ide (H_2O_2) a powerful bleaching compound. It is made by treating barium dioxide (BaO_2) with sulphuric acid (H_2SO_4).

How to Make Disinfectants. A disinfectant is a substance that will kill the germs which cause various diseases. Among the better-known disinfectants are chlorine (Cl), sulphur (S), hydrogen peroxide (H_2O_2), formaldehyde (CH_2O) and phenol (C_6H_5OH), or *carbolic acid*, as it is popularly called.

Chloride of lime ($Ca(OCl)_2$) is a good disinfectant, and you need only to dissolve 1 ounce of it in 1 quart of water (H_2O) to make it. Where there are germs of malignant diseases, the rooms can be disinfected by burning sulphur (S) in them. The sulphur (S) combines with the oxygen (O) of the air, and this forms sulphur dioxide (SO_2). To make this gas effective you must seal up the windows and doors of the room you want to disinfect by pasting strips of paper over the cracks, then put a couple of lumps of sulphur (S), about the size of walnuts, in an iron pot and ignite them.

Hydrogen peroxide (H_2O_2) is not only a bleaching agent but it has the remarkable property of destroying tissues of the body that are dead or decaying, while it will not affect healthy, living tissues. Another good feature about it is that when it reacts on dead and decaying tissue, water (H_2O) only is left behind, and, hence, there is nothing which will irritate or poison the tissues that are living. For this reason, it is very much superior to disinfectants of other kinds. Use a 3-per-cent solution of hydrogen peroxide (H_2O_2) for disinfecting wounds and sores, and this you can get at any drug store.

While formalin ($CH_2O + H_2O$), which is a solution made by dissolving 40 per cent of formaldehyde (CH_2O), a gas, in 60 per cent of water (H_2O), is often used as a preservative of milk, it is harmful when taken into the system, but it is a very good disinfectant. You can get formalin ($CH_2O + H_2O$) all ready to use at the drug store.

Finally, phenol (C_6H_5OH), or carbolic acid, to give it its common name, is a most excellent disinfectant. It is one of the products of coal-tar, and to make a disinfectant of it you need only to mix 5 per cent of it with 95 per cent of water (H_2O). In use this disinfectant is sprinkled around.

How to Make and Use Dyes. Dyes are of two general kinds: *natural colors* and *artificial colors*. The former are made of various plant, animal, and mineral matter, while the latter are either extracted from *coal-tar* or else they are made *synthetically*.

Logwood (*red*), indigo[1] (*blue*), and tumeric (*yellow*) are some of the plant colors; cochineal (*scarlet*) is a dye made from insects; chrome (*green* and *yellow*), iron buff, prussian blue, and manganese brown are mineral colors. *Aniline dyes* are made from coal-tar, and other dyes, as for instance indigo, are made synthetically; that is, the chemist builds up a compound exactly like the one that nature makes by combining the same elements of which it is formed.

HOW TO MAKE AND USE NATURAL-COLOR DYES.

Direct, or Substansive Dyes. Nearly all the plant and animal dyes can be made by boiling the dye-stuffs in water (H_2O). The goods to be dyed are immersed in these, and

[1] Indigo was formerly obtained from the *indigo plant*, which was extensively grown in India and Egypt, but practically all that is used now is made synthetically.

hence they are called *direct*, or *substantive*, dyes. Very often the color can be changed or improved by adding some other compound, thus:

Red Logwood Dye. Put ½ teaspoonful of logwood in a test tube half full of water (H_2O) and boil it for several minutes. This done, put ¼ teaspoonful of cobalt chloride ($CoCl_2, H_2O$) in another test tube one-third full of water (H_2O); now pour the first solution into the second one, and you will have a dark-red dye.

Black Logwood Dye. For this dye, use the same amount of ferric ammonium sulphate ($(NH_4)_2SO_4, Fe_2(SO_4)_3, H_2O$) instead of cobalt chloride ($CoCl_2, H_2O$) given above.

Green Logwood Dye. For this dye use copper sulphate ($CuSO_4, H_2O$) instead of cobalt chloride ($CoCl_2, H_2O$), as given for the red logwood dye.

