**Subject: Science**

**Grade: 7**

**Chapter 18: Wastewater Story**

**Chapter Summary**

Water is needed by all forms of life. Clean water is a basic need of human beings. The water which is unfit for human consumption becomes the source of many water-borne diseases which ultimately lead to loss (of human life. It is estimated that one billion human beings do not get safe drinking water. So, realising the urgency we celebrate 22nd March as World Water Day to bring awareness amongst people for safe water, fit for human consumption.  
On the World Water Day, i.e. 22 March 2005, the General Assembly of the United Nations proclaimed the period 2005-2015 as the International Decade for action on Water for Life.

**Sewage**  
It is wastewater released by homes, industries agricultural fields and other human activities. It also includes rainwater that has run down the street during a storm or heavy rain and it is liquid waste. Most of its water has dissolved and suspended impurities called contaminants.

**Composition of Sewage**  
The following components make the sewage:

* Organic impurities - human faeces, animal wastes (like animal dung), urea (as urine), oil, fruits and vegetable wastes, pesticides, herbicides, etc.
* Inorganic impurities - nitrates, phosphates and metals.
* Nutrients - nitrogen and phosphorus.
* Bacteria - bacteria which cause water-borne diseases such as cholera and salmonella paratyphi which causes typhoid.
* Other microbes - Protozoa which causes dysentery.

**Sewerage System**  
The pipes which carry away wastewater or sewage from houses and other buildings are buried under the ground. An underground pipe which carries away dirty drainage water and waste matter is called sewer. The provision of drainage at a place by laying sewers under the ground is called sewerage.

**Wastewater Treatment Plant (WWTP)**  
A place where wastewater or sewage from houses and other buildings is brought for processing is called wastewater treatment plant.  
Treatment of wastewater involves physical, biological and chemical processes depending on the nature of contaminants.

1. **Physical Process (Screening)**  
   The bar screens first remove the large rubbish objects like rags, sticks, cans, polybags, napkins, sanitary towels, etc., from the wastewater.

After passing through the bar screen, wastewater is taken to a tank called grit and sand removal tanks. In this, sand and grit settle down slowly at the bottom of the tank as water passes slowly through this tank. The settled sand and impurities are removed from the tanks from time to time.

**2. Biological Process**  
The first sedimentation tank is sloped towards the centre. Solid like faeces settle at the bottom and is called sludge which is removed by a scraper. Oils and grease float at the surface of the water are removed by a skimmer. The biogas produced (by anaerobic bacteria) in the process can be used as fuel or can be used to produce electricity. Here, water gets cleared of rubbage, oil, grease, etc and we get clarified water which is sent to aeration tank now. In the aeration tank, the watery waste already contains bacteria (aerobic) in it. The compressed air bubbles are passed through this waste to provide 02 to the bacteria to increase bacterial activity which ultimately digests human waste, food waste, soaps and other unwanted and harmful matter still remaining in the wastewater leaving behind fairly pure water.

**3. Chemical Process**  
The water after aeration tank is allowed to stand in a second sedimentation tank. Here, the microbes present get settled at the bottom at the tank in the form of activated sludge which is about 97% water. At this stage, water has very low level of organic matter suspended matter and does not contain many harmful things. It is safe for human consumption but is disinfected by chlorine or ozone before distributing it.

**Become an Active Citizen**

We should be an enlightened citizen and approach the municipality or the gram panchayat. We should also insist that open drains should be covered. If the sewage of any particular house makes the neighbourhood dirty. We should request them to be more considerate about other’s health.

**Better House Keeping Practices**  
We must minimise and manage waste at our houses before its disposal in the following manner:

* Cooking oil and fats should not be thrown down the drain. They can harden and block the pipes. In an open drain, the fats clog the soil pores reducing its effectiveness in filtering water. Throw oil and fats in the dustbin.
* Used tea leaves, solid food remains, soft toys, cotton, sanitary towels, etc., should also be thrown in the dustbin. These wastes choke the drains. They do not allow the free flow of oxygen. This hampers the degradation process.
* The chemicals like paints, solvents, insecticides, medicines and motor oils should not be thrown in drains as they kill helpful microbes which digest the organic waste.

