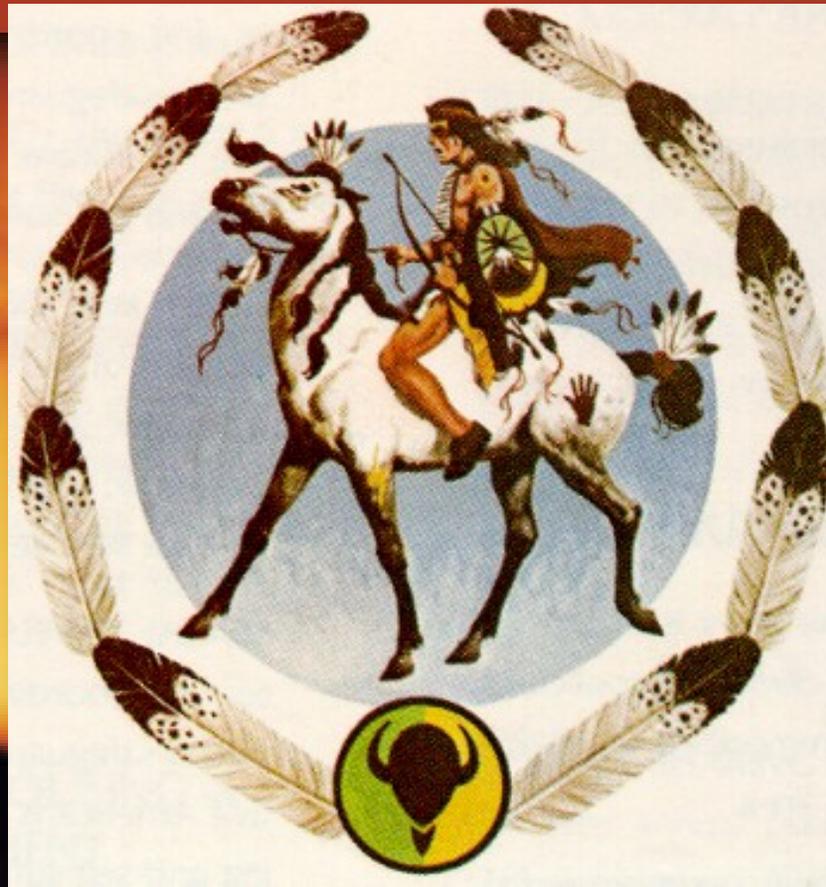


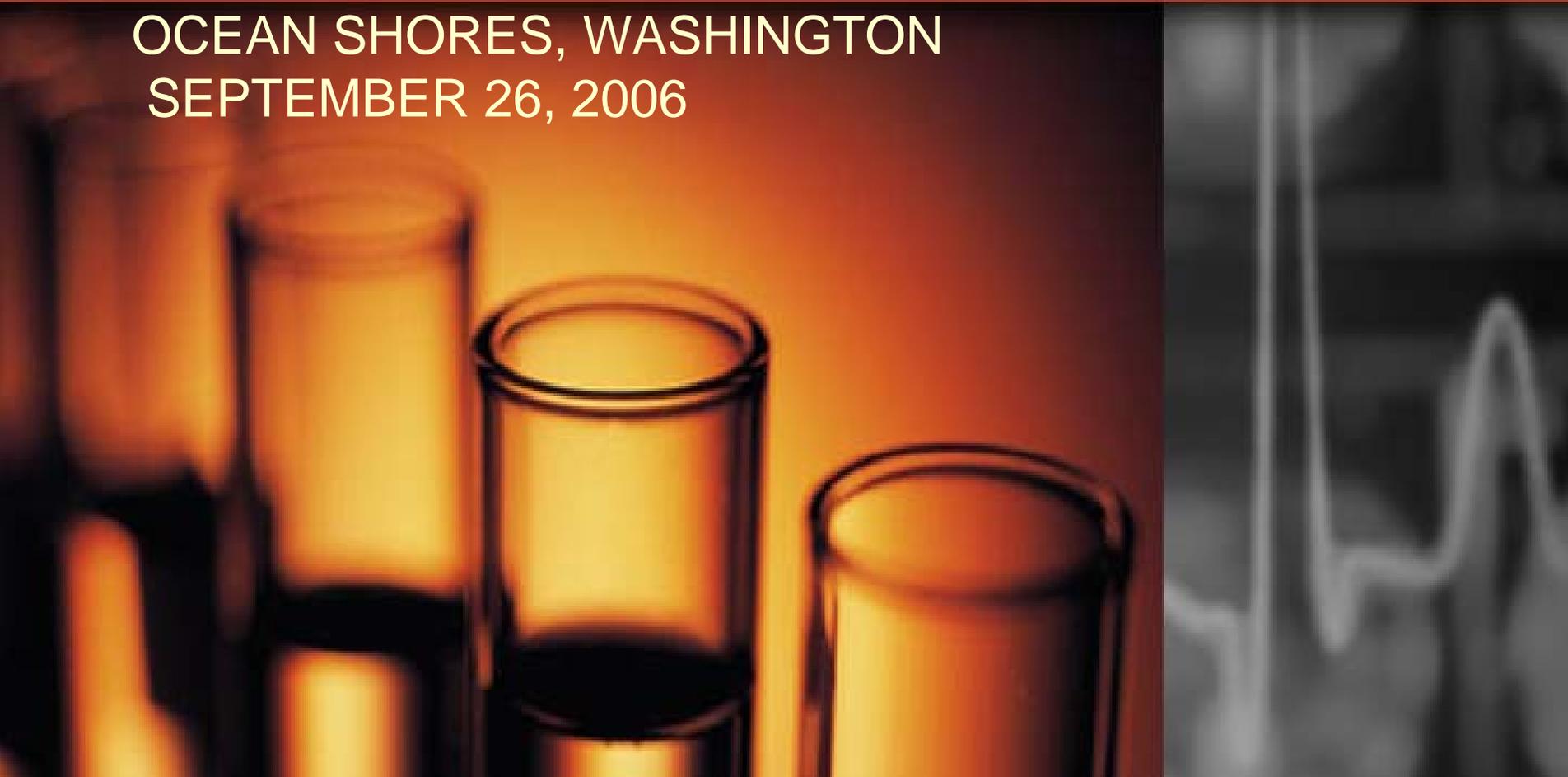
Kiowa Tribe Environmental Program

Carnegie, Oklahoma



EPA NATIONAL TRIBAL SCIENCE COUNCIL CONFERENCE

OCEAN SHORES, WASHINGTON
SEPTEMBER 26, 2006



EPA REGION VI



EPA REGION VI Dallas, Texas
Curtis Munoz
Kiowa Tribe Environmental Director
