M. TECH. ENVIRONMENTAL BIOTECHNOLOGY. 1st YEAR 2nd SEMESTER EXAM 2024.

Environmental Health and Toxicology

Time: 3 hours   Total Marks: 100

Answer any 10 questions

1. **Match the following 10**

1.	Chloracne	A. Arsine Gas
2.	Aplastic anaemia	B. $PM_{2.5}$
3.	High Cadmium absorption	C. High doses of dioxin
4.	Haemolytic agent	D. UV radiation
5.	Reaches alveoli of lungs	E. Asbestos body
6.	Glass blower's cataract	F. Benzene exposure
7.	Erythema	G. DDT
8.	Decayed, missing or filled teeth (DMFT)	H. Fluoride deficiency
9.	Pleural mesothelioma	I. Infrared radiation effect
10.	Accumulates in adipose tissue	J. Cigarette smoking

2. **Fill in the blanks (don't use acronym, write full form where applicable) 10**

   a. _____disease is a neurological syndrome caused by severe mercury poisoning.
   b. _____ disease is characterised by osteomalaecia and osteoporosis with severe bone pain and caused by cadmium poisoning.
   c. Of all of the dioxins and furans, _____ is considered the most toxic.
   d. The two different types of commercial asbestos with approximately 93% and 7% of commercial use are _____ and _____.
   e. The commonly quoted "lethal dose" of benzene is _____.
   f. The primary source of environmental lead pollution in 1970's was

   _____.
   g. Arsenic binds to _____ groups present in keratinised tissue.
   h. _____ is a bone and joint condition associated with prolong exposure to high concentrations of fluoride.
   i. _____is a measure of the rate of RF (radiofrequency) energy absorption by the body from a cell phone.

3. **Using the dose-response curve below, answer the following questions: 10**

   a. What is the NOEL range of substance A and B?
   b. What is the ED_{50} of A and B and TD_{50} of substance A?
   c. The therapeutic index of substance B is 9. Comparing substance A to substance B, which one would be considered safer? Explain your answer.
   d. At what dose is the maximum toxic effect of substance A observed?

Question 3 Dose-Response Curve
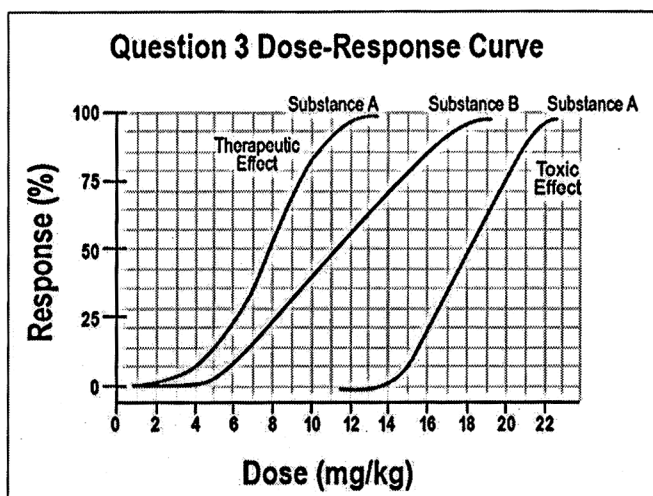
4. A 2 year old child consumes 50% of a 200 gram toothpaste tube containing 2000 ppm NaF (sodium fluoride). The child weights 5 kg. Will the child die of fluoride toxicity? Safety tolerated dose of fluoride is 8-16 mg fluoride /kg. Safety tolerated dose is 1/4th of the certain lethal dose. **6**

The following table summarizes ED_{50} and LD_{50} of two new drugs. Calculate the therapeutic index of each drug and discuss which drug is safer. **4**

	Drug A	Drug B
ED_{50}	5 mg/kg	12 mg/kg
LD_{50}	50 mg/kg	60 mg/kg

5. Name the 10 top chemicals that are of major public health concern according to WHO listing. **5**
   What are the organic and inorganic species of mercury? What are the residence time of the inorganic mercury species in the atmosphere? Which species is a neurotoxin? **2+2+1**