Yellow Tumeric Dye. Put a teaspoonful of *tumeric* in a test tube half full of water (H_2O). Boil it for several minutes, and to this solution add a few drops of acetic acid (HCO_2CH_3).

Brown Tumeric Dye. Add ¼ teaspoonful of sodium carbonate (Na_2CO_3, H_2O) to the above tumeric solution.

NOTE.— When an acid is added to a tumeric solution, it makes a yellow dye, and when an alkali is added to it, it makes a brown dye.

Bright-Red Cochineal Dye. Put ¼ teaspoonful of *cochineal* in a test tube half full of water (H_2O) and boil it for a few minutes.

Orange Cochineal Dye. Add ⅓ teaspoonful of tartaric acid ($C_4H_6O_6$) to the foregoing dye and shake the test tube thoroughly.

Violet Cochineal Dye. Add ⅓ teaspoonful of sodium carbonate (Na_2CO_3, H_2O) to the red cochineal dye, and shake the test tube well.

NOTE.— From this you will see that when an *acid* is added to a cochineal solution, it turns it an *orange* color, and when an *alkali* is added, it turns the solution to a *violet* color.

Insoluble Dyes. Different from the above natural colors, indigo blue ($C_{16}H_{10}N_2O_2$) and *chrome*, which latter is a metallic color, *will not* dissolve in water (H_2O) and, hence, these, and others like them, are called *insoluble dyes*. But indigo white ($C_{16}H_{12}N_2O_2$) will dissolve in water (H_2O).

To Dye Indigo Blue. Dissolve ½ teaspoonful of indigo white ($C_{16}H_{12}N_2O_2$) in a test tube of hot water (H_2O) and then soak a strip of muslin in it. Take it out and hang it up in the air to dry, and the oxygen (O) of the latter will oxidize it. This changes it into indigo blue ($C_{16}H_{10}N_2O_2$), which is a fast color.

To Dye Tumeric Yellow. To dye a strip of muslin a beautiful permanent yellow put ¼ teaspoonful of lead acetate ($Pb(CO_2CH_3)_2, H_2O$) in a test tube nearly full of water (H_2O) and boil the cloth in this solution for a few minutes; this done, put ¼ teaspoonful of potassium chromate (K_2CrO_4) in another test tube nearly full of water (H_2O) and heat it. While the solution is boiling-hot, put the strip of goods in it and let it soak for a few minutes.

When the potassium chromate (K_2CrO_4) comes in contact with the lead acetate ($Pb(CO_2CH_3)_2, H_2O$) in the goods they react on each other, and yellow lead chromate ($PbCrO_4$) is formed; this latter compound is a precipitate and fills the fibers of the goods with a yellow color. As the lead chromate ($PbCrO_4$) will not dissolve in water (H_2O), it cannot be washed out, and, so the color is a fast one.

Mordant, or Adjective Dyes. Again different from insoluble dyes are the *mordant*, or *adjective* dyes, as they are called. The word *mordant* comes from a Latin word which means *to bite*, and it is a substance that fixes, or bites a color in the goods. Take three test tubes, each of which is nearly full of water (H_2O). In the first, dissolve as much aluminum sulphate ($Al_2(SO_4)_3, H_2O$) as you can get on the head of a lead pencil. In the second, dissolve the same amount of ferric chloride ($FeCl_3$). In the third, dissolve the same amount chromic acetate ($Cr(CO_2CH_3)_3$). You can hasten the action by heating the solutions.

Now dissolve ¼ teaspoonful of alizarin[1] ($C_{14}H_8O_4$), commonly called *madder*, and which is an orange-yellow dye, in each of the tubes; you will now have in the first one a *red* dye known as *Turkey red*, in the second a *violet* dye, and in the third one a *maroon* dye. This done, immerse a strip of goods in each of these different solutions, and the coloring matter will be absorbed by the mordant, and together they form an insoluble dye called a *lake* in the fibers, and so each strip is dyed a permanent color.

How to Make and Use Aniline Dyes. The simplest way to make dyes is to use *aniline colors*, and these are products of coal-tar. You can usually get these colors at a drug store, but if you actually want to dye a garment, the best

[1] Alizarin is the active coloring matter of *madder*, and 50 years ago this plant was largely grown and used as a dye to produce the well-known color called *Turkey red*. Alizarin is now made from *anthracene*, which is a coal-tar product.

way to go about it is to buy dyes already put up in packets.

