Introduction

To start with, the terms medicine, hygiene, public health, preventive medicine and social medicine may be defined or clarified. There are at least three levels at which any one, two, three or all the above mentioned disciplines exist in any area. The levels are as under:

a. Conceptual or philosophical level
b. Practice level
c. Demonstration level.

a. **Conceptual or philosophical level** may be defined as the unattained (may be also unattainable in the near future) idealistic level of practice for which a scientist may develop the strivings. The conceptual or philosophical level is essential to widen the horizons of the medical profession for ever continued strivings to achieve higher and higher. Without idealistic philosophy, long range scientific achievements are not possible.

b. **Practice level** is the level at which any of the above mentioned disciplines exists in actual practice. Since time immemorial, medical profession has been a practice, a science and an art in the background of the profession's ideals during any phase of human existence.

c. **Demonstration level** may be defined as the scientific effort to demonstrate the raising of the existing practices scientifically towards the conceptual level in a graded manner.

The three levels of the five disciplines, e.g. medicine, hygiene, public health, preventive medicine, and social medicine and community medicine are discussed here under as these concepts provide the guidelines for discussion in the book. Further, each of the five disciplines is a science as well as an art. Each is a science as it is based on scientific knowledge. Each is also an art as it involves the development of skills for systematic application of knowledge for benefits of human beings in their ecological settings.

1. MEDICINE

a. **Conceptual or philosophical level:** The conceptual background for traditional disciplines of medicine are diagnostic and therapeutic services including surgical services of the highest order and quality. The emphasis is mostly on sophisticated and well organised hospital services. In conceptual thinking, the inpatient services have greater emphasis than the outpatient services.

b. **Practice level:** The practice levels of the traditional disciplines are clear in terms of hospital services, both inpatients and outpatients, which are available both on payment and free out of tax or voluntary philanthropic contributions. In addition, diagnostic and therapeutic services are also available in homes on payment only. There is a whole spectrum of the quality of these services.

c. **Demonstration level:** There are, at times, evident scientific efforts to improve the organisational aspects of the hospital services. However, most of these improvements are seen in hospitals with easy resources, especially in developing countries. Scientific strivings to improve the hospital services maximally within available resources are not yet visible in our country.

2. HYGIENE

The word hygiene is derived from the Greek word *Hygeia*—the Goddess of health. Hygiene is defined as the science and art of preserving and improving health. Hygiene deals both with an individual and a community as a whole. Personal hygiene is the term used for improvement of hygiene of an individual or a person. Similarly, other terms like mess hygiene, milk hygiene, hygiene of feeding, hygiene of clothes, hygiene of infant feeding, etc. are self-explanatory.

Tanks or Ponds

These are important sources of water supply in some villages in India. These are the excavations in which rainwater is collected. These are generally full of silt and colloidal matter, especially after the rains. In these tanks, water undergoes natural purification to some extent.

For an ideal tank or a pond, the following points should be attended to:

1. The soil for excavation should not be made-soil and loose sandy soil having filthy ponds and cesspits. There should be no insanitary or borehole latrines in the vicinity. No surface drain should be allowed to empty into it.
2. The surroundings should be clean with proper fencing. Trees should be planted at a distance around it to keep away the cattle and dirt.
3. It should be fairly deep and large and preferably of a rectangular shape having an area of about an acre. Banks should be properly sloped and planted with grass. The surrounding area should have a low embankment to prevent any outside water getting access into the tank, except the rainwater.
4. All sorts of bathing and washing of utensils or clothes in the tank should be strictly forbidden and a notice to that effect should be displayed at a prominent place near it. Moreover, steps and ghats should not be provided into the tank.
5. Weeds and algae should be removed regularly. Whenever water in the tank or the pond deteriorates, it should be emptied out and re-excavated as growth of algae makes the water unpleasant to taste.
6. Any trade, like jute-steeping, should not be allowed in the tank.
7. Some varieties of fish which thrive on larvae may however, be stocked, if so desired.