EPA National Tribal Science Council Region VI
Representative

PRESENTATION

Mold/Mycotoxins: Indoor Air Health Crisis in Indian Country



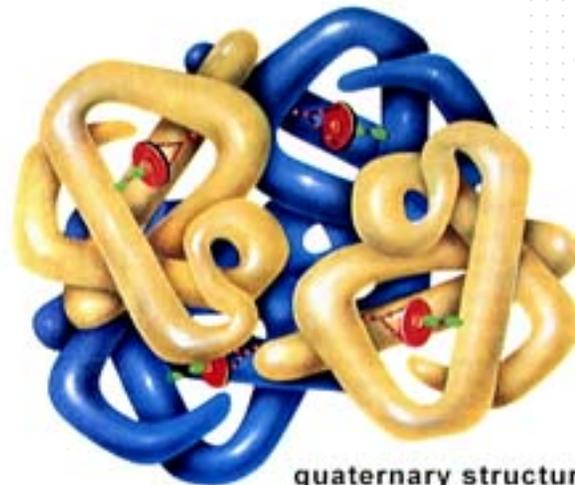
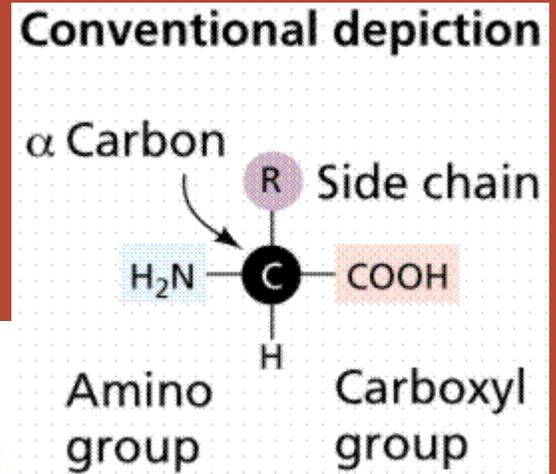
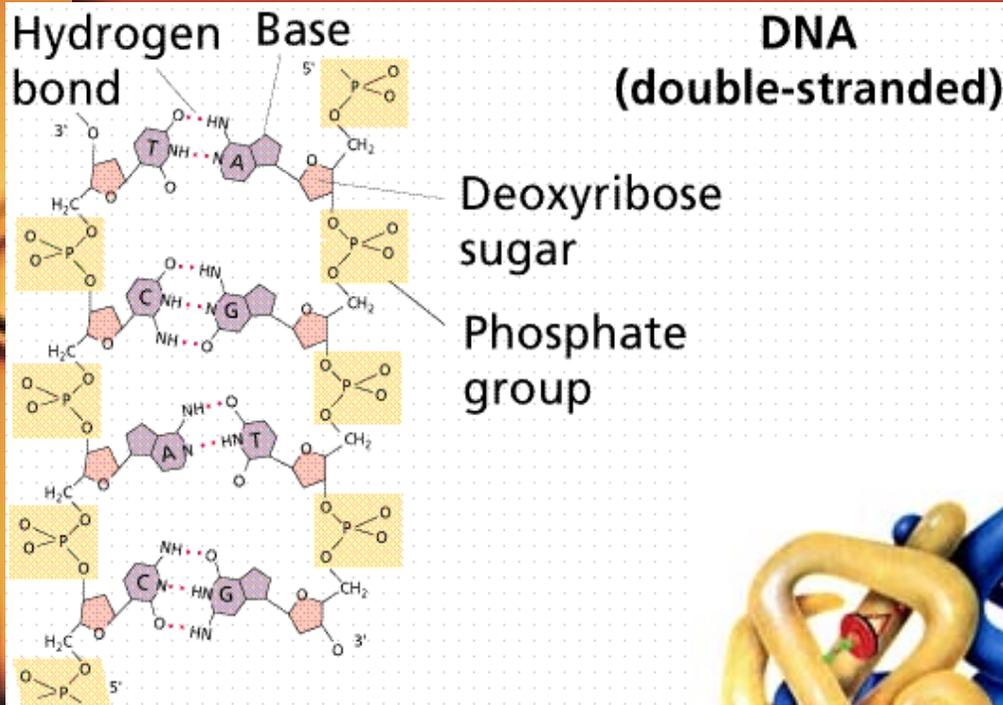
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Tribal Science Council Window Rock



