an important role in nitrogen metabolism. Which TWO of the following are NOT roles of glutamate in nitrogen metabolism?

A. Transports nitrogen groups throughout the body
B. Is a substrate for an ammonia fixation reaction
C. Is a substrate for the biosynthesis of the activator of carbamoyl-phosphate synthetase I
D. Is a nitrogen donor in transamination reactions
E. Is the nitrogen donor for the biosynthesis of asparagine
F. Combines with citrulline to form argininosuccinate

Questions 28 and 29 (2 points each) are based on the following case. A new born infant visits your office with a failure to thrive and frequent crying episodes. Blood work indicates a marked increase in the levels of glutamine, ammonia, and orotic acid. You immediately suspect a urea cycle defect.

28. The most likely enzymatic defect in this patient is which ONE of the following?

A. Carbamoyl-phosphate synthetase I
B. Carbamoyl-phosphate synthetase II
C. Ornithine transcarbamoylase
D. Argininosuccinate synthetase
E. Argininosuccinate lyase
F. Arginase
G. N-acetylglutamate synthase

29. The orotic acid accumulation in this patient is due to which ONE of the following?

A. Activation of carbamoyl-phosphate synthetase II.
B. Inhibition of carbamoyl-phosphate synthetase II.
C. Bypassing of the regulated step of purine biosynthesis.
D. Bypassing of the regulated step of pyrimidine biosynthesis.
E. Activation of carbamoyl-phosphate synthetase I.
F. Inhibition of carbamoyl-phosphate synthetase I.
G. Reduced pyrimidine degradation due to elevated ammonia levels.

30. (2 points) Zellweger’s syndrome is a fatal disease due to which ONE of the following?

A. An inability to synthesize cardiolipin.
B. An inability to produce sphingomyelin.
C. An inability to produce vinyl ether lipids.
D. An inability to degrade GM1.
E. An inability to degrade GD1.
F. An inability to degrade GT1.
Questions 31 through 45 (1 point each) should be answered True (T) or False (F) on the answer sheet. Be sure to use T or F to answer these questions on the answer sheet.

31. Cerebrosides are components of gangliosides.
32. Sphingomyelin is the only sphingosine based phospholipid.
33. GM1 can be classified as a glycolipid.
34. Phosphatidylcholine can be classified as a glycolipid.
35. Gangliosides must contain sialic acid residues.
36. CDP-diglyceride is used for the biosynthesis of phosphatidylinositol and phosphatidylglycerol.
37. CDP-choline is used for the biosynthesis of phosphatidylcholine and sphingomyelin.
38. Sphingosine contains a peptide bond.
39. Dihydroxyacetone-phosphate is the starting point for the biosynthesis of the ether lipids.
40. Dipalmitoyl phosphatidylcholine is an essential component of human surfactant.
41. The first pyrimidine nucleotide to be synthesized de novo, and which is found in nucleic acids, is UMP.
42. Pyrimidine nucleoside phosphorylase utilizes ribose-1-phosphate to generate a pyrimidine nucleoside.
43. CMP is made directly from UMP via the donation of a nitrogen from glutamine.
44. The methyl donor for the production of TMP from dUMP is 5-methyl-tetrahydrofolate.
45. The regulated enzyme in pyrimidine biosynthesis in mammals is aspartate transcarbamoylase.

Questions 46-50 (2 points each) are based on the sphingolipidoses. There is only ONE answer per question, to be picked from choices A through J. An answer may be used once, more than once, or not at all.

46. This disease results in an inability to degrade sphingomyelin, thereby leading to a buildup of sphingomyelin in the lysosomes. A. Generalized GM1 gangliosidosis
B. Tay-Sachs disease
C. Sandhoff’s disease
47. Glucose-cerebroside accumulates in the lysosomes in this disease. D. Niemann-Pick disease
E. Farber’s disease
48. The lipids GM2 and globoside accumulate in the lysosomes in this disease. F. Gaucher’s disease
G. Lactosyl-ceramidosis
49. Sulfated glycolipids accumulate within the lysosomes of this disease. H. Fabry’s disease
I. Krabbe’s disease
50. Hexosaminidase A is deficient in this disease. J. Metachromatic leukodystrophy

51. (2 points) The production of which ONE compound listed below is inhibited in the presence of lithium?

A. Phosphatidylinositol bisphosphate
B. Phosphatidylinositol trisphosphate
C. Phosphatidylinositol phosphate
D. Phosphatidylinositol
E. Inositol
52. (2 points) Treating phosphatidylethanolamine with phospholipase D will produce which **TWO** of the following compounds?