Ferrocement tanks are a type of storage tank that consist of an armature (framework) of steel reinforcing, which is then covered with a sand-cement plaster. They offer complete flexibility in shape, have a long life and are cost-competitive when contractor-built, and are owner-buildable in both industrialized and non-industrialized countries.

c. Upland Surface Water

Upland rivers rise in mountaneous regions. It is the water which runs on the sides of hills, slopes and valleys and is taken off as water supply before such water collects to form big streams and rivers. Water may be collected in the form of natural lakes as in the city of Glasgow or in artificially constructed lakes as has been done in cities like Mumbai, Chennai and Darjeeling. The area from which this water is collected, is called the *catchment area*. The water supplied to Simla is an example of this kind of water supply. At a short distance from Simla, there is a ridge of low hills, called the *Mahasu ridge* which drains into a deep *Nala*, between the ridge and Simla. The rainwater flows along the slope of the ridge, which is well wooded and constitutes the catchment area. The water thus collected is called the upland surface water. Similarly, Mumbai city receives its water supply from upland surface water in the form of four artificial lakes *(viz. Tulsi Lake, Tansa Lake, Vihar Lake* and *Vaitarna Lake)* situated away at great distances from Mumbai proper.

An upland surface water is safe because it is pure rainwater, which has travelled a short distance over the earth. However, the dangers are:

1. Excreta of human beings and animals in catchment area may find its way into the water, and infect it with pathogenic micro-organisms.
2. Freshly collected water is acidic in nature and may corrode lead, thus forming a easily soluble hydrate of lead, which remains on the inner surface of lead pipes, cisterns, etc. and on becoming detached mixes in water. Since the water is acidic in reaction, lead gets dissolved in the water and may cause lead poisoning on consumption.
3. The water may become brownish or yellowish in colour due to the decayed vegetable substance called peat in some catchment areas.

The upland surface water needs purification by filtration and sterilisation by chlorination or it can simply be purified by running the water through a bed of fine sand, before final storage for human consumption.

Yield of the catchment area can be found by E. Pole's formula:

$$Q = 62.15\ A\ (4/5\ R–E)$$

$$Q = \text{Gallons per day}$$

Where,

A = Area in acres.
R = Average rainfall for three driest consecutive years.
E = Loss in inches of evaporation.

Lakes

These are simply natural collections of upland surface water in a valley with a high ground at its outlets, which checks all water from escaping at once. When collected from unpopulated hilly districts such water being usually soft and containing a little chlorine, affords an excellent supply. It does not contain ammonia nitrates and nitrites more than the proportion in which they are usually found in rainwater. It, however, contains more dissolved matter than rainwater. Water collected from low land surfaces usually contains much peaty matter as well as phosphates and nitrates, washed from manures of cultivated fields. That is why it becomes yellow or brownish in appearance. The lake water requires filtration and disinfection before

There are two basic approaches to well cleaning—mechanical and chemical, with the most effective strategy often being a combination of the two. Within both the chemical and mechanical methods are an array of options. Mechanical processes for loosening debris and/or encrustations and removing them from the well include the use of: (a) Pressurised air or water, (b) wire brushes or scrapers, (c) agitation of water in the well, and (d) sonic waves. Chemical cleaning often involves the use of various acids to loosen or dissolve debris so that it can be pumped out of the well. Depending on the nature of the cleaning job, there are also polymers and "caustic" chemicals (that increase the alkalinity of the water) to remove debris. For chemical cleaning, the well can be chlorinated by treating it with a solution of 1 part of freshly prepared slaked lime to 4 parts of water or bleaching powder or by potassium permanganate solution.

The age of a well may determine which methods are used to clean it. If a well's water intake areas or the well casing have corroded significantly over time, they may be damaged or destroyed by more aggressive cleaning practices.

