

Science Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

CLE: 5.1. Earth's Systems (geosphere, atmosphere, and hydrosphere) have common component and unique structures.

Health Profession: Dentist

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References:

http://en.wikipedia.org/wiki/Ozone_layer

http://www.geography4kids.com/files/cycles_nitrogen.html

<http://gcmd.nasa.gov/Resources/FAQs/N2O.html>

http://en.wikipedia.org/wiki/Nitrous_oxide

<http://www.bls.gov/oco/ocos072.htm#nature>

<http://dentistry.umkc.edu/>

Objectives:

At the completion of this presentation the high school student will be able to:

1. State why Nitrogen and Ozone are important to the atmosphere.
2. State the chemical composition of Nitrous oxide and Ozone and the chemical change that occurs when they interact
3. State the top three causes of ozone depletion.
4. Show how Nitrous oxide breaks down the ozone layer with a model
5. Discuss the regulation of nitrous oxide.

Background Summary of Information as Related to Dentist and CLE

As a healthcare professional you need to have an understanding how your practice impacts your patients and the environment. A practicing Dentist may choose to use nitrous oxide in their office and should know the impact that this choice will have. In order to cut down on ozone depletion the dentist could find an alternative to nitrous oxide or use it for only on a very limited case-to-case basis.

THE OZONE LAYER

The ozone layer is a layer in [Earth's atmosphere](#) which contains relatively high concentrations of [ozone](#) (O₃). This layer absorbs 97-99% of the [sun's](#) high frequency [ultraviolet light](#), which is potentially damaging to life on Earth.^[1] Over 90% of ozone in earth's atmosphere is present here.^[1] "Relatively high" means a few parts per million—much higher than the concentrations in the lower atmosphere but still small compared to the main components of the atmosphere. It is mainly located in the lower portion of the [stratosphere](#) from approximately [15 km to 35 km](#) above Earth's surface, though the thickness varies seasonally and geographically.^[2] The ozone layer was discovered in [1913](#) by the French physicists [Charles Fabry](#) and [Henri Buisson](#).

Its properties were explored in detail by the British meteorologist [G. M. B. Dobson](#), who developed a simple [spectrophotometer](#) that could be used to measure stratospheric ozone from the ground. Between [1928](#) and [1958](#) Dobson established a worldwide network of ozone monitoring stations which continues to operate today. The "[Dobson unit](#)", a convenient measure of the total amount of ozone is named in his honor.

http://en.wikipedia.org/wiki/Ozone_layer

HOW THE OZONE REGENERATES

The photochemical mechanisms that give rise to the ozone layer were worked out by the British physicist [Sidney Chapman](#) in [1930](#). Ozone in the earth's stratosphere is created by [ultraviolet light](#) striking [oxygen molecules](#) containing two oxygen [atoms](#) (O_2), splitting them into individual oxygen atoms (atomic oxygen); the atomic oxygen then combines with unbroken O_2 to create ozone, O_3 . The ozone molecule is also unstable (although, in the stratosphere, long-lived) and when ultraviolet light hits ozone it splits into a molecule of O_2 and an atom of atomic oxygen, a continuing process called the [ozone-oxygen cycle](#), thus creating an ozone layer in the [stratosphere](#), the region from about 10 to 50 km (32,000 to 164,000 feet) above Earth's surface. About 90% of the ozone in our atmosphere is contained in the stratosphere. Ozone concentrations are greatest between about 15 and 40 km, where they range from about 2 to 8 parts per million. If all of the ozone were compressed to the pressure of the air at sea level, it would be only a few [millimeters](#) thick.

Ten percent of the ozone in the atmosphere is contained in the [troposphere](#), the lowest part of our atmosphere where all of our weather takes place. [Tropospheric ozone](#) has two sources: about 10 % is transported down from the [stratosphere](#) while the remainder is created in smaller amounts through different mechanisms

http://en.wikipedia.org/wiki/Ozone_layer

THE NITROGEN CYCLE

Nitrogen (N) is an element like carbon. All creatures need nitrogen to survive. There are huge amounts of nitrogen gas in the atmosphere, but most animals and plants have no way of using it. It needs to be fixed (put into a biologically useful compound). After it is fixed, it can then start to move through the cycles and organisms in an ecosystem.

WHERE CAN YOU FIND NITROGEN?