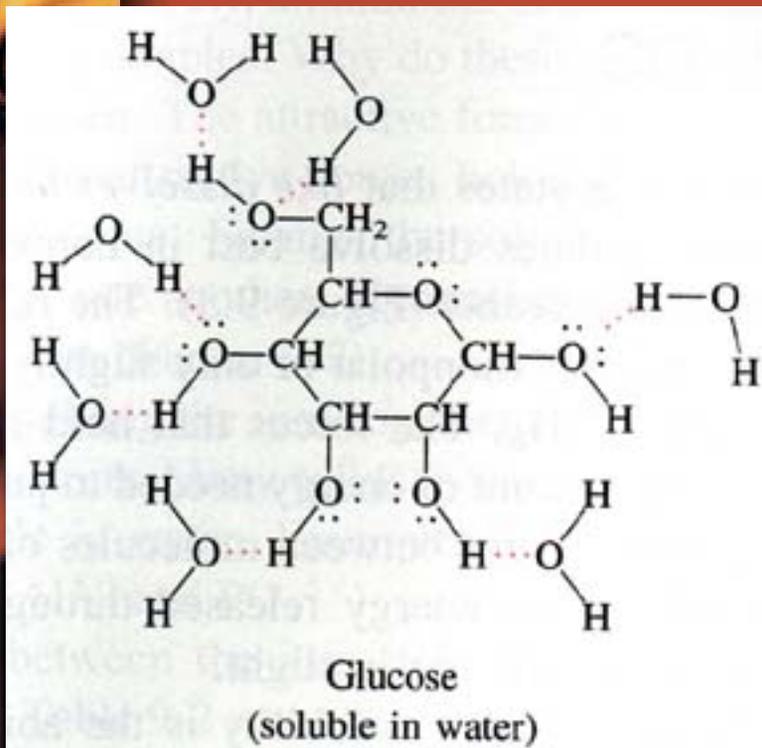
Educating Tribal Environmental Programs on science issues



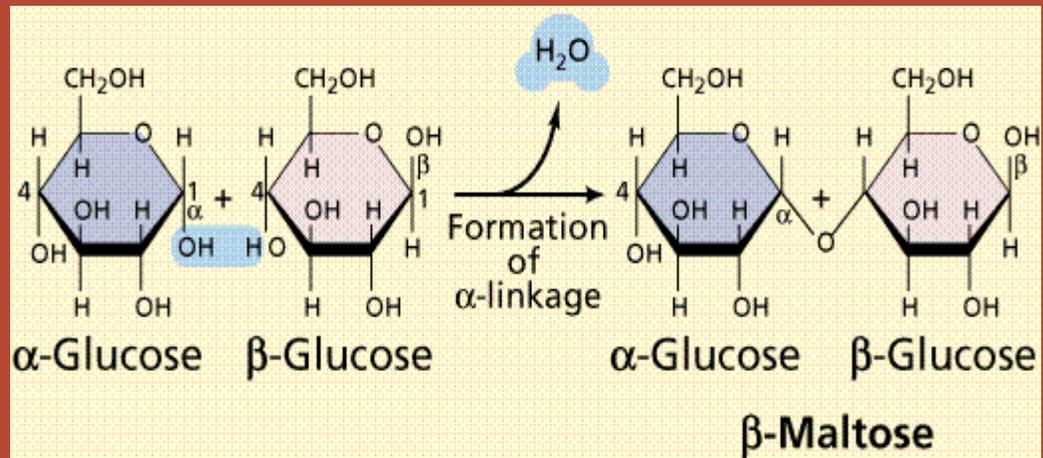
quaternary structure
(aggregation of two or more peptides)