**Sanitation and Disease**  
Contaminated water and poor sanitation practices are the major causes of the number of infectious diseases in our country. Safe sewage disposal facilities are still not available at many cities and villages in India. So, people go to open places and defecate. This causes the increase in insect-vector population which transmit diseases like cholera, typhoid, meningitis, etc.

Untreated human excreta is a health hazard which causes soil pollution and water pollution also. The river water and groundwater are sources of water for drinking for many people. So, the contaminated water can spread many diseases especially water-borne.

* **Vermi-processing Toilets**  
  In the vermi-processing toilets, human excreta is treated by earthworms in a pit. The earthworms usually eat up all organic matter present in human excrete and turn it into compost. These are low water use toilets for the safe processing of human.

**Alternate Arrangement for Sewage Disposal**  
Low cost outside the sewage disposal system has been developed to take care of places where there is no sewage system, e.g. rural areas, isolated buildings. These are described below:  
**(i) Septic tanks:** Septic tank is a low-cost onsite sewage disposal system. Septic tanks are suitable where there is no sewerage made. These tanks need cleaning every four to six months.

**Sanitation at Public Places**  
The government has laid down certain standards of sanitation but unfortunately, they are not strictly enforced. We should not scatter litter anywhere. If there is no dustbin in sight, we should carry the litter at home and throw it in the dustbin.

Ask thought-provoking questions cited throughout the lesson plans and lastly use the **Concept Map** to revise the entire chapter. Use the chapter end test to review the learnings of the concepts involved. Figure out the misconceptions and apply remediation.

**Chapter Plan**

**Concepts**

* Water, our lifeline
* What is sewage?
* Water freshens up – an eventful journey
* Treatment of polluted water
* Wastewater treatment plant (WWTP)
* Become an active citizen
* Better housekeeping practices
* Sanitation and disease
* Alternative arrangement for sewage disposal
* Sanitation in public places
* Conclusion

**Learning Objectives:**

Based on the Learning Objectives, the period-wise plan can be made based on the following topics keeping 35 mins duration in mind.

* Define sewage and explain the process of sewage treatment.
* List and explain different types of impurities found in sewage water.
* Explain different stages of waste water treatment.
* Define sludge.
* List and explain few better housekeeping practices.
* Explain the need for sanitation.
* Briefly explain onsite sewage disposal system.
* Briefly explain ways to maintain sanitation in public places.

**Lesson Plans**

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| **S#** | **Topics/Concepts** | **# of periods ()** |
| 18.1 | Water, our lifeline | 1 |
| 18.2 | What is sewage? |
| 18.3 | Water freshens up – an eventful journey   * Treatment of polluted water |
| 18.4 | Wastewater treatment plant (WWTP)   * Become an active citizen | 1 |
| 18.5 | Better housekeeping practices |
| 18.6 | Sanitation and disease |
| 18.7 | Alternative arrangement for sewage disposal |
| 18.8 | Sanitation in public places   * Conclusion |
|  | Chapter Review |  |
|  | Chapter End Assessment |  |
|  | Extended Learning |  |

**Common Errors/Precautions:**

* **Myth: Wastewater treatment plants smell.**

There are indeed bad odors associated with wastewater treatment. These include odors of ammonia and the decomposition of organic materials. Amines and mercaptans can also cause bad smells due to their [sulfur content](https://www.sciencedirect.com/topics/engineering/mercaptans). However, treatment plants can effectively work against them by deploying carbon filters, biofilters, wet air scrubbing, chemical agents, neutralizing mists, and other [odor control](https://chemtech-us.com/products/odorgone/) methods to prevent the smell.

* **Myth: Water of Ganga river is very pure.**

The Ganges River provides water access for around 400 million nearby dwellers, and unfortunately, cities directly inject over [three-quarters of untreated sewage](https://www.ifc.org/wps/wcm/connect/ed4d5a55-c5a3-4acd-b6f1-f26ae80429a3/PPPStories-India-Clean-Ganga.pdf?MOD=AJPERES&CVID=mzDvD.g) into the river. The government approved [Namami Genge program](https://nmcg.nic.in/NamamiGanga.aspx) has achieved operation of 75 sewage treatment plants, a river surface cleaning action plan and a desire to rejuvenate the river from heavy pollution.