Examination of wells: The following points should be borne in mind while examining a well:

1. Size and depth of the well.
2. Depth of water in the well.
3. Nature of soil in which the well is sunk.
4. Any possible sources of pollution within 200 to 350 ft (60.96 to 106.68 metres) of the well. Practical aspects are discussed subsequently.
5. Average quantity of water which is daily drawn out.
6. The way in which water is disposed off.
7. Mechanical contrivance with which water is drawn, e.g. pump, rope and bucket, etc.
8. Whether there are cracks and fissures on the sides or not.
9. Whether the mouth of the well is closed or open.

Detection of sources of pollution of a well: If a source of contamination is suspected in the neighbourhood of a well, it is detected by pouring certain chemicals which may be recognised on account of their characteristic smell, taste, colour and other chemical and physical properties into all the pools, drains, etc. which may be regarded as possible sources of pollution. The following methods of examination may be adopted:

1. By adding a strong solution of sodium chloride and detecting the increase in the amount of chlorides in well water by titrating with a standard solution of silver nitrate using potassium dichromate as an indicator.
2. By adding alkaline solution of fluorescein (1 lb or 0.453 kg of fluorescein and 1 lb or 0.453 kg of caustic soda) to 10 gallons (45.5 litres of water) and detecting the fluorescein in well water by means of a fluoroscope.
3. Suspension of *Bacillus prodigiosus (viz.* culture of *Chromobacterium prodigiosum*) may be added and subsequently red colonies grown and ultimately isolated from the water.
4. Kerosene oil may be poured and its smell and tinge detected in well water.

Yield of a well: The quantity of water in a well can be measured by the following formula:

Depth of water in feet × square of diameter of the well in feet × 5 = gallons of water.

Tube Wells

These yield water which is bacteriologically safe. These consist of lengths of iron tubing driven deep into ground up to the desired length. Firstly, a hole is made into the soil about 5–6 feet (1.52 to 1.83 metre) deep and first part of the tube having a perforated steel point at its lower end is hammered in. Subsequently, successive lengths of tubes are driven deep into the soil, one length being screwed into the other, till the sub-soil water is reached. In this case, water is drawn by means of a pump. Tube wells form a rapid means of obtaining groundwater and are comparatively more sanitary than dug wells.

Deep tube wells: These are largely used for municipal water supply and also for irrigation purposes. The average yield of a deep tube well of 1 to 1 ½" (2.5 to 3.8 cm) diameter is 200–300 gallons (909.20–1363.80 litres) and of 9" (22.86 cm) diameter is 60,000 gallons (272,760 litres) of water per hour. The yield mainly depends upon the water-bearing strata and a little on the diameter and depth on the tube well.

These are sunk through hard surfaces by boring through rocks with special machines. The depth is between 300–400 ft (91.44 to 121.92 metres) and the characteristics of water are like deep well waters. In many towns, the water supply is now obtained from these tube wells.

The water is hard due to presence of calcium carbonate and sodium chloride in variable quantity, traces of iron, etc., however, is free from bacteria. The greater the depth from which the water is obtained, the more likely is the higher percentage of its mineral contents. While operating, limitation of their working speed must be kept in view, as they silt up, if their rate of pumping exceeds the critical velocity.

Critical velocity: The water flows through the filtering medium of sand outside the strainer of a tube well, without disturbing the sand bed. But if the rate of pumping is rapid or excessive, the water carries sand grains with it and the velocity at which this disturbance starts is called *critical velocity.*

- ***Potassium permanganate***: It is a strong oxidising agent thus oxidises organic matter and also serves as a deodorant. 0.5 part of this salt added to 100,000 parts of water is sufficient to destroy 98% of micro-organisms in 4 to 6 hours. It is largely used for disinfection of wells. 4–6 oz (113.40–170.10 gm) of it used for a well, so that water will give a proportion of 1/2 oz (14.17 gm) of the chemical per 1000 gallons (4546 litres) of water in the well. It is better to treat water of the well with the chemical in the evening so that it may be ready for use on the following morning, when it should have a faint pink tinge, if the dose has been added in right proportion. If smell reappears in the well water after 2 or 3 days, potassium permanganate treatment should be repeated. Its disadvantage is that taste and odour of the water treated changes, although temporarily. Moreover, the method is not considered very dependable, since it may kill cholera vibrios, but it does not destroy other disease organisms.