A. Phosphatidic acid  
B. Diacylglycerol  
C. Ethanolamine  
D. Phospho-ethanolamine  
E. 1-lyso phosphatidylethanolamine  
F. 2-lyso phosphatidylethanolamine

53. (2 points) Initiation of the phosphatidylinositol cycle occurs when the appropriate signal binds a receptor in the membrane, which activates the Gp protein. The immediate target of the Gp protein is which **ONE** of the following?

A. Adenylate cyclase  
B. Adenylate kinase  
C. Phospholipase C  
D. Phospholipase D  
E. PIP$_2$ phosphatase  
F. PIP$_3$ phosphatase

54. (2 points) **TWO** biologically active components derived from the PI cycle are:

A. Inositol-phosphate  
B. Inositol-bisphosphate  
C. Inositol-trisphosphate  
D. Monoacylglycerol  
E. Diacylglycerol  
F. Tricaylglycerol

55. (2 points) Upon activation of the PI cycle, which **TWO** of the following effects occur?

A. Increase in cytoplasmic calcium levels.  
B. Decrease in cytoplasmic calcium levels.  
C. Activation of protein kinase A.  
D. Inhibition of protein kinase A.  
E. Increase in cytoplasmic sodium levels.  
F. Decrease in cytoplasmic sodium levels.  
G. Activation of protein kinase C.  
H. Inhibition of protein kinase C.
56. (2 points) Compounds known as tumor promoters activate which ONE enzyme listed below?

A. Protein kinase A
B. Protein kinase C
C. Protein kinase E
D. Phospholipase A1
E. Phospholipase A2
F. Phospholipase C

57. (2 points) The conversion of phosphatidylinositol to phosphatidylinositol bisphosphate is catalyzed by which ONE of the following?

A. A series of phosphatases
B. A series of phospholipases
C. A series of proteases
D. A series of kinases
E. A series of glycosidases

58. (2 points) Starting with serine labeled in the beta carbon (the CH₂OH carbon) with ^14C, and allowing liver cells to metabolize it for a number of hours, which of the following components of phosphatidyl choline would NOT have the ^14C label associated with it? This question may have more than one correct answer; be sure to indicate all correct answers on the answer sheet.

A. The glycerol backbone
B. The fatty acid at the one position
C. The fatty acid at the two position
D. The choline group
E. The sphingosine group

59. (2 points) Which ONE of the following components is NOT found in GM1?

A. Ceramide
B. Sphingosine
C. Glucose
D. Sialic Acid
E. Galactose
F. N-acetylglucosamine

60. (1 point) PRPP is used in all of the following mammalian pathways except for which ONE?

A. Purine biosynthesis
B. Pyrimidine biosynthesis
C. Purine salvage pathways
D. Pyrimidine salvage pathways
61. (2 points) The biosynthesis of the purines and pyrimidines share some common features. Which ONE of the following is not a shared feature between these two pathways?

A. The use of aspartate as a precursor for ring synthesis.
B. The use of glutamine as a precursor for ring synthesis.
C. The use of carbon dioxide as a precursor for ring synthesis.
D. The use of PRPP to synthesize a purine or pyrimidine nucleotide.
E. The use of N^10^-formyl tetrahydrofolate as a precursor for ring synthesis.

62. (2 points) A six month old male child has a history of recurrent infections and viral disease. X-rays indicate that the patient is athymic. The patient also lacks circulating T and B cells. The ONE enzyme deficiency which is most likely to lead to these symptoms is:

A. Adenosine deaminase
B. Adenosine kinase
C. Adenine phosphoribosyl transferase
D. Purine nucleoside phosphorylase
E. Pyrimidine nucleoside phosphorylase
F. Hypoxanthine-guanine phosphoribosyl transferase

63. (2 points) The major regulated step of purine biosynthesis is catalyzed by which ONE of the following enzymes?

A. PRPP synthetase
B. AICAR carboxylase
C. Amidophosphoribosyl transferase
D. Adenine phosphoribosyl transferase
E. Glutamine synthetase
F. IMP dehydrogenase

64. (2 points) The regulated step specific for AMP biosynthesis is catalyzed by which ONE of the following enzymes?

A. IMP dehydrogenase
B. Xanthine oxidase
C. Adenylosuccinate lyase
D. Adenylosuccinate synthetase
E. Adenine phosphoribosyl transferase
F. GMP synthase
65. (2 points) Which of the following conditions **CANNOT** lead to gout? This question may have more than one correct answer. Be sure to indicate all correct answers on the answer sheet.