Let's start with the main sources of nitrogen. Nitrogen gas is the most abundant element in our atmosphere. The other main source of nitrogen is in the nitrates of soil. The nitrogen in the atmosphere cannot be used while the nitrates in the soil can be used by plants. Nitrogen can be converted into useful nitrate compounds by bacteria, algae, and even lightning. Once in the soil, the nitrogen becomes biologically accessible.

http://www.geography4kids.com/files/cycles_nitrogen.html

NITROUS OXIDE

The chemical formula for nitrous oxide is N_2O . Actually, the elements that make up N_2O , nitrogen and oxygen, are the two most abundant elements in the earth's atmosphere. Nearly 99 percent of the earth's atmosphere is nitrogen and oxygen. In the atmosphere, both oxygen and nitrogen exist in their natural and most stable elemental states; in other words, atmospheric oxygen exists as a molecule of two oxygen atoms bonded together, O_2 , and atmospheric nitrogen exists as a molecule of two nitrogen atoms bonded together, N_2 . O_2 and N_2 are very stable molecules and don't usually break up to form a compound like N_2O . In fact, the N_2O that dentist use as laughing gas is made by a completely different chemical reaction. So, naturally, there is very little N_2O in the atmosphere (about 0.000003 percent), but due mostly to human activity, it is actually increasing by about 0.3 percent every year. Even so, there is not enough N_2O in the atmosphere to make us giggly. (Laughing gas is actually 50 percent O_2 and 50 percent N_2O ; a very concentrated mixture compared to the air we breathe everyday.)

So, if there isn't enough N_2O in the atmosphere to make us funny, why is it considered a problem? N_2O is extremely efficient at warming up the atmosphere. In fact, one molecule of N_2O has 200 to 300 times the greenhouse warming effect of CO_2 , the primary greenhouse gas. So, it only takes a little N_2O to cause greenhouse warming, but it takes a whole lot to make us funny.

<http://gcmd.nasa.gov/Resources/FAQs/N2O.html>

Despite its relatively small concentration in the atmosphere, nitrous oxide is the third largest greenhouse gas contributor to overall global warming, behind [carbon dioxide](#) and [methane](#). (The other nitrogen oxides contribute to global warming indirectly, by contributing to tropospheric ozone production during smog formation).

http://en.wikipedia.org/wiki/Nitrous_oxide

Medical use of nitrous oxide

Previously, nitrous oxide was typically administered by dentists through a demand-valve inhaler over the nose that only releases gas when the patient inhales through the nose; full-face masks are not commonly used by dentists, so that the patient's mouth can be worked on while the patient continues to inhale the gas. Current use involves constant supply flowmeters which allow the proportion of nitrous oxide and the combined gas flow rate to be individually adjusted. The masks still obviously cover only the nose.

Because nitrous oxide is minimally metabolized, it retains its potency when exhaled into the room by the patient and can pose an intoxicating and prolonged-exposure hazard to the clinic staff if the room is poorly ventilated. Where nitrous oxide is administered, a continuous-flow fresh-air ventilation system or nitrous-scavenging system is used to prevent waste gas buildup.

Nitrous oxide is a weak general anesthetic, and so is generally not used alone in general anesthesia. In general anesthesia it is used as a carrier gas in a 2:1 ratio with oxygen for more powerful general anesthetic agents such as [sevoflurane](#) or [desflurane](#). It has a MAC ([minimum alveolar concentration](#)) of 105% and a blood gas partition coefficient of 0.46. Less than 0.004% is metabolized in humans.

http://en.wikipedia.org/wiki/Nitrous_oxide

DENTIST

Nature of work

Dentists diagnose and treat problems with teeth and tissues in the mouth, along with giving advice and administering care to help prevent future problems. They provide instruction on diet, brushing, flossing, the use of fluorides, and other aspects of dental care. They remove tooth decay, fill cavities, examine x rays, place protective plastic sealants on children's teeth, straighten teeth, and repair fractured teeth. They also perform corrective surgery on gums and supporting bones to treat gum diseases. Dentists extract teeth and make models and measurements for dentures to replace missing teeth. They also administer anesthetics and write prescriptions for antibiotics and other medications.

Dentists use a variety of equipment, including x-ray machines, drills, mouth mirrors, probes, forceps, brushes, and scalpels. They wear masks, gloves, and safety glasses to protect themselves and their patients from infectious diseases.

Dentists in private practice oversee a variety of administrative tasks, including bookkeeping and the buying of equipment and supplies. They may employ and supervise dental hygienists, dental assistants, dental laboratory technicians, and receptionists. (These occupations are described elsewhere in the *Handbook*.)

Most dentists are general practitioners, handling a variety of dental needs. Other dentists practice in any of nine specialty areas. *Orthodontists*, the largest group of

specialists, straighten teeth by applying pressure to the teeth with braces or retainers. The next largest group, *oral and maxillofacial surgeons*, operates on the mouth and jaws. The remainder may specialize as *pediatric dentists* (focusing on dentistry for children); *periodontists* (treating gums and bone supporting the teeth); *prosthodontists* (replacing missing teeth with permanent fixtures, such as crowns and bridges, or with removable fixtures such as dentures); *endodontists* (performing root canal therapy); *public health dentists* (promoting good dental health and preventing dental diseases within the community); *oral pathologists* (studying oral diseases); or *oral and maxillofacial radiologists* (diagnosing diseases in the head and neck through the use of imaging technologies).

