MODEL ANSWER

M.Sc Botany 4th Semester (specialization: pollution ecology)

Air Pollution and Climate Change

Answer 1 MCQs/fill in the blanks/one sentence answer

i. **(d)** Photosystem II

ii. **(b)** Increased agricultural productivity worldwide

iii. **(d)** Teeths

iv. **(a)** Free radical

v. Ocean

vi. Robert Angus Smith

vii. Lichens

viii. The term bioindicator is used for organisms or organism associations which respond to pollutant load with changes in vital functions, or which accumulate pollutants. Bioindicators are commonly grouped into accumulation indicators and response indicators. Accumulation indicators store pollutants without any evident changes in their metabolisms. Response indicators react with cell changes or visible symptoms of damage when taking up even small amounts of harmful substances.

ix. Bronzing is upper leaf discoloration with reddish-brown specks and results from high atmospheric levels of ozone and over time, some leaves become yellow and fall from the plants.

x. Grey air is industrial smog consisting mostly of sulphur dioxide, suspended droplets of sulphuric acid, and a variety of suspended solid particles and droplets (called aerosols).

Q 2. Long answer type question

i. Give an account about bioindicator parameters?

Answer:

The term bioindicator is used for organisms or organism associations which respond to pollutant load with changes in vital functions, or which accumulate pollutants. Information about specific biological effects supplements data on air pollutions generated by technical analysis methods. The most important reasons for using bioindicators are:

a. the direct determination of biological effects
b. the determination of synergetic and antagonistic effects of multiple pollutants on an organism,
c. the early recognition of pollutant damage to plants as well as toxic dangers to humans and
d. relatively low cost compared to technical measuring methods.

The great potential of bioindicators for environmental monitoring is often confronted with difficult questions of methodology resulting from the use of "living measuring instruments". The effects of environmental load cannot always be clearly differentiated from natural stress factors. Lack of practical experience with certain bioindicators sometimes makes clear interpretation of findings more difficult, especially if no comparable pollutant measurements are available.

Intensive research over the last decades has resulted in the availability of numerous bioindicators which satisfy the requirements of convenience, standardization, cost, and evaluative capability.

Bioindicators are commonly grouped into

a. accumulation indicators and
b. response indicators.

Accumulation indicators store pollutants without any evident changes in their metabolisms. Response indicators react with cell changes or visible symptoms of damage when taking up even small amounts of harmful substances.

Biomonitoring is divided into two groups

a. Passive biomonitoring and
b. Active biomonitoring.

Passive biomonitoring is the use of organisms, organism associations, and parts of organisms which are a natural component of the ecosystem and appear there spontaneously.

Active biomonitoring includes all methods which insert organisms under controlled conditions into the site to be monitored.

Following are the important bioindicator parameters:

a. Lichens are used for biomonitoring the presence of sulphur pollutants in ambient air. If the lichens populations are eliminated from an area it means the area is heavily polluted by sulphur di-oxide
b. Presence of chlorosis in leaves after rain indicated that the precipitation was acid rain.
c. Brozing of leaves indicated that there is ozone pollution in the ambient air.
d. Rye grass has the capacity to accumulate the fluoride, lead, copper, zinc and sulphur from the ambient air.
e. Black spots on the bottom of mango fruits is indicator of fluoride pollution in the surroundings.

Besides these several other parameters may be adopted for biomonitoring the air pollutants and they are:

a. Total chlorophyll content of the plant leaves
b. Leaf extract pH
c. Relative water content of the leaves
d. Ascorbic acid content of the leaves

ii. What are important causes and effects of increased CO_2 on plants?

Answer:

Following are the important causes of increasing CO_2 concentration in the atmosphere:

a. Natural sources of atmospheric carbon dioxide include volcanic eruptions
b. Combustion of organic matter
c. Wildfires and the respiration processes of living aerobic organisms
d. Man-made sources of carbon dioxide include the burning of fossil fuels for heating
e. Power generation and transport
f. Industrial processes such as cement making
g. It is also produced by various microorganisms from fermentation and cellular respiration
h. Decomposition of organic materials by microbes.

