

## Content-6: Effects of Exposure to Chemicals

### Orientation

What can this unit help you with?

You may use this unit if you

- Have to know the meaning of hazard, exposure and effect;
- Have to understand the effects of exposure to chemicals.

Intended results of the unit

- Students are capable of finding a relationship among hazard, exposure and effect;
- Students have an understanding of the different exposure pathways;
- Students can understand the effects/hazard-end-points;
- Students can understand human exposure to chemical hazards;
- Students are aware of the prevention of the combined effects of chemicals.

# Input

Knowingly or unknowingly, we come into contact with chemicals every day. This is called chemical exposure. Not all chemical exposures are safe. A certain amount of a harmful chemical can make us sick by entering our body through ingestion, inhalation, skin absorption, etc. Likewise, plants and animals can also get harmed by chemical exposure resulting in great damage to our overall well-being. This unit will discuss hazard-exposure-effect relationships, exposure pathways, effects/hazards endpoints, human exposure to chemical hazards, influencing factors on effects caused by chemical exposure, and the combined effects of hazardous chemicals.

## Hazard-Exposure-Effect Relationships

Hazard is the intrinsic property of a substance, event or situation to pose a potential threat, which could harm health, life, property or environment. Anything that hasn't caused any harm but could is a hazard.

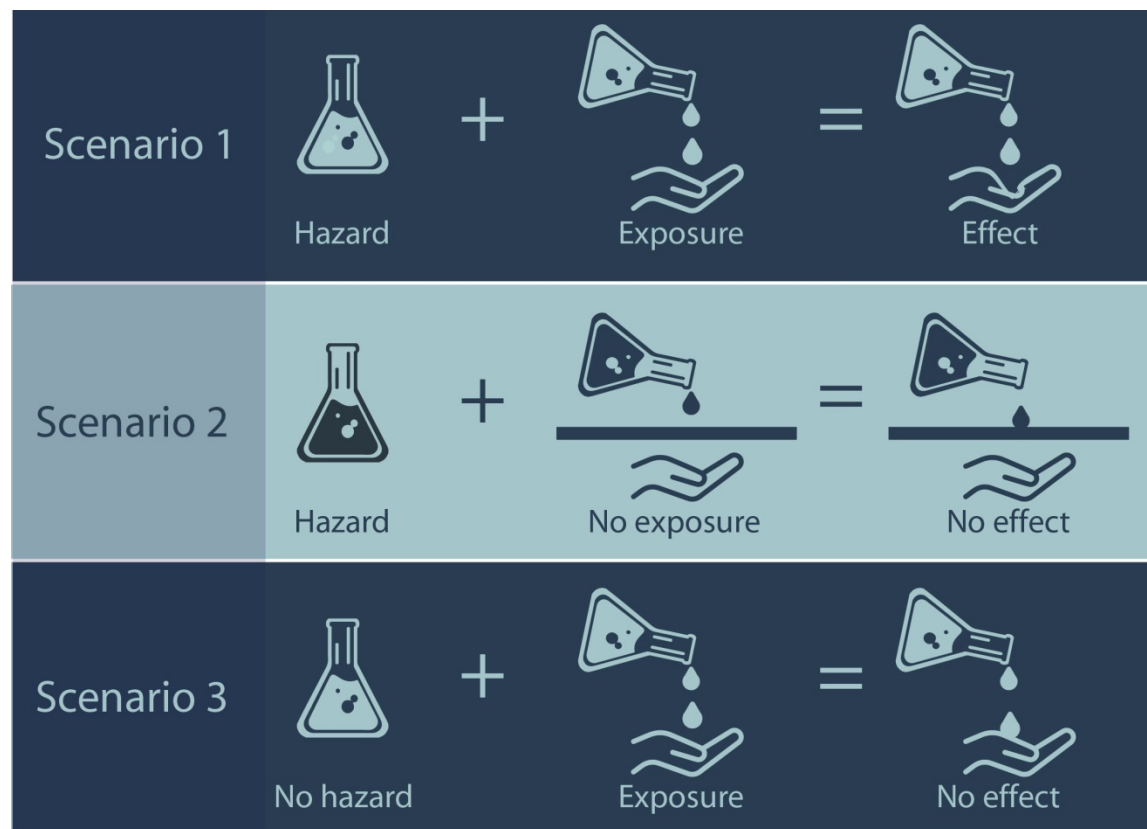


Figure 1: Hazard-Exposure-Effect Relationship. Picture courtesy: Kazi Farhan Hossain Purba.

