Water Sanitization:

Most people can only survive 3 days without water. With that in mind a source of safe drinkable water is critical for survival. Worldwide 3.57 million people die each year from unsanitary water related disease. If safe drinkable water is not available it is better to consume untreated water with it's infectious risks than to die from dehydration.

There are multiple techniques for treating naturally found water to reduce the risk of water borne disease. This includes heat, distillation, ultraviolet treatment, reverse osmosis, solar, chemical treatment, and filtration. Other than infectious organisms one must be aware of the risk of chemical contamination and radioactive contaminants. There are some sources of water that are naturally found that may not require any treatment. Water from a natural spring that is coming up out of the ground has not usually had an opportunity for environmental contamination and is usually safe to drink without treatment. Collected rainwater does not usually need to be treated if it has not passed over dirty shingles, through a forest canopy or foliage. Typically water from streams, rivers, lakes, ponds, and gutters from roofing usually carry infectious risks and should be treated.

Heat treatment - boiling water is a well-established technique for rendering water safe from infectious organisms. Water does not have to be boiled to make it safe for consumption- raising the water for a few minutes to pasteurization temperature will not eliminate all organisms but can eliminate disease causing organisms. Typically this is considered 65 °C or 149 °F. There is a pasteurization technique where 3 parts of boiling water have added to it one part of untreated/unheated water and then thoroughly mixed. This should result in the entire amount of water reaching pasteurization temperature. The advantage of pasteurization is that it does save heating fuel. The advantages of boiling water is that it does not require a thermometer and requires little specialized equipment. The disadvantage of heat treating water is that it is often a slow process, requires fuel/heat and may generate a smoke/light signature from a fire. Generally it also does not remove much chemical/radiologic contaminants.

Distillation - boiling or heated water will generate water vapor which can be collected and cooled to allow condensation of water which is free of infectious organisms. A simple distillation technique involves a pot filled with untreated boiling water with an inverted lid placed over the top and with a collection vessel attached to the knob. This allows condensation from the lid to run down onto the knob and drip into the collection vessel. The advantage of distillation is that it does generate water which is free of infectious organisms and there is some reduction in chemical and possibly radiologic contaminants. The disadvantage of distillation is that distalization requires more equipment than simply boiling the water and is a slower process than boiling.

Ultraviolet light treatment - ultraviolet light very effectively destroys the DNA of infectious organisms and is therefore very effective at rendering water free of infectious organisms. This effectiveness does depend on the cloudiness of the water, temperature, and intensity of the ultraviolet light. There are commercially available portable ultraviolet light water treatment devices for camping. Some of these devices require batteries and others may require a hand crank. The disadvantage of ultraviolet water treatment is that it does require specialized equipment and does not remove chemical/radiologic contaminants or improve water taste. The advantage of ultraviolet water treatment is that it is rapid and effective.

Reverse osmosis - Reverse osmosis works by forcing water through material with very tiny pores—as tiny as .0001 microns—so that ALMOST nothing except water emerges on the other side. Almost nothing. The EPA recommends reverse osmosis water treatment for most kinds of radioactive particles. Dissolved gases and materials that readily turn into gases can easily pass through most reverse osmosis membranes. Iodine-131 can escape from damaged nuclear plants as a gas - which allows it to disperse quickly through the atmosphere. The Iodine-131 gas can then get captured in atmospheric water and fall to the earth in rain and enter the water supply where it might fail to be removed with the reverse osmosis system. In order to remove the Iodine-131 activated carbon and ion exchange resins have been felt to be effective-until they have become saturated. Ion exchange resin is also helpful for removal of radioactive cesium-137 from water. The advantage of reverse osmosis water purification is that it does capture infectious organisms and many radioactive particles. The disadvantage is that a reverse osmosis water purification system requires sophisticated equipment and repair/spare parts may not be easily available. To be the most effective against radioactive contaminants the reverse osmosis filter would need to be paired with an activated carbon and ion exchange resin system.