Solar Disinfection (SODIS)

This can be done by filling 0.3–2 litres of plastic bottles with low turbidity water, shake them to oxygenate and place the bottles on the roof in a rack for 6 hours, if sunny or 2 days, if cloudy. The process inactivated the disease causing organism by combined effects of UV-induced DNA alteration, thermal inactivation and photo-oxidative destruction. Over 2 million people in 28 developing countries use this method for purification of drinking water.

Slow Sand Filters

Filtration of Water Supply on a Large Scale

Filtration cleans the water by removing suspended matters, ova, cysts, spores and bacteria by the use of filters, which are of the following two types (Table 1.3):

1. "Biological" or "slow sand" filters (Fig. 1.11).
2. "Rapid sand" or "mechanical" filters.

1. ***Biological or slow sand filters***: This system was first introduced in England about more than a century back and it is, therefore, often termed as "English System".

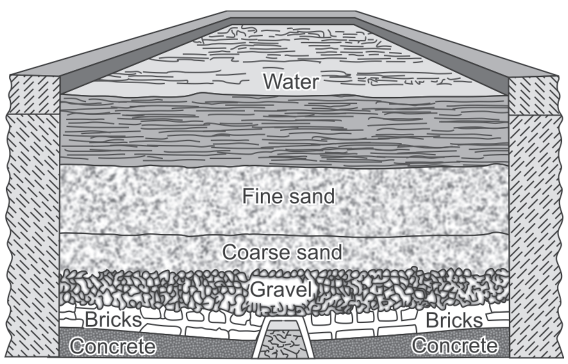

Fig. 1.11: Section of a slow sand filter

The raw water from the source, usually a river, canal or stream is collected and stored in large open reservoirs known as *settling tanks* and is allowed to remain there for a period of 24 to 48 hours. The solid matter present in water as suspension gravitates to the bottom. Storage of water for a period of about 3–4 weeks renders the water supply pretty safe prior to filtration. The process of sedimentation can be hastened by adding a flocculent/coagulant such as alum or sulphate of ammonia, which is specially done in rainy season, when the water becomes turbid, in specially constructed circular mixing troughs, before its entrance to the settling tanks. This process of sedimentation has a great influence on bacterial counts and life thus significantly reducing their numbers, may be as much by 90% with a higher extent of reduction of *coliform bacteria.*

The water is now allowed to circulate slowly from a higher level and then to gravitate from above into the filter beds downwards.

Filter beds are watertight rectangular masonry tanks or reservoirs usually arranged side by side and ordinarily kept open. These are usually about 9–12 feet (2.74–3.96 metres) deep. They are filled up from bottom upwards as follows:

a. There are two layers of bricks placed one above the other on their edges which are arranged in the form of drains and channels for the passage of filtered water. Over the bricks, layers of the following materials are arranged systematically one after the other.
b. 6″ (15.24 cm) to 12″ (30.48 cm) gravel, broken stones or pebbles (size 1″ or 3.81 cm) cubes.
c. Coarse sand 6″–12″ (15.24–30.48 cm).
d. Fine sand 36″ (91.44 cm).
e. Water from settling tanks 36″ (91.44 cm).

Thickness of these materials varies at different places, but an important thing is that the thickness of sand layer is never less than one foot (0.3 metre). To ensure uniform filtration, these filter beds are provided with valves at outlets and inlets. The size of filter depends upon:

a. The size of the community to be supplied with water.
b. The quantity of water to be supplied per head.

The action of slow sand filter is three-fold:

a. *Mechanical obstruction or physical*: The suspended impurities are strained off by upper portion of the filter.
b. *Chemical*: The organic matter in water is oxidised by the presence of air and nitrifying micro-organism in the sand.
c. *Biological action is carried on in the vital layer*: After the filter bed has been working for 2–3 days, a thin green slimy gelatinous layer of low vegetable organisms, thread-like algae and fungi, etc. called *Schmutzdecke vital layer* forms on the surface of the