Exposure refers to the process coming in contact with any hazard. A hazard can't cause any harm until it is exposed to any human personnel or environment.

The effect is the result or phenomenon which may occur after exposure to the hazard in any way. The effect will take place when the hazard is exposed. If any non-hazardous substance comes to exposure, there will be no effect. In another way, if any hazard doesn't come to exposure, then no effect will take place.

## Emission of Chemicals to the Environment

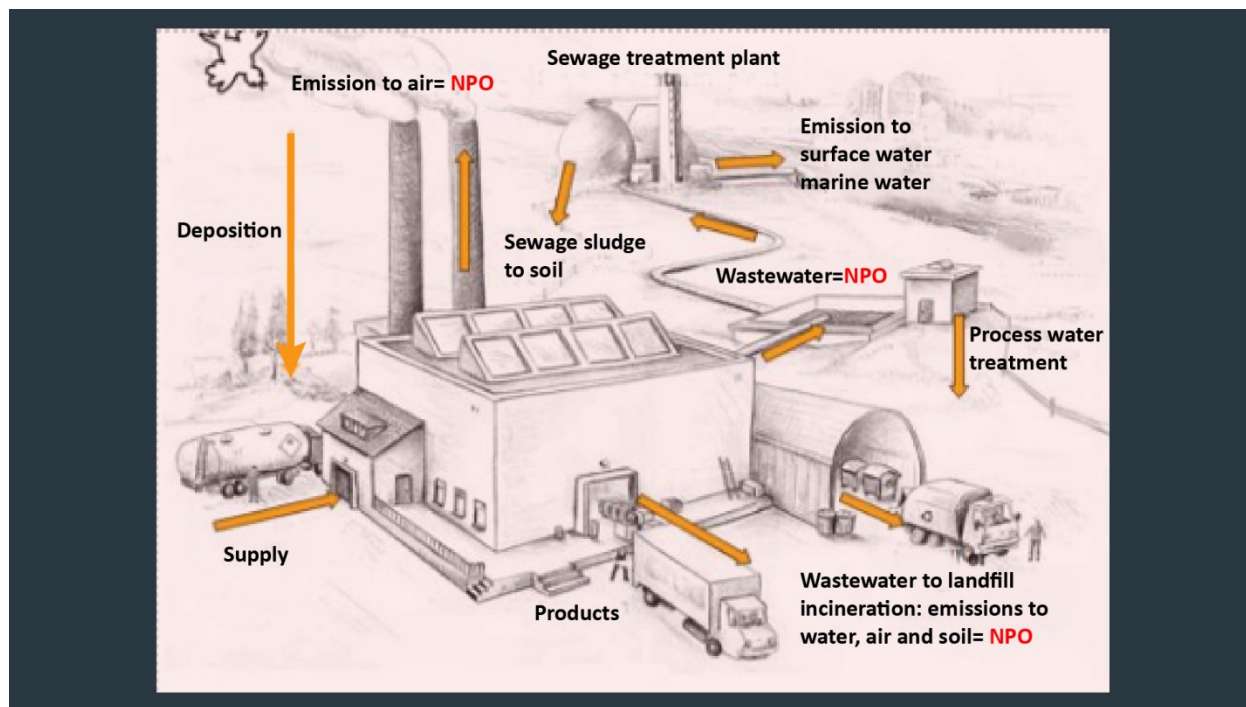


Figure 2: Emission of chemicals to the environment. Picture source: Resource Efficient Management of Chemicals (REMC) Presentation by GIZ.

In Figure 2, we can see various forms of emissions of chemicals to the environment. Here, raw materials for production are being supplied, and the factory is producing goods. But there are some by-products produced during production and are being released to the environment after treatment. Wastewater generated goes into a wastewater/sewage treatment plant and gets released to marine water after treatment.

Sludge produced from wastewater treatment is released to the soil and can negatively impact soil or adverse effect on human health. Similarly, emission to air can have a negative effect on the air quality of that area. Dust, mists, acid vapours, volatile compounds can cause severe air pollution. People can suffer from respiratory diseases after being exposed to polluted air for an extended time.