Tribal Science Council: Science Education

Water bonding with glucose



Glycosidic bonds



TSC Science Priorities

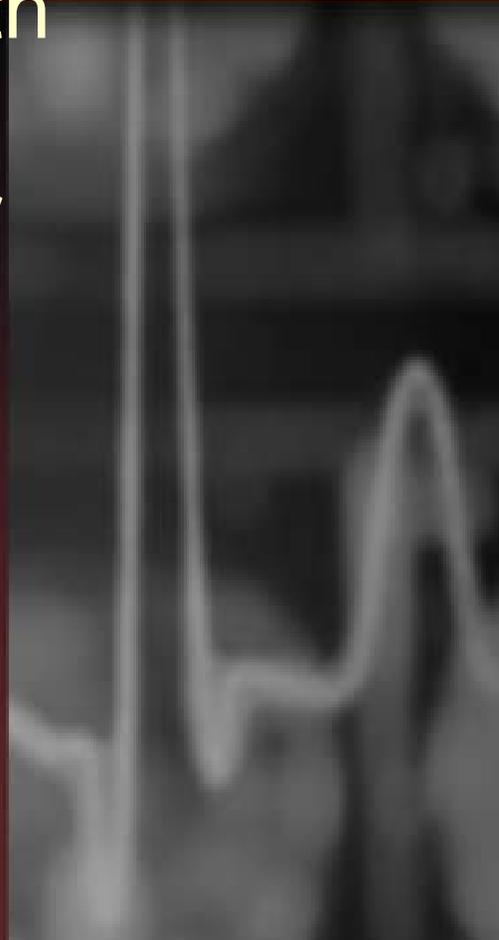
- There are 9 science priorities that the TSC is focusing on for Indian Country.
- These priorities are what the TSC sees as common environmental science issues that are common to all tribes across the nation.
- These issues are addressed with goals from identification to remediation of the problems which effect the environment and human health.

Science Priorities

- Endocrine disrupting chemicals
- Dioxin and dioxin-like compounds
- Persistent bio-accumulative toxics source reduction
- Pharmaceuticals in wastewater
- Habitat loss
- Environmental triggers for respiratory distress
- Contaminated precipitation
- Biological stressors
- Mold

New Direction

While a lot is known in the area of outdoor air quality in the EPA, with the Tribal Programs emphasizing monitoring and gathering outdoor air data; little is known about indoor air quality. Even less is known on the mold issue, especially in Indian Country.



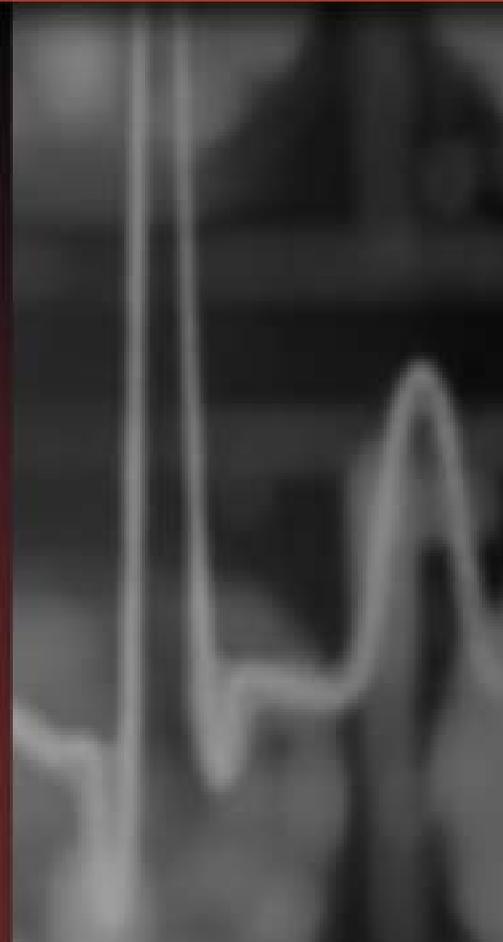
Why the Interest in Mold?