The increased concentration of CO_2 in the atmosphere results in increased global average temperature which has serious repercussions for the plant communities. Following are the important effects of increased concentration of CO_2 on plants:

a. Increased average global temperature will lead to submergence of islands which will ultimately destroy the plant diversity.
b. C_3 plants will be more benefitted to as compared to C_4 plants.
c. Decomposition rate of litter will be adversely affected due to increased concentration of carbon in the biomass.
d. Increased concentration of CO_2 will lead to erratic pattern of rainfall over the globe and will adversely affect the plant diversity.
e. Pole-ward shift of vegetation will be preferred by the changing climatic conditions and plant species failing to migrate will be eliminated.
f. Increased CO_2 level in the atmosphere will reduce the photo respiratory loss of plants
g. Productivity of rabi crops will be reduced and that of kharif crops will increase because of increasing CO_2 concentration.
h. El-Nino and La-Nina associated with the global warming phenomenon because of increase CO_2 concentration is causing severe drought and flood at different locations of the globe.
i. Heavy rainfall causes excessive leaching of mineral nutrients from the soil in tropical rainforest and leads to mineral deficiency diseases of the plants.
j. Diseased plants are more susceptible to attacks by the different types of pathogens.

iii. Discuss the effects of enhanced UV-B on microbes and human.

Answer

The enhanced concentration of UV-B on earth is due to depletion of ozone layer in the stratosphere. Following are the important adverse effects of enhanced UV-B on microbes:

a. The phytoplanktons population will be reduced because of reduced uptake of CO_2 because the UV-B have the capacity to alter the proteins and enzymes structures involved in the process of photosynthesis.
b. The reproductive capacity of the phytoplanktons will be impaired due to reduced mobility of the planktons.
c. The nitrogen fixing bacteria populations in the soil will be reduced because the enhanced concentration of UV-B destroys the DNA of the bacteria by the formation of thymine dimmers which prevents the decoding of genetic codons.
d. The nitrogen fixing capacity of the bacteria is adversely affected due to enhanced concentration of UV-B because it has the capacity to alter the structure of *nif* genes
e. The rate of litter decomposition by the various microbes will be adversely affected since the enzymes involved for litter decomposition will not be able to be synthesized.
f. Phyllosphere and phylloplane microbial populations playing important role in plant-microbes interaction will be reduced.
g. Rhizospheric and rhizoplane microbial populations playing important role in mineral nutrition of the plants will be reduced.
h. Due to adverse effects of UV-B on the microbial population the complete biogeochemical cycle in the near future will be disturbed.

Following are the important adverse effects of enhanced UV-B on microbes

a. Suppressed immune system which will lead to enhanced susceptibility to infection and increased rate of cancer
b. Severe sunburns in peoples of colder climate
c. Loss of skin elasticity leading to premature aging of skin
d. Photosensitivity of white skinned people will increase: an outbreak of rash in fair skinned people due to photo allergy
e. Increased rate of cataract due to breakage of corneal lens
f. The prevalence of cataract after age 30 is doubling each decade

g. Skin cancer (melanomas) will be more common in the people having less melanin content in their body (skin).
h. Higher risks of malignant melanoma from severe sunburns – especially in childhood
i. Blue eyed people are more sensitive to the UV-B as compared to the black eyed people.

iv. Explain the effects of acid rain on soil fertility and plants.

Answer:

Acid rain" is a broad term referring to a mixture of wet and dry deposition (deposited material) from the atmosphere containing higher than normal amounts of nitric and sulfuric acids. The precursors, or chemical forerunners, of acid rain formation result from both natural sources, such as volcanoes and decaying vegetation, and man-made sources, primarily emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx) resulting from fossil fuel combustion. The result is a mild solution of sulfuric acid and nitric acid. When sulfur dioxide and nitrogen oxides are released from power plants and other sources, prevailing winds blow these compounds across state and national borders, sometimes over hundreds of miles.

Following are the important adverse effects of acid rain on the soil fertility.

a. The acid rain changes the pH of the soil leading to change in CEC (cation exchange capacity) of the soil.
b. The acid rain causes excessive leaching of labile minerals from the soil reducing its fertility.
c. The nitrogen fixers such as *Rhizobium* and other cyanobacteria are very sensitive to change in pH of the soil and water and henceforth the fertility of soil in terms of nitrogen will be reduced.
d. Acid rain prevents the decomposition of litter by destroying the microbial population and therefore reduces the fertility of soil by locking the minerals in the biomass.
e. Acid rain leads to aluminium toxicity in rice fields because of its increased concentration.
f. Acid rain causes increase in the area of acidic soils which are unfertile and toxic.

The acid rain has severe repercussions to the plant community which are given below:

a. The acid rain causes bleaching of chlorophyll pigment from the plant leaves because the acid causes removal of magnesium metal from the chlorophyll and leads to the formation of pheophytin. The pheophytin is colourless and hence the colour of chlorophyll fades.
b. The reduced content of the chlorophyll will lead to reduced rate of photosynthesis.
c. The reduced photosynthesis will lead to reduced photosynthate and ultimately the plants will be weak since plants will not get sufficient nutrition.
d. The weaker plants are more sensitive to be attacked by the pathogens and may be killed and their population will be reduced and ultimately eliminated.
e. These may lead to depletion of new forests in the long time.
f. The lichens population are sensitive to acid rain and their population will be eliminated.
g. The loss of lichens from an area may prevent succession on rocks and therefore may disturb the ecosystem.
h. The acid rain destroys the symbiotic association of *Rhizobium* and legumes which may have serious consequences on the soil nitrogen content.
i. The acid rain causes leaching of minerals from the soil and making them unavailable for the plants.
j. The litter decomposition will be checked by acid rain which will lead to locking up of minerals in the biomass. The increased content of nitrogen in the soil is detrimental to the plant diversity.

v. What are particulate pollutants and explain their adverse effects on environment?