The factory sends its waste to landfill or incineration. A landfill is a place where the wastes are stored, and incineration means burning the waste. Both emit greenhouse gases are bad for the environment.

## Exposure Pathways

The different ways a person can come into contact with hazardous chemicals are called exposure pathways. There are many ways hazards can come to exposure. The people working in the factories have more chances of getting exposed to hazards. The workers, supervisors, managers, contractors or any other employees are the most prone to risk.



Figure 3: Exposure pathways. Picture courtesy: Kazi Farhan Hossain Purba.

Society exposure mainly indicates the neighbourhoods, downstream populations living in that area. If hazardous chemicals make their way to these, they may cause acute or long-term public health effects.

Another way of exposure is the interim handling personnel like transporters, customs officials, point of sale staff etc. Many of them might have no idea about the hazards of chemicals. Therefore, they would not use protective equipment or handle them carefully. So, the risk remains there.

Consumers can also get exposed to hazards if the potential threats of chemicals are not minimized or neutralized. It can cause skin problems, allergies etc. The threat is even more significant for medical textile consumers. If any hazardous chemical remains in textiles for medical use, it can cause infection, toxicity or carcinogenicity.

The chemicals can also get exposed via the environment and make their way to human health, aqua life, agriculture, microorganisms. The effects can be severe.

## Effects/Hazard End-Points

Exposure to chemical hazards affects and endangers both human health and the environment. Hazardous chemicals have many adverse effects on human health. Some chemicals can cause carcinogenicity which is the ability to produce cancer. Mutagenicity is the change in DNA which causes mutation above natural level. Reproductive toxicity can be caused by chemicals which adversely affects sexual function and fertility. Developmental toxicity affects normal growth or behaviour. Neurotoxicity refers to the brain or nervous system damage due to toxic substances. Endocrine disruption is the interfere with hormones which can cause tumours, birth defects or other disruptions. The inhalation of chemicals can cause respiratory problems like asthma. Moreover, skin or eye irritation is a common problem caused by chemical exposure.