**Did you know?**

* **Vulnerability against seasonal changes undermines the capacity to provide sanitation in India.** In the monsoon season, water treatment plants in low lying basins must shut down to avoid flash floods and power outages, while some water scarcity villages will only use the toilets during this period. In turn, villages cannot maintain sustainable water supply when periodic drought strikes.
* Limited water access in rural regions directly impedes children’s possibility to receive an education. In general, the shortage of water in rural areas gives people the added burden of carrying the water home. Instead of attending school, children are supporting their families with such undesired labor.
* The Swachh Bharat (Clean India Mission) contributed incredible achievements. India built about 1.5 million toilets in 2019 and over 100 million toilets during the past 5 years. In total, when the mission completed in October 2019, 60,000 villages [were open-defecation free](https://sbm.gov.in/sbmReport/home.aspx). The Individual Household Latrine (IHHL) coverage reached 100 percent of the state’s households.

**Keywords:**

* **Aeration:** Aeration is the process by which air is circulated through, mixed with or dissolved in a liquid or substance.
* **Aerobic bacteria:** Aerobic bacteria are bacteria that can grow and live when oxygen is present. Bacteria consume human waste, food waste, soaps and other unwanted matter still remaining in clarified water.
* **Anaerobic bacteria:** The bacteria that grow in the absence of oxygen are called anaerobic bacteria. Sludge is decomposed by anaerobic bacteria.
* **Biogas:** Biogas is an environmentally-friendly, renewable energy source. It's produced when organic matter, such as food or animal waste, is broken down by microorganisms in the absence of oxygen, in a process called anaerobic digestion.
* **Contaminant:** A contaminant is either a biological, chemical, physical or radiological substance that becomes harmful for humans or living organisms, when accidentally or deliberately introduced to air, water, soil or food.
* **Sanitation:** Sanitation is the promotion of hygiene and prevention of disease by maintenance of sanitary conditions. It includes measures taken up by the government to protect public health through proper solid waste disposal, sewage disposal, and cleanliness during food processing and preparation.
* **Sewage:** Wastewater is generated in homes, industries, agricultural fields and in other human activities is called sewage.
* **Sewer:**  A sewer is an underground pipe that carries sewage or transports the sewage from homes and commercial buildings to the sewage treatment plants, where the sewage can be treated.
* **Sewerage:** It is like a transport system that carries sewage from the point of being produced to the point of disposal, i.e. treatment plant.
* **Sludge:** Sludge is the solid material that settles at the bottom in wastewater treatment.
* **Wastewater:** Rich in lather, mixed with oil, black– brown water that goes down the drains from sinks, showers, toilets, laundries is dirty. It is called wastewater.