Education and training

In 2006, there were 56 dental schools accredited by the American Dental Association's (ADA's) Commission on Dental Accreditation. Dental schools require a minimum of 2 years of college-level pre dental education prior to admittance. Most dental students have at least a bachelor's degree before entering dental school, although a few applicants are accepted to dental school after 2 or 3 years of college and complete their bachelor's degree while attending dental school.

High school and college students who want to become dentists should take courses in biology, chemistry, physics, health, and mathematics. College undergraduates planning on applying to dental school are required to take many science courses. Because of this, some choose a major in a science, such as biology or chemistry, while others take the required science coursework while pursuing a major in another subject.

All dental schools require applicants to take the Dental Admissions Test (DAT). When selecting students, schools consider scores earned on the DAT, applicants' grade point averages, and information gathered through recommendations and interviews. Competition for admission to dental school is keen.

Dental school usually lasts 4 academic years. Studies begin with classroom instruction and laboratory work in science, including anatomy, microbiology, biochemistry, and physiology. Beginning courses in clinical sciences, including laboratory techniques, are also completed. During the last 2 years, students treat patients, usually in dental clinics, under the supervision of licensed dentists. Most dental schools award the degree of Doctor of Dental Surgery (DDS). Others award an equivalent degree, Doctor of Dental Medicine (DMD).

Some dental school graduates work for established dentists as associates for 1 to 2 years to gain experience and save money to equip an office of their own. Most dental school graduates, however, purchase an established practice or open a new one immediately after graduation.

Licensure. Licensing is required to practice as a dentist. In most States, licensure requires passing written and practical examinations in addition to having a degree from an accredited dental school. Candidates may fulfill the written part of the State

licensing requirements by passing the National Board Dental Examinations. Individual States or regional testing agencies administer the written or practical examinations.

In 2006, 17 States licensed or certified dentists who intended to practice in a specialty area. Requirements include 2 to 4 years of postgraduate education and, in some cases, the completion of a special State examination. Most State licenses permit dentists to engage in both general and specialized practice.

Salary

Median annual earnings of salaried dentists were \$136,960 in May 2006. Earnings vary according to number of years in practice, location, hours worked, and specialty. Self-employed dentists in private practice tend to earn more than do salaried dentists.

Dentists who are salaried often receive benefits paid by their employer, with health insurance and malpractice insurance being among the most common. However, like other business owners, self-employed dentists must provide their own health insurance, life insurance, retirement plans, and other benefits.

<http://www.bls.gov/oco/ocos072.htm#nature>

A dental school that is close is UMKC School of Dentistry in Kansas City, MO

<http://dentistry.umkc.edu/>

Scenario

Billy is a 15 year old that goes to the dentist to get his 6 month cleaning. While he is getting his teeth cleaned the dentist notices a tooth that is soft in the groove and slightly gray in color. She explains to Billy that he has a cavity and will need to have a filling to prevent the tooth from further root and decay. Billy explains to the dentist that he is very fearful of needles and the drill that she will need to use to fix the cavity. The dentist asks if he has ever used nitrous oxide at the dentist before. He states that he has heard of it but not ever received it and not sure how it works. The Dr. Smith explains that first she will place a device over his nose and then when he breaths in through his nose he will receive the nitrous oxide. This is a gas and will act very quickly. Then he will feel less pain, dizzy, not like yourself (depersonalized), like you are having a "out of body" experience, happy(euphoria), and possible hallucinations.

Dr. Smith knows that this is a case that if she did not use nitrous oxide that this patient may not return and continue to get preventative care like cleanings every six months, and she will not be able to find cavities before they start to hurt. So when the patient does seek treatment the cavity is bigger and involves more of the tooth.

She is working in a room that has continuous-flow fresh-air ventilation system to prevent waste gas buildup. She starts the procedure and Billy tolerates the gas and filling very well. He is happy that he informed Dr. Smith about his fears and was able

to receive the nitrous oxide. After he is done he returns home to rest and let the effects of the gas wear off.

Activities

At this time a simple activity would be to have different color balls to represent the different atoms (Nitrogen/green and Oxygen/blue). Then show how Nitrous Oxide will change ozone into oxygen.

OR

Take balloons and place the balls in the balloons. Then inflate the balloons with helium. Collect an even number of balloons filled with nitrous oxide models as ozone. Arrange the balloons filled with ozone models in a canopy by arranging them so all the strings are the same length. Then one-by-one have the students come up with their balloons filled with the nitrous oxide models and pop the balloon with ozone and arrange the balls to two oxygen models and one free standing nitrogen.