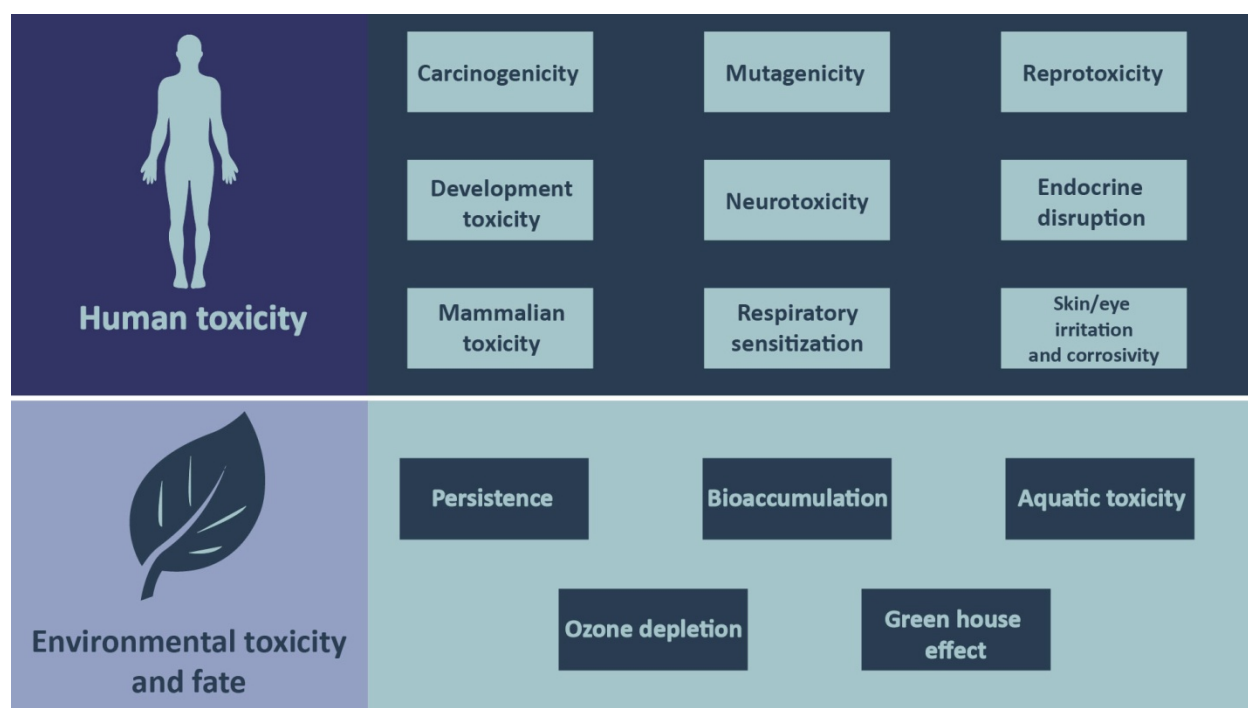


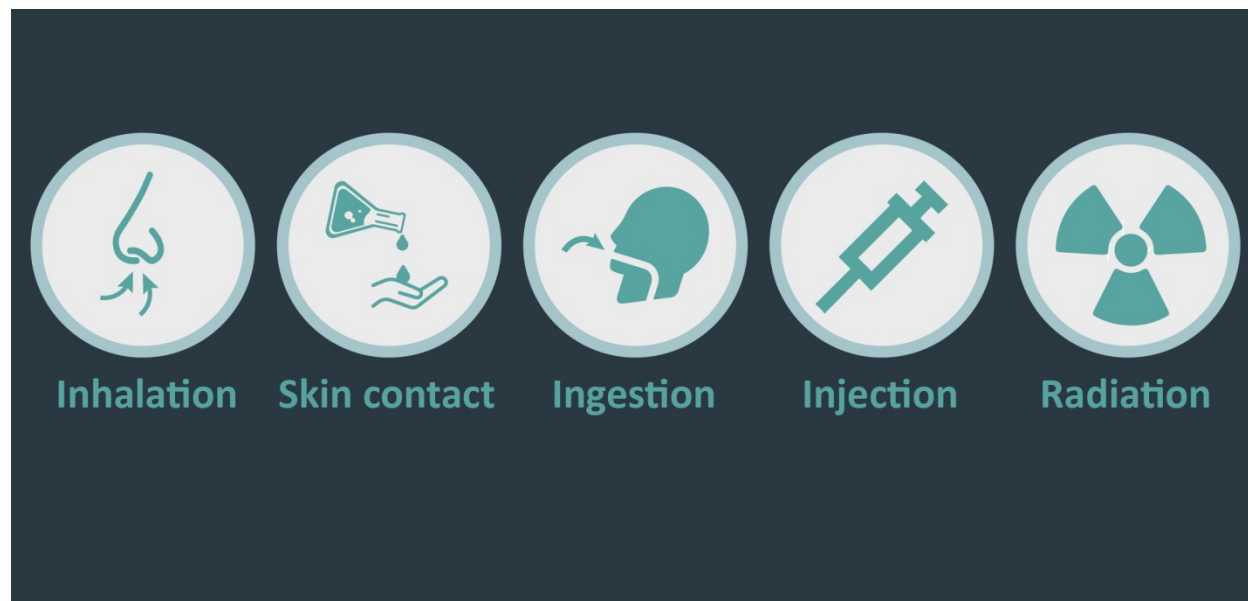
Figure 4: Effects/hazard endpoints. Picture courtesy: Kazi Farhan Hossain Purba.

The environmental impacts of chemicals are also an issue of high concern. Persistence is the half-life of chemicals released into the environment. Persistent chemicals remain in the environment for an extended period and pollute it. Bioaccumulation is the build-up of chemicals in living organisms. It occurs when toxins build up in a food chain. The animals at the top of the food chain are most affected by it. Aquatic toxicity is the effect of chemicals on aqua life. This affects the fish, microorganisms and plants underwater on which we greatly depend on. Ozone depletion is the gradual destruction of the ozone layer existing in the upper atmosphere. This layer protects us from harmful UV rays. The release of chlorine or bromine-containing chemical compounds by human activity is responsible for ozone depletion. Global warming is the gradual heating of Earth's surface, ocean and atmosphere. Greenhouse gases released from human ac-

tivities is the reason for it. It is causing extreme weathers, ocean level rise, increased fire threats and many more problems.