In traveling around the nation to different Indian tribes and Nations, I kept seeing the problem of mold in Indian housing.

Many told of how they would get sick while at home, but felt good when away.

The same physical ailments were appearing, regardless the diet of the people.

Could mold really be causing these people to get sick?



Could it be?

I began to look and find if there was a connection.

I knew mold and fungi were known in small circles to be causes of contaminants in certain foods due to their mycotoxins.

Could these molds/fungi and their mycotoxins be causing the air inside the homes to become contaminated?

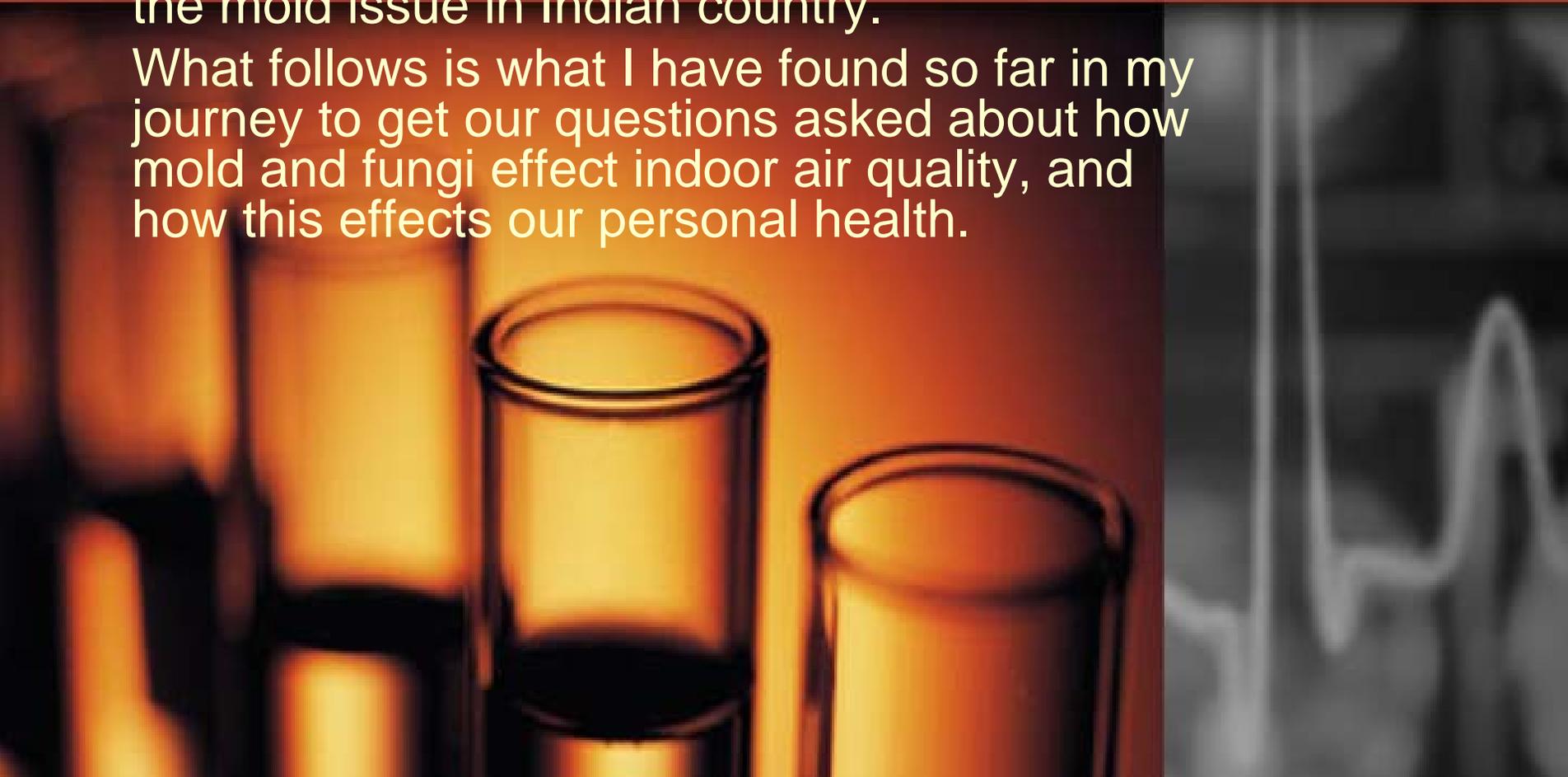
Is this contaminated indoor air quality affecting the health of the Indian people; causing the different sicknesses of those living in these indoor environments?



OPPORTUNITY ARISES

Being selected to the EPA National Tribal Science has given me the chance to look in the mold issue in Indian country.