6. Calculate the non-carcinogenic health risk ($\sum$HQ) of fire fighters from the elements given in the table below in **PM$_1$**. Healthy adults were considered for risk assessment. **Inhalation rate (IR)** is typically assumed to be **20 m^3 day^{-1}** and **body weight (BW)** to be **70 kg for adults**. Assuming only inhalation as exposure route, the reference dose (RfD, mg kg^{-1}, day^{-1}) for metals that are non-carcinogenic should be calculated from reference concentrations (RfC, mg/m^3) provided by the USEPA. Risk characterization or estimation of health risk will be calculated based on the exposure and dose–response assessments. For non-carcinogenic metals, it is indicated by hazard quotient (HQ) = CDI /RfD. Depositional fraction of particle given by size is calculated by **10**
$$E_i = -0.081 + 0.23 \cdot \ln(d_p)^2 + 0.23 \cdot \sqrt{d_p}$$

ELEMENTS	RfC in mg/m^3	Concentrations ng/m^3
Cr	1×10^{-4}	562
Cd	1×10^{-5}	74
Ni	1.4×10^{-5}	609

7. Mention four functions of the skin and approximate chemical composition of the skin? What are the routes of skin absorption? Mention any four skin variations that can affect absorption. **4+2+4**

8. Calculate the carcinogenic (for arsenic) and non-carcinogenic (for arsenic and fluoride combined) risk of the exposed population from arsenic and fluoride exposure through water assuming average age to be 35 years and body weight 70 kg. Assume average life expectancy to be 70 years and exposure frequency is 365 days a year. Cancer slope factor for direct ingestion of arsenic is 1.5 (per mg/kg/day) and RfD is 0.0003 mg/kg/day. RfD value for fluoride is 0.06 mg/kg/day. **10**

Arsenic concentration in water	100 ppb
Fluoride concentration in water	3 ppm
Daily water consumption	2 litres

9. Dhapa vegetables are contaminated with heavy metals and the following concentrations were reported for the non-essential metals arsenic, cadmium and lead. Calculate the Potential ecological risk index (RI) of these metals when the vegetables are consumed by humans, assuming the toxicity response coefficient of As, Cd and Pb as follows $T_{Pb} = 5$, $T_{As} = 10$, $T_{Cd} = 30$. Which metal poses the largest ecological risk? **10**

	Pb (ppm)	As (ppm)	Cd (ppm)
Spinach + Radish	15	8	3
WHO reference value for food	0.3	0.068	0.2

E_r^i	Risk classification	PERI
$E_r^i \leq 40$	Low risk	PERI ≤ 150
$40 \leq E_r^i < 80$	Moderate risk	$150 <$ PERI ≤ 300
$80 \leq E_r^i < 160$	Considerable risk	$300 <$ PERI ≤ 600
$160 \leq E_r^i < 320$	High risk	PERI > 600
$E_r^i \geq 320$	Severe high risk	

10. **Fill in the blanks**   **10**
    a. The scientist referred to as 'Father of Toxicology' is _____ .
    b. The author of the book 'Silent Spring' (in which the detrimental effect of DDT and other pesticides on environment –particularly on .birds was document) is

    _____.

    c. The key organ responsible for biotransformation is the _____.

d. The dose of a substance that causes death in 50% of a test population is referred to as the _____.

e. _____ is a sub discipline of toxicology that is concerned with the study of chemicals that contaminate food, water, soil, or the atmosphere.

f. _____ is a sub discipline of toxicology that is involved in delivering a safe and edible supply of food to the consumer.

g. _____ is a sub discipline of toxicology that is concerned with health effects from exposure to chemicals in the workplace.

h. The process by which harmful chemicals are degraded by microorganisms in the environment is called_____.

i. Substances with a Low Log P below 0 are typically administered in an _____ form.

j. Substances with a High Log P (3-4) are often delivered via a _____ route.

11. It has been reported that 300 mg/kg of mercury(II) chloride ($HgCl_2$) is the lethal oral dose. Calculate the amount of Hg in mg/L in human blood at the time of death. Assume an average weight of 70 kg, a blood volume of 5.5 liters, and 100% absorption of Hg from mercury(II) chloride in the blood. Atomic weights: Hg – 200.59; Cl – 35.45. Additionally, a 70-kg worker is exposed to 500 mg Hg/m³ of air through mercury(II) chloride inhalation. How long will it take him to reach the lethal dose if he breathes at a rate of 40 litters per minute and absorption is 100%? **10**

12. What is the difference between acute and chronic toxicity? What is an antidote? What is the therapeutic index (TI)? What is non-ionizing radiation? Can non-ionizing radiation cause cancer? **3+1+2+2+2**