## Human Exposure to Chemical Hazards

There are many ways of exposure to chemicals. They can cause acute or long-term effects which result in injury or diseases.



*Figure 5: Human Exposure to Chemical Hazards. Picture courtesy: Kazi Farhan Hossain Purba.*

Inhalation is one of the ways of exposure to chemicals. Airborne chemicals and airborne particles can easily get into our body by inhalation. The smaller the particles, the easier they are inhaled. Inhalation of toxic vapours, mists or gases can produce poisoning by absorption through mouth, throat and lungs. It can cause serious damage to these tissues. The degree of injury depends on the toxicity of the material, solubility in tissue and duration of exposure.

Skin contact is the most common case of human exposure. Chemicals can also get absorbed through the skin or come in contact with eyes. Skin contact can cause localized irritation, skin burn, dry or rough skin, corrosion etc. Contact of chemicals with eyes is an issue of high concern because it is a sensitive organ. It can lead to eye irritation, burn or loss of vision.

Ingestion of chemicals can be extremely dangerous and sometimes can result in death. It can happen during smoking, drinking, eating in the workplace or accidentally swallowing. Even consumers can ingest chemicals by consuming contaminated water, food, cosmetics etc. It directly affects the tissues of the mouth, throat, lung and gastrointestinal tract.

Injections or radiation may not be a frequent exposure route, but it has adverse effects. The injection can seldom occur through mechanical injury by contaminated metal or glass. Exposure

to chemical radiation can cause acute health effects like skin burn and radiation sickness. It can also be a cause of cancer and cardiovascular diseases.

## Understanding Influencing Factors on Effects Caused by Chemical Exposure

There are some factors that influence the effects caused by hazardous chemical exposure. Around 500 years ago, Paracelsus, a Swiss physician and chemist stated that “The dose makes the poison”. It means everything is poison if too much is ingested or absorbed by the body. Even non-toxic substances over a concentration become a poison for us. Here dose is an influencing factor on the effects.