What follows is what I have found so far in my journey to get our questions asked about how mold and fungi effect indoor air quality, and how this effects our personal health.



Pine Ridge Indian Reservation

- On the Pine Ridge Indian Reservation, mold has been found in 75% of the 1,700 tribal housing units.
- Health affects range from chronic sinusitis, severe headaches, fungal skin infections in children and elderly, upper and lower respiratory illness, and on the fringe: reports of elevated cancer cases, and diabetes worsening.

Pine Ridge Reservation

- This mold is causing many tribal members to become sick.
- The diabetes epidemic on the Pine Ridge Indian reservation alone is 800% higher than the US national average of diabetes in a population.



Martin, South Dakota

- These pictures are from a home in Martin, South Dakota infested with mold.



BLACKFOOT INDIAN RESERVATION

- A community of 153 house east of Browning, Montana were found with black mold.
- These houses were built on wooded foundations
- Mold was so bad in one house that one-foot mushrooms were found growing in the basement carpet.

Candace LaMott showing mold in Blackfoot housing



Blackfoot Indian Reservation

- LaMott says her mother, who lived in the house, took ill and died three years ago. She says her son suffers from severe headaches, and two grandchildren living in the home "have a hard time breathing."

Jamie LaPier complained of frequent headaches that sometimes last for days. Her husband, Gale, says he's also been getting "strange" headaches the past two years. They say their son, not quite four years old, gets unexplained nosebleeds up to 20 times a month. The woman who lived in their house before them died of cancer.

Others who reside in the wood-foundation homes, which are scattered across the reservation, report ailments ranging from constant sore throats, asthma and other respiratory distress, odd bumps and lumps, general fatigue, dizziness, and a host of other maladies ranging from kidney disease to cancer.

Turtle Mountain Indian Reservation, BELCOURT, N.D.

- 320 federally subsidized homes are infested with mold.
- Residents say the infestation is sickening, and tribal officials say at least seven deaths in recent years could be related to the infestation,
- 210 homes will had to be destroyed.

Most of the infested homes are small - about 600 square feet with two bedrooms. They are built of wood-frame construction, have dirt floors and sit on a concrete block foundation over crawl spaces.

Tribal officials are worried about the black mold, causing flulike and allergylike symptoms which include skin rashes, inflammation of the respiratory tract, bloody noses, fever, headaches, neurological problems and immunosuppression.

Navajo Nation Greasewood Springs, Arizona

- Even energy efficient homes are not off limits to mold.
- 25 homes had to be vacated and repaired due to mold infestation
- "Energy efficiency was a big push ... making the home the most energy efficient as possible," Jelina Petzinger said. But condensation forms if the house was "too tight", she said, and subsequently, mold growth.

"Any home that did not have a wood stove (has the problem)," Petzinger said. "The stove allows air to escape."



Kiowa Tribe of Oklahoma

- I can show many more examples across this country, but will share a personal experience.
- I was called to come see a home where mold infested the walls and bathroom.
- Within 10 minutes I had to go outside and get fresh air because my chest began to tighten up and I developed a massive headache.

Kiowa Tribe

- I had been infected with mold from concrete dust in late 1999, and I knew what mold could do from experience.
- This situation at this Kiowa tribal house brought back scary emotions



Is there a connection?

- Many tribal people see a clear connection between mold and sickness because we see through different scientific eyes.
- Western science, via the CDC, does not see a connection I am told, because they do not have enough “statistical power” to take a stance.
- Western science needs a number, Traditional science sees the spiritual connectivity of all things.
- But new information and research is coming forward in the new science of the mold/fungi:mycotoxin field.

Science of Mold/Fungi and their Mycotoxins

- Fungi, mold in this specific case, are in a completely different kingdom of organisms called Eumycota.
- They are eukaryotic having a well defined nucleus enclosed by a nuclear membrane, and the cells contain a cell membrane and the various cellular organelles making it similar to animal cells.
- Molds are found virtually everywhere in the environment (over 200,000 species of fungi have been catalogued by scientists, at least 200 of these have been identified as familiar pathogens).
- Molds break down organic waste, and because of this they are readily found in building materials ranging from wood, drywall, stucco, sheetrock, wall paper, ceiling tiles, showers, and the lists goes on.
- Whereas, much is known of viruses and bacteria, little is known of mold/fungi concerning indoor air quality. New research is coming forth showing a distinct link between mold and human health and disease. Mayo clinic discovered that fungi, and not bacteria, are the culprit behind chronic sinusitis.
- According to a recent Mayo Clinic study, one in seven Americans suffers from acute fungal sinusitis.

