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科目：熱力學與反應工程
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國立臺灣大學 114 學年度碩士班招生考試試題

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※ 注意：全部在試卷內之「非選擇題作答區」標明題號依序作答，中括弧答案需加上【 】，底線答案需加上_____ 。

Choose the single answer in the [brackets] (3 points for each); **Fill** in the blanks (_____) (5 points for each); or briefly **Answer** the questions (Q) on the blank space marked below (10 points for each). 99 points+1 for total. 請於中括弧內選出一個答案(各3分)，作答在試卷非選擇題作答區；底線空白處填入答案(各5分)，作答在試卷非選擇題作答區作答；或簡答於問題的指定空白處(各10分)。合計99+1分。

【1】 After one shot of drinking 100ml of cool (7°C) whisky containing 46% ethanol (~46g/mol), ethanol is quickly absorbed through your empty stomach with a surface area of 0.5m^2 under the following kinetics: $-\frac{d[W]}{dt} = k_{ab}A = \frac{d[S_I]}{dt}$, where $[W]$ and $[S_I]$ are the concentration of ethanol in your stomach and blood (or circulation), respectively. k_{ab} is the rate constant for the [zero; first; second; third] order absorption process, A is the surface area of your stomach. The ethanol absorbed is soon distributed into your circulation to achieve a plateau blood concentration of 20mM from 200s. k_{ab} = __1-1__ mMS^{-1}m^{-2}. The apparent volume of distribution (V_d) of ethanol in your body is c.a. __1-2__ L. k_{ab} follows Arrhenius equation as: $k_{ab} = k_o e^{-\frac{E_a}{RT}}$, where k_o is a constant, E_a is the activation energy, R is the gas constant (10.0 Jmol^{-1}K^{-1}) and T is the absolute temperature (= celsius temperature + 273 °K). If the whisky was kept at room temperature of 27°C; the E_a of your stomach permeation at 7°C and 27°C are 8.4 and 4.2 Jmol^{-1}, respectively. It will take __1-3__ s to reach a plateau blood concentration after drinking 50 ml of 27°C whisky containing 46% ethanol. {ln2=0.7; ln3=1.1; ln4=1.4; ln5=1.6; ln6=1.8}

Alcohol metabolism in human body
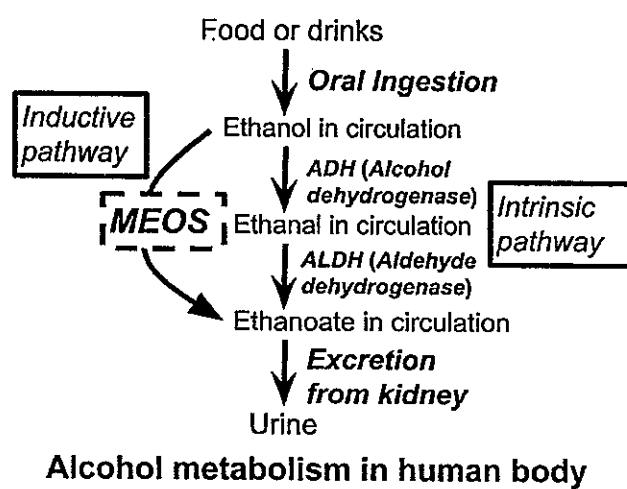
【2】 **Cont. from** 【1】 Ethanol $[S_I]$ in your circulation is then first [hydrolyzed; oxidized; reduced] to ethanal by alcohol dehydrogenase (ADH): $-\frac{d[S_I]}{dt} = k_{ADH}[E]_t \alpha$, where k_{ADH} is the turnover rate constant of ADH, its dimension in the SI unit should be [S^{-1}; S^{-2}; M; MS^{-1}; MS^{-2}]. $[E]_t$ is the total enzyme concentration in blood which is the summation of free enzyme concentration ($[E]$) and the concentration of enzyme-substrate complex ($[ES_I]$). $\alpha = \frac{[ES_I]}{[E]_t} = \frac{[ES_I]}{[ES_I]+[E]} = \frac{1}{1+[E]/[ES_I]} = \frac{1}{1+K_{MI}/[S_I]}$ is the fraction of the "working" enzyme bound with the substrate S$_1$, ethanol. K_{MI} is the Michaelis-Menten constant of ADH to S_I, its dimension in the SI unit should be [S^{-1}; S^{-2}; M; MS^{-1}; MS^{-2}]. The higher the

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Michaelis-Menten constant, the [lower; higher] the enzyme-substrate affinity and the [lower; higher] the substrate specificity.

【3】 Cont. from 【2】 The reaction rate is saturated when K_{MI} is much [higher; lower] than the substrate concentration, and the reaction becomes a/an [zero; first; second] order reaction. In this occasion, the reaction rate practically holds constant for a while and follows a pseudo-[zero; first; second] order kinetics since the [enzyme; substrate] concentration in your body is a constant. K_{MI} of ADH is 5mM, the rate of the enzymatic reaction will reach __3-1__ % of its maximum speed (10 μMS^{-1}) after drinking 100ml of whisky. If ADH concentration in blood is 0.5μM, k_{ADH} will be __3-2__ S^{-1}. In this case, the speed of absorption through the stomach is __3-3__ -fold higher than the metabolism of ADH.

【4】 Cont. from 【3】 The blood alcohol content test for driving has a lower limit of 0.046%(w/v). By keeping a maximum speed of ethanol conversion by serum ADH, a driver should wait for at least __4-1__ min after drinking 100ml of whisky. But practically only 10% of the maximum conversion speed can be achieved on average, so people should at least wait for __4-2__ hours to drive safely.

【5】 Cont. from 【1】 Rather than ethanol, ethanal is the major cause of ethanol intoxication syndrome (ie. hangover), and it will be [hydrolyzed; oxidized; reduced] by aldehyde dehydrogenase (ALDH) to ethanoate with [lower; higher] hydrophobicity and [lower; higher] toxicity to be excreted in your urine. Q5: Women tend to have lower ADH activity and some Asian people have ADLH deficiency, describe the effects on their alcohol tolerance in the blank below.

【6】 Answer to Q5:

【7】 Cont. from 【1】 MEOS (microsomal ethanol oxidizing system) is the inductive pathway for ethanol metabolism, which has both the function of ADH and ADLH but with less specificity. Alcohol tolerance can be trained by inducing the MEOS level of liver, but the "trained" drinkers are more susceptible to methanol poisoning. Q7: Give possible explanations for the methanol poisoning of "trained" drinkers in the blank below.

【8】 Answer to Q7:

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