**Lesson Plan 16 (Light)**

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| **Chapter**: 16 Light |
| **Concepts**:   * Water, our lifeline * What is sewage? * Water freshens up – an eventful journey * Treatment of polluted water * Wastewater treatment plant (WWTP) * Become an active citizen * Better housekeeping practices * Sanitation and disease * Alternative arrangement for sewage disposal * Sanitation in public places * Conclusion |
| **Skills**:   * Observing * Reasoning * Contrasting and comparing * Defines situation/ event * Exploring * Collect/categorize and record data * Expressing through creative writing * Environmental awareness * Collaboration |
| **Prerequisite Knowledge**:   * Water is a precious resource. * Waste from homes, factories etc mix in water and make it unfit for use. * Maintaining hygiene in public places is as important as hygiene at home. |
| **Materials Required**:   * Video resource to show the process involved in treatment of polluted water.   <https://www.youtube.com/watch?v=Tgb5GRcfRdw>   * Video resource to explain vermi-processing toilet.   <https://www.youtube.com/watch?v=d1oel5jFrDg>   * Picture of vermi-processing toilet.   ILIAS 3 |
| **Learning Outcomes**: The students will be able to:   * Define sewage and explain the process of sewage treatment. * List and explain different types of impurities found in sewage water. * Explain different stages of waste water treatment. * Define sludge. * List and explain few better housekeeping practices. * Explain the need for sanitation. * Briefly explain onsite sewage disposal system. * Briefly explain ways to maintain sanitation in public places. |
| **Period Plan 1**  **Initialization 5 mins**  Write the name of the chapter on the board. Inform students that today we are starting a new chapter – “Wastewater story”. Suggested questions that can be asked to the students:   * Why water is called precious resource? * Why hygiene is important? * Are they aware of any water purification methods? * Is the tap water that we get is fit for consumption?   **Procedure 25 mins**   * Ask the students, if they have noticed different ways water is either wasted or polluted? If they have done anything to stop or reduce it. Let the students brainstorm about their observations. * Briefly explain about “water for life”. * Define and explain about sewage and different types of impurities that are part of sewage. * With the help of a picture or diagram of sewerage system of the school/area around school explain sewerage system * Following video resource can be used to show the process involved in treatment of polluted water.   <https://www.youtube.com/watch?v=Tgb5GRcfRdw>  detailed explanation can be done during next class.  **Word of Caution:**  **Wrap Up 5 mins**   * Recall the definition of sewage and different types of impurities in sewage water. * Ask the students to briefly explain the waste water treatment after watching the video.   **Homework**   * Ask the students to conduct a contaminant survey and note their observations in Table 18.1.   **Additional Resources/Materials** |

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| **Period Plan 2**  **Recall 5 mins**   * Recall the definition of sewage and different types of impurities in sewage water. * Ask few students to present their contaminant survey. * Ask the students what can they recall from the video that was shown during last class.   **Procedure 25 mins**   * Explain in detail, the different steps of water treatment in a wastewater treatment plant (WWTP). * Define sledge. * Ask the students to list few steps that we, as responsible citizens can take up to reduce wastage and polluting of water. * Let the students brainstorm about ways to minimise or eliminate waste and pollutants at their source. * Explain how poor sanitation and contaminated water is the root cause for many diseases. * Explain onsite sewage disposal systems.   **Note:** We should plant Eucalyptus trees all along sewage ponds. These trees absorb all surplus wastewater rapidly and release pure water vapour into the atmosphere.   * With the help of a picture or video resource explain vermi-processing toilet.   <https://www.youtube.com/watch?v=d1oel5jFrDg>  ILIAS 3   * To conclude, discuss the importance of sanitation and our responsibility in maintaining our surroundings clean.   **Word of Caution:**  **Wrap Up 5 mins**   * Recall the different stages and processes involved in treating wastewater in a facility. * Recall alternative arrangements of sewage disposal.   **Homework**   * Ask the students to complete exercises 1, 11 and 12 and mark answers for the remaining exercises in the text book. These can be discussed during the upcoming class.   **Additional Resources/Materials**   * Video resource to explain vermi-processing toilet.   <https://www.youtube.com/watch?v=d1oel5jFrDg>   * Picture of vermi-processing toilet.   ILIAS 3 |

**Lesson Plan 18 (Chapter Review)**

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| **Period Plan 3**  **Chapter Review 35 mins**  Use the Concept Map to connect all the concepts discussed during the last 8 periods. Let students also make one on their notebooks while you compile the information shared by the students on the board.  Suggested Concept Map:    **Homework**  Ask students to complete any pending work to be done in the notebook. Ask them to revise the chapter for the upcoming chapter end assessment. |

**Extended Learning**

* **Water filtration challenge**

In this activity, students are challenged to design and build a water filtration device using commonly available materials. To meet this challenge, students can use an iterative process as they build, test and measure the performance of the filtration device, analyze the data collected, and use this information to work toward an improved filtration design.

Although students will work in teams of two to three, they are encouraged to think of their entire class as a single design team working cooperatively and learning from the efforts of all members in order to produce the best water filtration device.

Students measure the effectiveness of their filtration device using pH test strips and a conductivity tester that is assembled from readily available materials and requires about a half-hour to construct.

* Visit the nearest water treatment facility and make a note of different procedures used to treat water to make it fit for use.
* Write a letter to the municipal corporation of your area requesting them to address issues related to leaking water pipes, taps, piling of garbage near a water body etc.

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