A. Von Gierke’s disease  
B. Constant elevated glutamine levels in the circulation  
C. Lesch-Nyhan syndrome  
D. Adenosine phosphoribosyl transferase deficiency  
E. Adenosine deaminase deficiency

66. (2 points) Allopurinol can be used to treat gout due to its ability to inhibit which **TWO** of the following reactions?

A. AMP to XMP  
B. Xanthine to uric acid  
C. Inosine to hypoxanthine  
D. IMP to XMP  
E. XMP to GMP  
F. Hypoxanthine to xanthine

67. (2 points) Similarities between carbamoyl-phosphate synthetase I and carbamoyl-phosphate synthetase II include which of the following? This question may have more than one correct answer. Be sure to indicate all correct answers on the answer sheet.

A. Intracellular location  
B. Nitrogen source  
C. Carbon source  
D. Regulation by N-acetylglutamate  
E. Regulation by UMP

68. (2 points) Pyrimidine synthesis differs from purine synthesis by which of the following ways? This question may have more than one correct answer. Be sure to indicate all correct answers on the answer sheet.

A. Pyrimidine synthesis first produces the free base; purine synthesis first produces a nucleotide.  
B. The production of a pyrimidine nucleotide does not require PRPP, whereas the production of purine nucleotides requires PRPP.  
C. Glycine is required for purine, but not pyrimidine, biosynthesis.  
D. A number of the activities of the purine biosynthetic pathway are aligned as different active sites on the same protein molecule. For pyrimidine synthesis each activity resides on a separate protein molecule.  
E. Glutamine is required for pyrimidine biosynthesis, but not for purine biosynthesis.
Questions 69-72 (2 points each) should be answered from the lists below. Each question has two answers, one from the choices A-D, the other from the choices E-M. The choices A-D refer to nucleotides which may bind to the activity site of ribonucleotide reductase, whereas choices E-M refer to nucleotides which may bind to the substrate specificity site of ribonucleotide reductase.

<table>
<thead>
<tr>
<th>ACTIVITY SITE</th>
<th>SUBSTRATE SPECIFICITY SITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>69. Required to produce dADP.</td>
<td>A. ATP</td>
</tr>
<tr>
<td>70. Required to produce dUDP.</td>
<td>B. dATP</td>
</tr>
<tr>
<td>71. Required to produce dGDP.</td>
<td>C. GTP</td>
</tr>
<tr>
<td>72. Required to produce dCDP.</td>
<td>D. dGTP</td>
</tr>
</tbody>
</table>

73. (1 point) In the reaction catalyzed by ribonucleotide reductase a ribose base is reduced. The electrons for this reduction are derived from which ONE of the following?

A. Reduced thioredoxin
B. Oxidized thioredoxin
C. Reduced glutathionine
D. Oxidized glutathionine
E. Reduced FAD
F. Oxidized FAD

74. (2 points) In the conversion of dUMP to TMP the cofactor required is oxidized. The enzyme which catalyzes the reduction of this cofactor is which ONE of the following?

A. Dihydrobipterin reductase
B. Dihydroropterin reductase
C. Dihydrofolate reductase
D. Dihydroaminopterin reductase

75. (2 points) Which TWO enzymes listed below would you expect to be inhibited by azaserine?

A. PRPP synthetase
B. Adenylosuccinate synthetase
C. GMP synthase
D. Amidophosphoribosyl transferase
E. Hypoxanthine guanine phosphoribosyl transferase
F. Adenosine deaminase
76. (2 points) Which **TWO** of the following inhibitors act through prevention of the production of TMP?

A. AZT  
B. 5-flurouracil  
C. 5-iodouracil  
D. Methotrexate  
E. PALA  
F. Azaserine  
G. Mercaptopurine

77. (2 points) Which **TWO** of the following inhibitors act via chain termination during DNA synthesis?

A. Azaserine  
B. Methotrexate  
C. 5-iodouracil  
D. Acyclovir  
E. PALA  
F. AZT

78. (2 points) The regulated step specific for GMP biosynthesis is catalyzed by which **ONE** of the following enzymes?