Direct Aniline Dyes for Cotton Goods. For experimental purposes, take whatever color of aniline dye you want, say, black, red, green, blue, or yellow that will dissolve in water (H_2O), and to get this kind you must ask for *direct aniline dyes*. Now nearly fill a test tube with water (H_2O) and heat it until it boils; then add a few grains of the aniline dye at a time until you have produced the depth of color you want. This done, dip a strip of muslin or other cotton goods in the dye while it is still very hot, and the job is done.

Mordant Aniline Dyes for Cotton Goods. To dye cotton goods with aniline dyes and fix them with a mordant, you must ask for *basic aniline dyes*. Put ¼ teaspoonful of tannic acid ($C_{14}H_{10}O_9$) in a test tube full of boiling water (H_2O), and then put a few grains of basic aniline dye in another test tube half full of water (H_2O) to give you the color you want. Now dip a strip of muslin in the mordant and let it soak for 5 minutes or so, then take it out and dip it in the aniline dye, and the color will be fixed there.

Acid Colors for Silk and Woolen Goods. To dye silk and wool you must get aniline dyes that are sold under the name of *acid colors*. Add a few grains of the dye to a test tube nearly full of boiling-hot water (H_2O) until you have the desired color, and then add as much sodium chloride ($NaCl$), that is common table salt, as you can get on the head of a lead pencil. Now dip a strip of silk or woolen goods in the dye while it is hot, take the strip out and dip it in a solution of tannic acid ($C_{14}H_{10}O_9$), and the dye will be fixed there.

How to Make Inks.— Black Ink. Put ½ teaspoonful of tannic acid ($C_{14}H_{10}O_9$) in a test tube two-thirds full of water (H_2O); then put ½ teaspoonful of ferric ammonium sulphate ($(NH_4)_2SO_4,Fe_2(SO_4)_3,H_2O$) in another test tube two-thirds full of water, add ¼ teaspoonful of *gum arabic* to it, and heat the contents to dissolve them.

This done, pour the two solutions into a beaker and stir them well with a glass rod, and then add a couple of drops of *oil of wintergreen* to keep the ink from spoiling. Fill a bottle with the solution and you will have a good black ink. The moment the solutions come in contact, they react on each other and form ferric tannate ($Fe(SO_4)_3$), or *iron tannate*, as it is called, and it is this compound that makes the ink black.

Blue Ink. To make blue ink, dissolve ½ teaspoonful ferric ammonium sulphate ($(NH_4)_2SO_4,Fe_2(SO_4)_3,H_2O$) in a test tube half full of water (H_2O) and then dissolve ½ teaspoonful of sodium ferrocyanide ($Na_4Fe(CN)_6,H_2O$) in a test tube half full of water (H_2O). This done, pour one solution into the other, and the reaction set up will form a blue precipitate, which is ferro-ferricyanide.

Purple Ink. Put 1 teaspoonful of *logwood* into a test tube two-thirds full of water (H_2O) and boil it until the coloring matter is well out of it; now add ½ teaspoonful of aluminum sulphate ($Al_2(SO_4)_3$) and boil it again, and a fine purple ink will result. In this ink, a *lake* is made by the combination of the *plant matter*, that is, the logwood, with a *metal*, that is, with the aluminum sulphate ($Al_2(SO_4)_3$).

Red Ink. Make the purple ink just described and then add 1 teaspoonful of sodium bisulphate ($NaHSO_4$) to it, and you will have a red ink.

Green Ink. Put ½ teaspoonful of nickel ammonium sulphate ($(NH_4)_2SO_4,NiSO_4,H_2O$) and ¼ teaspoonful of sodium ferrocyanide ($Na_4Fe(CN)_6,H_2O$) in a test tube half full of water (H_2O) and shake it until they are thoroughly dissolved. This done, put in ⅛ teaspoonful of ferric ammonium sulphate ($(NH_4)_2SO_4,Fe_2(SO_4)_3,H_2O$), and again shake it until this is dissolved, and you will have a beautiful green ink.