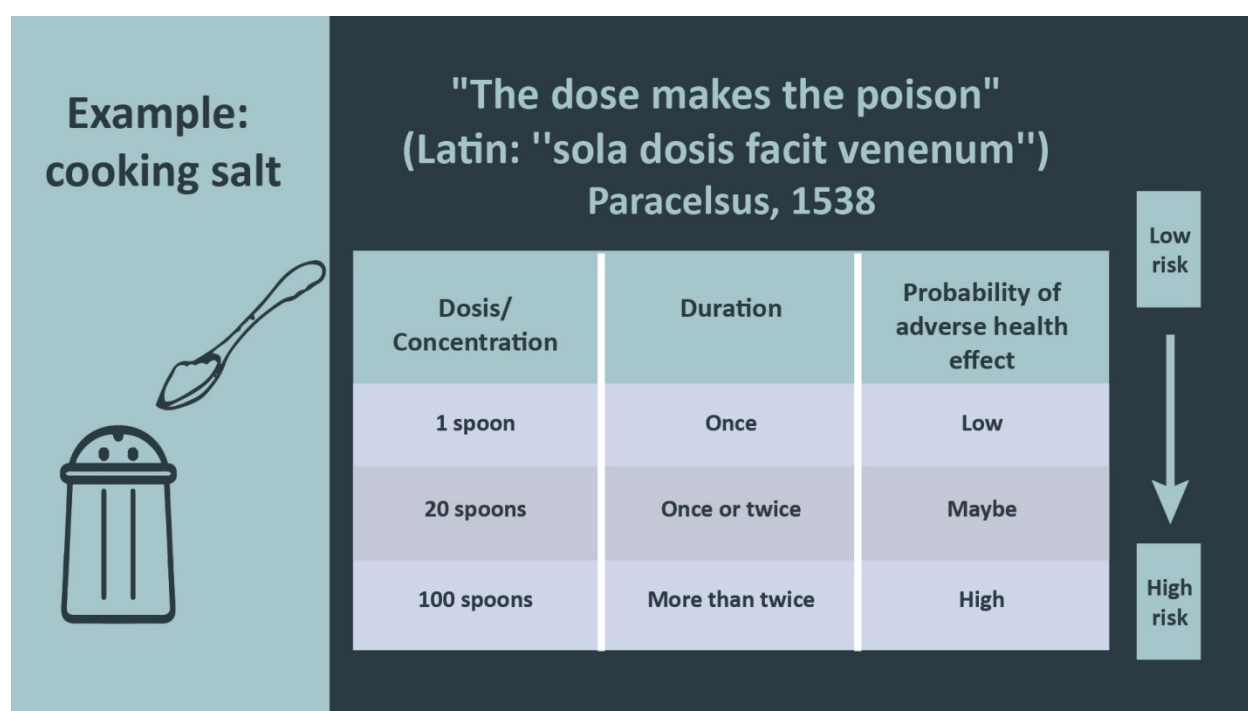


Figure 6: The dose makes the poison. Picture courtesy: Kazi Farhan Hossain Purba.

We can take cooking salt as an example. We take it every day with other foods or drinks. If the dose is one spoon a day, then there is a very low possibility of a negative effect on health. But when we increase the dose to 20 spoons once or twice a day, there is a possibility of adverse health effect. One may get sick if one consumes that much salt. When any person consumes 100 spoons of salt, and even if the duration is only once or twice, the probability of adverse health effect is very high. That much dosage is potent to kill him; even though salt is not a toxic substance. But consuming a high concentration of salt made it poisonous for the body. So, everything we consume is safe up to a specific concentration. Even water can kill us if we drink too much of it too quickly.

We should keep in mind that short term exposure to a high-level concentration may result in acute or immediate effects. The acute effect is a physiological reaction in the body that develops rapidly due to short term exposure to toxic chemicals. Most of the times, effect subsides if the exposure stops.

Long term exposure to chemicals can result in chronic effect, which develops over a long period. Even if the concentration or toxicity is low, the results can be severe. For example: consuming alcohol will instantly result in loss of coordination and judgement. But consuming it for a long time will lead one to liver disease, cancer or even death.



## We Need to Be Aware of the Combined Effects of Hazardous Chemicals

At the workplace, sometimes workers get exposed to two or more chemicals. We know the hazards of individual chemicals, but the combined effect is unknown in most cases.

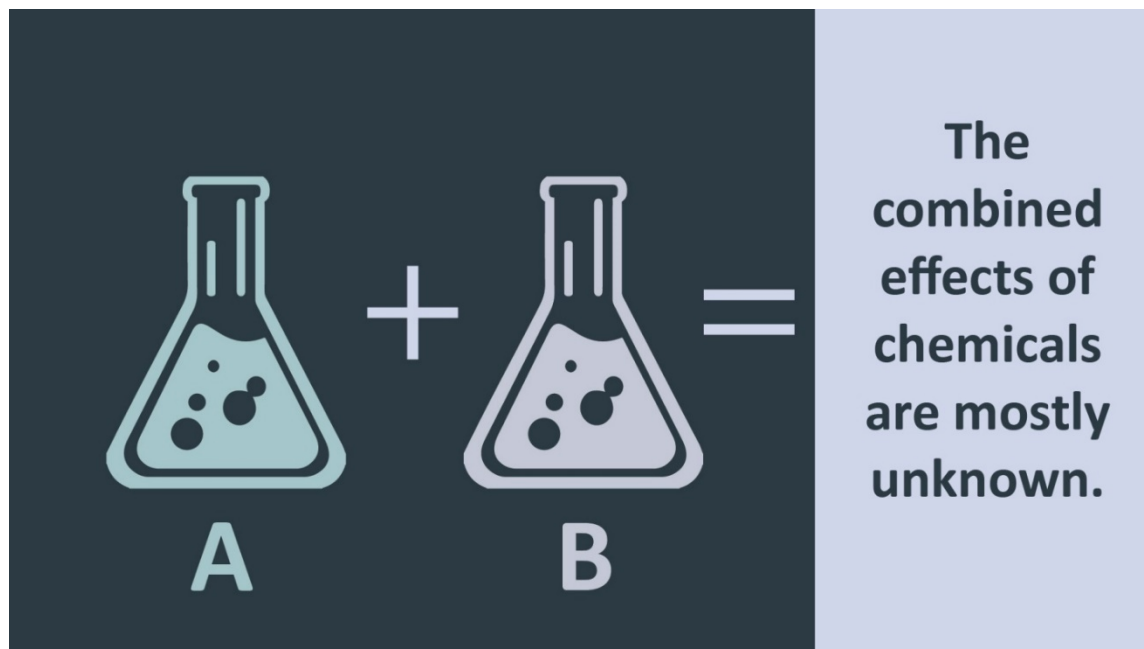


Figure 7: The combined effects of chemicals are mostly unknown. Picture courtesy: Kazi Farhan Hossain Purba.