Solar - an interesting technique for reducing infectious organisms in water is to place the non-cloudy untreated water in a clear plastic water or soda bottle of 2 L or less in size (technique called Sodis). The labels must be removed and the plastic clear. The bottle is then placed in direct sunlight for 1 or 2 days and certainly 2 days or longer if partly cloudy. It may not be effective at all if the weather is rainy. This technique works even better if the bottle has additional reflected light directed to it. The advantage of this technique is that it requires little specialized equipment and is a simple technique. The disadvantage of this technique is that it will not work unless under direct sunlight, will not remove chemical/radiologic contaminants, and does not have a clear success endpoint. Another solar technique involves a solar still using plastic sheeting and a pebble and a water collection cup. The solar still is simple and effective at removing infectious organisms but still may not remove all the chemical or radiologic contaminants and is slow.

Chemical treatments - bleach (sodium hypochlorite), iodine, pool shock (calcium hypochlorite) and potassium permanganate have been chemicals was used in water treatment. With all of these treatments the chemicals are added to the water and a treatment time is allowed giving the chemical time to appropriately destroy infectious organisms. Many water purification tablets utilize bleach or iodine as the active chemical for destroying infectious organisms. If household bleach is used in 2 to 4 drops per quart is the usual amount with more used for cloudy or cold water. The container should then be placed in the shade and allowed to rest for 30 to 45 minutes before consumption. Iodine may be used to treat water but may risk medical issues for some people; pregnant women, those with allergies to iodine and people with certain thyroid disease. 2% tincture of iodine can be used by placing 5 to 10 drops in a quart of water and placed in the shade to rest for 30 minutes. The same effect can be achieved using Betadine- 4-8 drops/L. (This gives double purpose for betadine- wound cleaning and water treatment). Potassium permanganate is a powerful oxidizer and a few crystals in a liter of clear untreated water will cause it to turn a very light pink color and this is allowed to sit for 2 hours. The potassium permangonate can be toxic at higher levels so only a light pink color would be indicated for water treatment- a bright pink or light purple may be used to clean wounds. The use of bleach and iodine for water disinfectant is more established and I would use those techniques preferentially to the potassium permanganate technique. Pool shock (powder calcium hypochlorite) can be used for water treatment for drinking using about a teaspoon per 100 gallons. Do not use pool shock that contains other additives. The advantage of chemical treatment techniques is that they require little equipment, are simple, and have no smoke or light signature. The disadvantage is that you must have those chemicals, allow for treatment time, they may flavor the water a disagreeable taste, and the treatment chemicals do not remove chemical/radioactive contaminants.

Filtration - filters can be made with ceramic material, micro-tubes, pleated paper or other fibers, or other similar materials that allow a fine pore size to be present. This can allow for the passage of water while physically obstructing the passage of infectious organisms. There are numerous types of filters for outdoor use and these have varying capabilities with regard to removal of infectious organisms. Viruses are small and are more difficult to filter. Some of the systems are designed for an individual and are like a straw while other systems are larger and can treat water for a group of people. Some water filtering systems involve sucking on a straw, others utilize a gravity flow system and some others use a pump. Some sources indicate that these filters may remove as much as 60 to 85% of radioactive contaminants. If a filter is combined with activated carbon then there is greater success at removing radioactive and chemical contaminants and may help remove a disagreeable taste from some water. The advantage of the water filtration devices is that they are simple and effective and portable and fast. The disadvantage is that eventually the filter will become nonfunctional once it is saturated and it may have only partial success against viruses. Some filters (especially after

use) may be damaged in freezing temperatures or by ice crystals. Sadly there may be no easy way to tell if the filter was damaged.

Other considerations - if one is concerned about radiologic contaminants in the water to be treated then it is possible to reduce these radiologic contaminants with an earth filter. Earth is collected that is a few inches below the soil surface. By removing the more superficial soil you are removing the soil that might have radioactive fall-out contaminants. Allow the untreated water to percolate through this "clean" earth filter before filtering or other treatment. Studies have shown that using a "clean" earth filter a significant amount of radiologic contaminants can be removed.

Lastly, keep in mind that is better to be infected or contaminated and alive than to be uninfected or uncontaminated and dead therefore consuming raw or untreated water may still be a necessity.