Answer:

Particulate matter," also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

The size of particles is directly linked to their potential for causing health problems. Environmental protection agency (EPA) is concerned about particles that are 10 micrometers in diameter or smaller because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. EPA groups particle pollution into two categories:

"Inhalable coarse particles," such as those found near roadways and dusty industries, are larger than 2.5 micrometers and smaller than 10 micrometers in diameter.

"Fine particles," such as those found in smoke and haze, are 2.5 micrometers in diameter and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

Following are the adverse effects of particulate pollutants on ecosystem:

a. Dust accumulating on leaf surfaces may interfere with gas diffusion between the leaf and air.
b. Sedimentation of coarse particles affects the upper surfaces of leaves more while finer particles affects lower surfaces
c. Particulate deposition reduces growth, yield, flowering, and reproduction of plants.
d. Chronic pollutant injury to a forest community may result in the loss of susceptible species, loss of tree canopy
e. Reduction in growth of the dominant trees owing to crust formation on leaves which reduces photosynthesis and bringing premature leaf fall and destruction of leaf tissues
f. Limestone dust coating of lichen thallus damages its photosynthetic apparatus which leads to change in community structure and functions.

g. Deposition of particulate matter affects the microbial community living in the phyllosphere

h. Since fungi are important decomposers, changing the fungal community on the needles finally weakens the decomposer community which decreases the rate of litter decomposition. All these processes alter nutrient cycling.

i. Epiphytic lichens and mosses, because of their nutritional dependence upon and continued contact to particulate deposition, are at risk

j. Particle pollution especially fine particles that contains microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including:

- premature death in people with heart or lung disease,
- nonfatal heart attacks,
- irregular heartbeat,
- aggravated asthma,
- decreased lung function, and
- increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing

vi. Describe the adverse effects of global warming on the environment.

Answer

The increase in average temperature of earth's atmosphere due to presence of green house gases is known as global warming. Following are the important effects of global warming on the environment.

a. Ice is melting worldwide, especially at the Earth's poles. This includes mountain glaciers, ice sheets covering West Antarctica and Greenland, and Arctic sea ice.

b. Researcher Bill Fraser has tracked the decline of the Adélie penguins on Antarctica, where their numbers have fallen from 32,000 breeding pairs to 11,000 in 30 years.

c. Sea level rise became faster over the last century.

d. Due to increase sea level, islands will be submerged leading to huge loss of biodiversity.

e. Because of global warming pathogen attacks on flora and fauna will increase and chances of their extinction will be more.

f. Ecological niches of different species will change leading to severe competition.

g. Mangrove population will be eliminated because of increase sea level.

h. Coastal cities around the world will be inundated due to increases sea level.

i. Some butterflies, foxes, and alpine plants have moved farther north or to higher, cooler areas because of changing temperature belts.

j. Precipitation (rain and snowfall) has increased across the globe, on average owing to changing climatic conditions.

k. Spruce bark beetles have boomed in Alaska thanks to 20 years of warm summers. The insects have chewed up 4 million acres of spruce trees.

l. Sea levels are expected to rise between 7 and 23 inches (18 and 59 centimeters) by the end of the century, and continued melting at the poles could add between 4 and 8 inches (10 to 20 centimeters).

m. Hurricanes and other storms are likely to become stronger in higher latitudes.

n. Species that depend on one another may become extinct. For example, plants could bloom earlier than their pollinating insects become active.

o. Floods and droughts will become more common. Rainfall in Ethiopia, where droughts are already common, could decline by 10 percent over the next 50 years.

p. Less fresh water will be available. If the Quelccaya ice cap in Peru continues to melt at its current rate, it will be gone by 2100, leaving thousands of people who rely on it for drinking water and electricity without a source of either.

q. Prevalence of diseases will increase such as malaria carried by mosquitoes.

r. Wildlife research scientist Martyn Obbard has found that since the mid-1980s, with less ice on which to live and fish for food, polar bears have gotten considerably skinnier. Polar bear biologist Ian Stirling has found a similar pattern in Hudson Bay. He fears that if sea ice disappears, the polar bears will as well.