Combined exposure to two or more chemicals at one time results in health effects that are greater than the sum of the effects of individual chemicals. To prevent that, workers must be more careful with sufficient chemical handling knowledge. They have to avoid mixing several chemicals. Otherwise, the results can be very dangerous.

## Conclusion

In this unit, we have discussed different ways of exposure to chemicals and their effects. Now we are capable of finding a relationship among hazard, effect and exposure. We also have a better understanding of the different exposure pathways, effects/hazard-end-points, influencing factors on effects and combined effects of chemicals. All of these will help us to be aware of the effects of exposure to chemicals and further understand our next units.

# Didactical Elements

## Quizzes And Self-tests:

### True-False

1	Hazard refers to the process coming in contact with any exposure.	
	<ul style="list-style-type: none"><li>▪ Correct</li><li>▪ False</li></ul>	False
2	A hazard can't cause any harm until it is exposed to any human personnel or environment.	
	<ul style="list-style-type: none"><li>▪ Correct</li><li>▪ False</li></ul>	Correct
3	Society exposure mainly indicates the neighbourhoods, downstream populations living in that area.	
	<ul style="list-style-type: none"><li>▪ Correct</li><li>▪ False</li></ul>	Correct
4	Consumers can also get exposed to hazards if the potential threats of chemicals are not minimized or neutralized.	
	<ul style="list-style-type: none"><li>▪ Correct</li><li>▪ False</li></ul>	Correct
5	With the advent of advanced technology, we have figured out all the probable combined effects of multiple chemicals.	
	<ul style="list-style-type: none"><li>▪ Correct</li><li>▪ False</li></ul>	False

## Open Questions:

1	How can hazardous materials be released/emitted to the environment by a factory?
	<p><i>Open text</i></p> <p>Various forms of emissions of chemicals to the environment can happen from a factory. Here, raw materials for production are supplied, and the factory produces goods. But there are some by-products which are produced during production and are released to the environment after treatment. Produced wastewater goes into a wastewater treatment plant and gets released to marine water after treatment. Sludge produced from wastewater treatment is released to the soil, which can have a negative impact on soil or adverse effect on human health.</p> <p>Similarly, emission to air can have a negative effect on the air quality of that area. Dust, mists, acid vapours, volatile compounds can cause severe air pollution. People can suffer from respiratory diseases after being exposed to polluted air for an extended period. Moreover, the factory sends its waste to landfill or incineration. A landfill is a place where the wastes are stored, and incineration means burning the waste. Both emit greenhouse gases are bad for the environment.</p>

## Choose Multiple:

1	Which are related to human toxicity? (Choose multiple)	
	<ul style="list-style-type: none"><li>▪ Carcinogenicity</li><li>▪ Reprotoxicity</li><li>▪ Respiratory sensitization</li><li>▪ Ozone depletion</li><li>▪ Aquatic toxicity</li><li>▪ Endocrine disruption</li><li>▪ Mammalian toxicity</li></ul>	<p>Answer:</p> <ul style="list-style-type: none"><li>▪ Carcinogenicity</li><li>▪ Reprotoxicity</li><li>▪ Respiratory sensitization</li><li>▪ Endocrine disruption</li><li>▪ Mammalian toxicity</li></ul>

## Sorting Tasks:

Sort the words to the correct sentences:

chronic	mutation	exposure	acute	n e i g h- bourhoods	DNA
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1. Short term exposure to a high-level concentration may result in \_\_ effects.
2. Society \_\_ mainly indicates the \_\_, downstream populations living in that area.
3. Mutagenicity is the change in \_\_ which causes \_\_ above natural level.

Answers:

1. acute
2. exposure, neighbourhoods
3. DNA, mutation.

Exercise:

See the situation in the below photo and complete the tasks:



*Figure 8: Worker emptying a bag of unhydrated lime. Picture source: Resource Efficient Management of Chemicals (REMC) Presentation by GIZ.*

Situation: A worker is emptying a bag of unhydrated lime.