Mold Science

- There are 4 genera of toxigenic molds which are frequently found in exceeding levels more indoors than outdoors.
- Aspergillus
- Penicillium
- Stachybotrys
- Cladosporium
- The mycotoxins they release into the environment are the culprit causing sickness in mold infested housing across Indian country.

Mold/Fungi

- Are saprophytic: utilize nonliving organic materials as a nutrient source for metabolism and reproduction.
- Digestion: secrete enzymes to break down the nutrient source from complex compounds to smaller usable compounds.
- The digested nutrients are primary and secondary metabolites.
- Primary metabolites are carbohydrates such as cellulose and glucose, these are used for metabolism.
- Secondary metabolites are the mycotoxins: our culprit.

MYCOTOXINS

- These are toxins produced by molds to defend against enemies in nature which are bacteria, viruses, and other organisms such as dust mites. The well known mold *Aspergillus* produces the powerful carcinogens aflatoxin, it is the only mycotoxin regulated in America, and “is the most carcinogenic chemical known to science” , and ochratoxin.
- “Although aflatoxin is the most carcinogenic substance on the planet, ochratoxin beats it ten times over in terms of toxicity and damage inflicted on the human body” .
- Mycotoxins are relatively large and non-volatile molecules (do not readily release into the air themselves), so direct contact is mostly required. The mold overcome this due to the spores they produce and release into the air..
- Exposure to molds and the secondary metabolites they produce are an area of growing concern in Indian Country.

MYCOTOXINS

- Routes of entry into the human body
- The main route of exposure in indoor air quality issues is inhalation into the respiratory system
- Direct skin contact, mainly from handling contaminated materials
- Ingestion into the digestive tract

Mycotoxin: Aflatoxin

- Aflatoxin found in species of *Aspergillus*.
- Is the only mycotoxin regulated in America, and “is the most carcinogenic chemical known to science”
- A hepatotoxin
- FDA has set maximum allowable levels of total aflatoxin in food commodities at 20 ppb
- The MAL's for milk products is 0.5 ppb
- Their toxicity and carcinogenicity are believed to be related to inhibition of nucleic acid synthesis.
- If you have eaten 40 tablespoons of peanut butter, you have experienced in a one in a million risk of dying from aflatoxin poisoning or an induced cancer.

Sickness due to Aspergillus

- Aspergillosis is a large spectrum of diseases caused by members of the genus *Aspergillus*. The three principal entities are: allergic bronchopulmonary aspergillosis, pulmonary aspergilloma and invasive aspergillosis.
-
- **Aspergilloma**
- This is a very different disease also caused by the *Aspergillus* mold. The fungus grows within a cavity of the lung, which was previously damaged during an illness such as tuberculosis or Sarcoidosis. Any lung disease which causes cavities can leave a person open to developing an aspergilloma. The spores penetrate the cavity and germinate, forming a fungal ball within the cavity. The fungus secretes toxic and allergic products which may make the person feel ill.
- The person affected may have no symptoms (especially early on). Weight loss, chronic cough and feeling rundown are common symptoms later. Coughing of blood (hemoptysis) can occur in up to 50-80% of affected people. The diagnosis is made by X-rays, scans of lungs and blood tests.

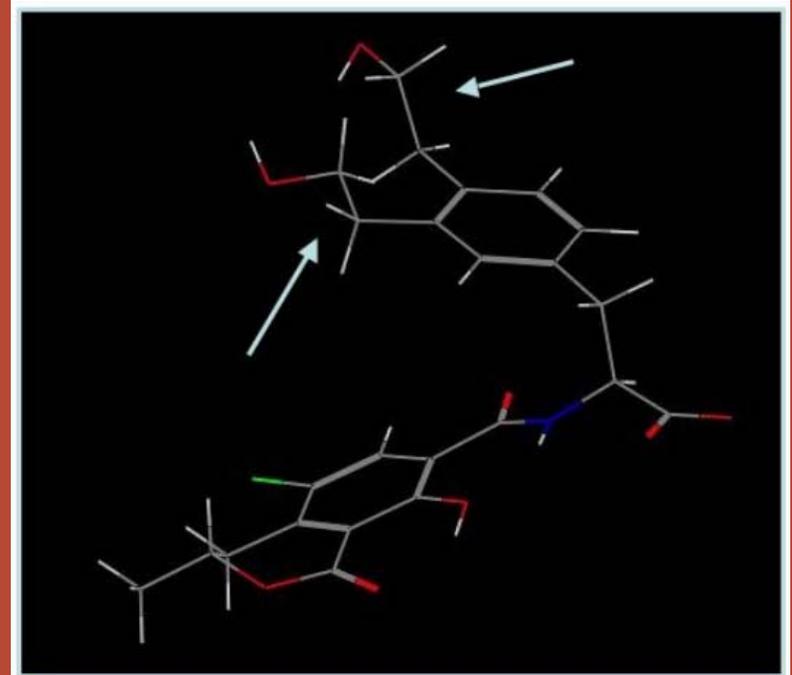
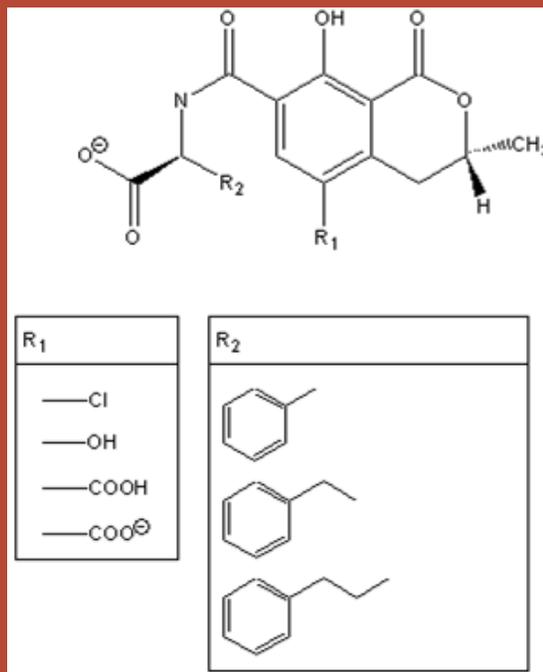