A. IMP dehydrogenase  
B. Xanthine oxidase  
C. Adenylosuccinate lyase  
D. Adenylosuccinate synthetase  
E. Adenine phosphoribosyl transferase  
F. GMP synthase
Questions 79 and 80 (1 point each) are based on the situation described below. You are shadowing your year one preceptor in Clinical Opportunities and she has asked you to take a history from her next patient. You eagerly and competently do this and are able to present the following history:

Mr. Smith is a 50 yo white male who has come for a check-up because his wife made him. He has no current complaints and feels his health is OK. He says his wife wants him to ask what things he can do to keep healthy. His past medical history is significant only for an appendectomy as a teenager, and a back injury in a motor vehicle accident when he was in his early twenties. He has no allergies and takes no prescription or over-the-counter medications. His family history is significant for father dying at age 55 from a heart attack and his father's mother dying from a stroke; he has one older sister living who has diabetes and who has also had a stroke. He lives with his wife of 30 years; they have a satisfying relationship and two grown children. He is a long-distance truck driver and spends many hours on the road without a break but the money is good. He has smoked one pack per day for 30 years; he drinks 1-2 six packs of beer per weekend. He describes his diet as "normal steak and potatoes", with no "sissy foods". He eats lots of fast food on the road, drinks several pots of coffee a day, loves desserts, and eats few fruits and vegetables.

Your preceptor is pleased with this thorough yet succinct summary and proceeds with the physical exam. The only notable findings on exam is that Mr. Smith is overweight (BMI=30) and his blood pressure is 150/96 (mildly elevated). Your preceptor tells the patient she would like to order an EKG, a chest X-ray and some baseline labs. She then turns to you and asks if there is anything else you would like to check. She is intrigued when you suggest a serum homocysteine level and asks you to explain this to her as she has not heard about this.

79. Which of the explanations below are valid reasons for suggesting the homocysteine level analysis? This question may have more than one correct answer. Be sure to indicate all correct answers on the answer sheet.

A. elevated levels of homocysteine are an independent risk factor for thromboembolic disease
B. the test is cheap and is covered by insurance
C. treatment is risky and it would be important to be sure of the level before starting treatment
D. his family history and social history suggest he might have elevated levels of homocysteine

The preceptor is impressed with your fund of knowledge. She then gives recommendations to Mr. Smith to quit smoking and lose weight. She also suggests taking an aspirin a day and starting on a blood pressure medicine. She then asks you what additional recommendations you would have. You tell Mr. Smith that taking frequent breaks on his long trips would help reduce his risk of blood clots.

80. Other items you would tell him include which of the following? This question may have more than one correct answer. Be sure to indicate all correct answers on the answer sheet.

A. to add methionine to his diet
B. to make no changes in his diet as he has a good balanced diet
C. to take a vitamin supplement daily that includes B6, B12 and folic acid
D. to never drink alcohol when taking a vitamin supplement
E. to eat greens daily
81. (10 points) Starting with glucose labeled in the 1 position with \(^{14}\text{C}\), methionine, alpha-ketoglutarate, and phosphatidyl ethanolamine, indicate the pathways required to produce phosphatidyl-choline labeled with \(^{14}\text{C}\) in the methyl groups on the nitrogen in choline. Assume that all required cofactors are present in catalytic amounts, as well as unlimited amounts of ammonia and carbon dioxide. Structures and enzyme names are not required for the answer, however, if a reaction requires a cofactor, that should be indicated in your answer.

**In order to get the \(1\) \(\text{CH}_3\) groups on the nitrogen in PC labeled we need to use the transmethylated pathway of PE \(\rightarrow\) PC by 3 successive SAM methylations. So how do we get the \(^{14}\text{C}\)-label into SAM?**

To make glu for transaminations: \(\alpha\text{KB} + \text{NH}_3 + \text{NADH} \rightarrow \text{glu} + \text{NAD}^+\) (given)
Answers to Med Biochem Exam 3

1. B, E  47. F
2. C  48. C
3. C,F  49. J
4. Delete  50. B
5. D  51. E
6. C, F  52. A, C
7. B  53. C
8. C  54. C, E
9. F  55. A, G
10. D  56. B
11. B  57. D
12. F  58. Delete
13. G  59. F
14. I  60. D
15. E  61. E
16. C  62. A
17. C  63. C
18. E  64. D
19. E  65. E
22. D  68. A, C
23. E  69. A, J
24. F  70. A, E
25. Delete  71. A, M
27. E, F  73. A
28. C  74. C
29. D  75. Delete
30. C  76. B, D
31. T  77. D, F
32. T  78. A
33. T  79. A, D
34. F  80. C, E
35. T  81. Answer in test booklet
36. T
37. T
38. F
39. T
40. T
41. T
42. T
43. F
44. F
45. F
46. D