

and impurities. There is carburetted hydrogen, which Dr. Dunglison in his *Physiology*, characterizes, "as very depressing to the vital functions. Even while largely diluted with atmospheric air, it occasions vertigo, sickness, diminution of the force and velocity of the pulse, reduction of muscular vigor and every symptom of diminished power." There is also sulphuretted hydrogen, which the same author says, in its pure state, kills instantly, and in its diluted state, produces powerful sedative effects on the pulse, muscles, and whole nervous system. There are also offensive and destructive impurities arising from the decomposition of animal and vegetable matter in contact with the stove, or dissolved in the evaporating dish.

Two objects to be attended to.—The objects to be attained are—the removal of such impurities, as have been referred to, and which are constantly generated, wherever there is animal life and burning fires, and the due supply of that vital principle, which is constantly consumed by breathing and combustion. The first can be in no other way effectually secured, but by making provision for its escape into the open air, both at the top and the bottom of the room; and the second, but by introducing a current of pure air from the outside of the building, warmed in winter by a furnace, or in some other mode, before entering the room. The two processes should go on together—i. e. the escape of the vitiated air from within, and the introduction of the pure air from without. The common fireplace and chimney secures the first object very effectually, for there is always a strong current of air near the floor, towards the fire, to support combustion, and supply the partial vacuum in the chimney occasioned by the ascending column of smoke and rarified air, and in this current the carbonic acid and other impurities will be drawn into the fire and up the chimney. But there is such an enormous waste of heat in these fireplaces, and such a constant influx of cold air through every crevice in the imperfect fittings of the doors and windows, to supply the current always ascending in the chimney, that this mode of ventilation should not be relied on. The common mode of ventilating, by opening a window or door, although better than none, is also imperfect and objectionable; as the cold air falls directly on the head, neck, and other exposed parts of the body, when every pore is open, and thus causes discomfort, catarrh, and other more serious evils, to those sitting near, besides reducing the temperature of the whole room too suddenly and too low. This mode, however, should be resorted to at recess.

Openings for Ventilation.—There should be one or more openings, expressly for ventilation, both at the top and the bottom of the room, of not less than twelve inches square, capable of being wholly or partially closed by a slide of wood or metal, and, if possible, these openings, or the receptacle into which they discharge, should be connected with the chimney or smoke-flue, in which there is always a column of heated air. By an opening in or near the ceiling, the warmer impurities (and air when heated, and especially when over-heated, will retain noxious gases longer) will pass off. By an opening near the floor, into the smoke-flue, the colder impurities (and carbonic acid, and the other noxious gases, which at first rise, soon diffuse themselves through the atmosphere, cool, and subside towards the floor) will be drawn in to supply the current of heated air and smoke ascending the chimney. These openings, however, may let cold air in, and will not always secure the proper ventilation of a school-room, unless there is a current of pure warm air flowing in at the same time. Whenever there is such a current there will be a greater economy, as well as a more rapid and uniform diffusion of the heat, by inserting the outlet for the vitiated air near the floor, and at the greatest distance from the inlet of warm air.

There is a mischievous error prevailing, that if a room is kept at a low temperature there is no need of ventilation. Dr. Alcott mentions the case of a teacher, who when asked if she did not find it difficult to keep her room ventilated, replied, "not at all, it is one of the coldest rooms in the city." The necessity of ventilation arises from the consumption of the oxygen and the generation and accumulation of carbonic acid principally in breathing, and both of these processes can go on and do go on, in a cold room, as well as in a warm one, if human beings are collected in it, and goes on rapidly and fatally according to the number of persons and the size and closeness of the apartment.

6. TEMPERATURE.

The means of producing, diffusing and duly regulating artificial heat in a school-room, is, in a climate like ours, another of the indispensable conditions of health, comfort and successful labor. To effect this, the structure must not be "a summer-house for winter residence," but be calculated to keep out the cold wind and especially to prevent its entering at cracks, and defects in the doors, windows, floors, plastering, so as to fall suddenly and directly on the feet, neck, or other sensitive and exposed portions of the body. Fuel of the right kind, in the right condition, in suitable quantity and in due season must be provided. The best modes of consuming it so as to extract its heat and diffuse it equally through all parts of the room and retain it as long as is safe, must be resorted to. The means of regulating it, so as to keep up a uniform temperature in different parts of the room, and to graduate it to the varying circumstances of a school at different periods of the day, and in different states of the weather, must not be overlooked.

Methods of warming School-houses.—The open stove with large pipe, not bending till the horizontal part is carried ten or twelve feet above the heads of the children, affords as effectual, economical and unobjectionable a mode of consuming the fuel and disseminating the heat as any stove of this kind. It is far superior in point of economy to the open fireplace, as ordinarily constructed, in which near seven-eighths of the heat evolved ascends the chimney and only one-eighth, or according to Rumford and Franklin, only one-fifteenth is radiated from the front of the fire into the room. It has to some extent the cheerful light of the open fire, to which habit and association have attached us, and the advantages of the latter, in opening broadly near the floor, and thus drawing in the colder air with the carbonic acid in the current which goes to sustain the combustion and ascend the large pipe of the stove.

Various plans have been proposed and adopted, to make the common stove, whether close or open, serviceable in warming pure air before it is thrown into the room. Mr. Woodbridge in his essay on school-houses, describes one as follows:—the stove is inclosed on three sides in a case of sheet iron, leaving a space of two or three inches beneath and around the stove, and as it rises around it becomes warmed before it enters the room at the top of the case. The case is movable so as to allow of the cleaning out of any dust which might collect between it and the stove. Mr. Palmer in his *Manual for Teachers*, secures the same object by conducting the air from without, into a passage which traverses the bottom of the stove five or six times before it enters the room, and thus becomes warm.

In Millar's *patent ventilating school-house stove* the air is conducted from without, into a chamber below the fire-plate, and after circulating through pipes around the fire, escapes into the room.

The best mode, however, at the same time of warming and ventilating a school-room, especially if it is large, is by pure air heated in a stove or furnace placed in the cellar or a room lower than the one to be warmed. No portion of the room, or the movements of the scholars, or the supervision of the teacher, are encumbered or interrupted by stove or pipe. The fire in such places can be maintained without noise and without throwing dust or smoke into the room. The offensive odors and impurities of burnt air, or rather of particles of vegetable or animal matter floating in the air, are not experienced. The heat can be conducted into the room at different points, and is thus diffused so as to secure a uniform summer temperature in every part of it. A room thus heated, even without any special arrangements for this object, will be tolerably well ventilated, for the constant influx of warm pure air into the room will force that which is already in it out at every crack and crevice, and thus reverse the process which is ordinarily going on in every school-room. By an opening or rather several small openings into the ceiling, or a flue, which in either case should connect with the outer air, the escape of the impure air will be more effectually secured.

Importance of uniform Temperature.—But whatever may be the mode of warming adopted, whether by open fireplace, or grate, stove wood or coal, or furnace, the temperature of the room should be uniform, and of the proper degree in every part. Not a child should be exposed to sudden and extreme changes of temperature, or compelled when overheated, or at any time, to sit against an