NOTE.— In writing with any of the above inks, always use a perfectly clean pen.

Printer's Ink. Put 1 teaspoonful of sodium silicate (Na_2SiO_3), or water-glass, as it is called and ½ teaspoonful of lampblack (C), which is the soot formed by burning oil residues, in your mortar and rub them together with the pestle until they are thoroughly mixed; put this mixture in a test tube and then fill it half full of water.

This done, stir in ¼ teaspoonful each of ferric ammonium sulphate ($(NH_4)_2SO_4,Fe_2(SO_4)_3,H_2O$), and tannic acid ($C_{14}H_{10}O_9$), and then shake the tube vigorously until a thick black liquid is formed; finally pour it out on your evaporating-dish and let it remain exposed to the air until the ink is of the proper consistency.

SOME OTHER USEFUL RECIPES.

How to Make a Liquid Ink Eraser. There are two ways to erase writing done with ink, and these are with a *rubber* or *steel ink eraser*, and with a *liquid bleaching compound*. The latter usually makes the cleaner job when it is properly done. To make a liquid ink eraser, put ¼ teaspoonful each of tartaric acid ($C_4H_6O_6$) and calcium hypochlorite ($Ca(OCl)_2$), that is, bleaching powder, in a test tube one-third full of water (H_2O) and shake it well to dissolve them.

Now take a camel's-hair brush, dip it into the solution and wash it over the writing that you want to remove. It will quickly disappear, leaving no trace. The reaction that takes place is this: the calcium hypochlorite ($Ca(OCl)_2$) and the tartaric acid ($C_4H_6O_6$) combine, and in so doing chlorine gas (Cl) is set free. This forms hypochlorous acid ($HClO$) when it comes in contact with the water (H_2O) that is in the pores of the paper.

How to Make a Good China Cement. To make a cement for mending broken chinaware, take ½ teaspoonful of *albumen*, that is, the white of an egg, and 1½ teaspoonfuls of calcium carbonate ($CaCO_3$) and mix them thoroughly together. To cement two or more pieces of chinaware together, clean the broken edges with hot water (H_2O) and let them dry; now coat the edges with the cement, press the pieces together, and then let them dry for 48 hours, and a very firm joint will be made.

How to Make an Adhesive Paste. Put 3 teaspoonfuls of powdered starch ($C_6H_{10}O_5$) in a test tube one-third full of water (H_2O) and stir to a smooth paste. Now add ⅓ teaspoonful of calcium chloride ($CaCl_2$) to a test tube one-third full of boiling water (H_2O). Next, pour this latter solution into the first test tube and then bring it to a boil, add a drop or two of oil of wintergreen, to keep it sweet, and pour it into a bottle.

How to Make Fire-Extinguishing Compounds. Among the chief fire-extinguishing compounds are water (H_2O), carbon dioxide (CO_2), and carbon tetrachloride (CCl_4). Now make the following experiment: Light a sheet of paper and place it on an old plate, then let some water (H_2O) trickle on it, and you will see that the blaze rapidly goes out. This is because water (H_2O) absorbs a considerable amount of the heat, keeps the temperature below the kindling point, and the steam (H_2O) that is formed prevents the air from supplying more oxygen (O) to it.

Now light another piece of paper and direct a jet of carbon dioxide (CO_2) on it, and the flame will be quickly extinguished. This is because the carbon dioxide (CO_2) will not support combustion and is heavier than the air; hence it soon forms a blanket over the fire, and as this prevents the oxygen (O) from feeding the flames, the latter cannot burn.

In the usual kind of *hand fire-extinguisher*, the can to which the nozzle is connected is filled with a weak solution of sodium carbonate (Na_2CO_3, H_2O), and in the top of the can there is a bottle filled with sulphuric acid (H_2SO_4); now, when you turn the tank upside down the acid runs into the sodium carbonate solution and this sets free the carbon dioxide (CO_2) that is in the latter. As the gas is generated in large quantities it develops a high pressure, and at the same time some of it is dissolved in the water (H_2O), so that both of them are forced out in a stream and put out the fire, as explained above.

Light a sheet of paper and then let a little stream of carbon tetrachloride (CCl_4) play on it, which you can do with