Your tasks

1. Identify the potential chemical hazards to health and safety.
2. Assess how the worker is exposed to this and what can be the possible effects.

## Hotspots

From the below options, which one has presence of hazard but no exposure and effect?

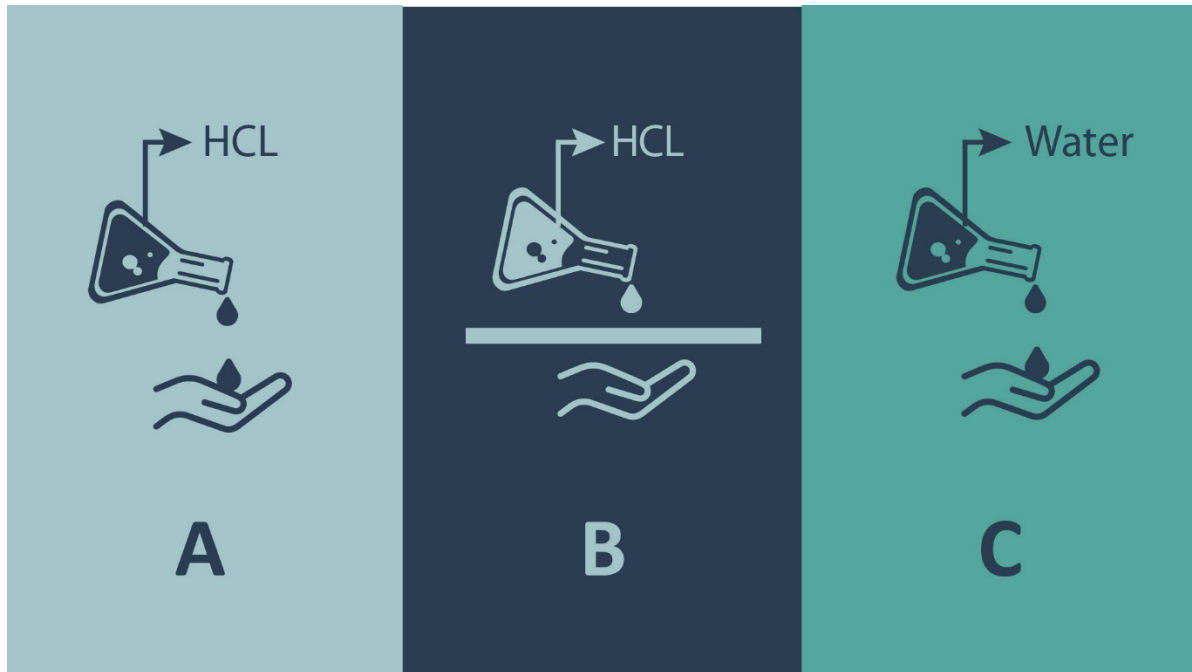


Figure 9: Hotspot. Picture courtesy: Kazi Farhan Hossain Purba.

Answer: B

## References/Additional Literature/Links

1. Resource Efficient Management Of Chemicals In Textile And Leather Sector Companies  
<https://www.sia-toolbox.net/solution/resource-efficient-management-chemicals-textile-and-leather-sector-companies>
2. More information on types of exposure, potential health risks, potential health effects and reducing risks from hazardous chemicals can be found here: <https://www.canada.ca/en/health-canada/services/health-effects-chemical-exposure.html>
3. More information on health effects from chemical exposure can be found here: <https://health.mo.gov/living/environment/hazsubstancesites/healtheffects.php>
4. To know about the signs and symptoms of chemical exposure, you can visit this link: <https://drs.illinois.edu/Page/SafetyLibrary/HealthEffectsOfChemicalExposure>
5. To read an illustrated article on the health effect of chemicals on our body system, you can go to this link: <https://www.atsdr.cdc.gov/emes/public/docs/health%20effects%20of%20chemical%20exposure%20fs.pdf>



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## Technical Elements

How did the technical elements of the unit work for you? Did you have any difficulties?

## Didactical Elements

How did the didactical structure of the learning unit work for you? Do you have any comments or suggestions to make it better?

## Open

Do you have any other comments on this unit?

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