Mycotoxin: Citrinin

- Mycotoxin from *Aspergillus*, *Penicillium*
- Is a nephrotoxin: effects the kidneys
- Causes renal damage
- vasodilation, and bronchial constriction

Mycotoxin: Ochratoxin

- Penicillium and Aspergillus
- Damages kidneys and liver
- Known Carcinogen



More Mycotoxins

- Gliotoxin: immunosuppressive toxin
- Patulin: has caused hemorrhaging in the brain and lungs
- T-2 Toxin: a tricothecene produced by *Fusarium*. Damages digestive tract and causes rapid death due to internal hemorrhage. Linked to pulmonary hemosiderosis.
- Cyclosporin: Immunosuppressant, used medically in organ transplant patients.

Tricothecenes

- Tricothecenes: inhibit protein synthesis in a variety of eukaryotic cells,
- This family of mycotoxins causes multiorgan effects including emesis and diarrhea, weight loss, nervous disorders, cardiovascular alterations, immunodepression, hemostatic derangements, skin toxicity, decreased reproductive capacity, and bone marrow damage.^{4,6}

During the 1970s and 1980s, the tricothecene mycotoxins were shown to be biological warfare agents when they were implicated in “yellow rain” attacks in Southeast Asia.

Stachybotrys is one genus to produce this mycotoxin

Black Mold

Stachybotrys chartarum (Ehrenberg ex Link) Hughes (*S. atra* Corda) is a cellulolytic saprophyte with worldwide distribution.

Frequently isolated from paper, wallpaper and gypsum wallboard in buildings or residences that experienced water damage.

The fungus produces several mycotoxins (highly toxic macrocyclic trichothecenes and related trichoverroids) as well as immunosuppressants and endothelin receptor antagonists (Jarvis and Hinkley, 1999). Its harmful effects on animals and human beings have been studied since the 1930s (Haugland and Heckman, 1998; Kendrick, 2000). It was demonstrated to be associated with sick building syndrome in wet buildings (Dearborn et al., 1999; Johanning et al., 1999)

C.S. Yang, *Indoor Air* 2005; 15 (Suppl 9) : 5-13

Black Mold

It has increasingly attracted public attention to its effect on human health following reports of its association with idiopathic pulmonary hemorrhage in infants from Cleveland, OH, USA (Dearborn et al., 1999).

Subsequently, *S. chartarum* was reportedly isolated for the first time from the lung of a child diagnosed with pulmonary hemosiderosis in Houston, TX, USA (Elidemir et al., 1999).

Another case of infant pulmonary hemorrhage associated with the presence of *S. atra* (*S. chartarum*) was reported in Kansas City, MO, and mycotoxin analysis demonstrated that the isolate was highly toxigenic (Flappan et al., 1999).

Vesper and Vesper (2002) studied and hypothesized that stachylysin, a hemolysin, produced by *S. chartarum* could be a contributing factor to infant pulmonary hemorrhage and hemosiderosis.

Mycotoxic effects

- The science and studies on mycotoxins is still in it's infancy
- Most of what is known is on exposure to single mycotoxins in a laboratory setting.
- In real life situations, there is multiple exposure to mixed mycotoxins.
- This increases the health risk.
- If mycotoxins are not bad as some still say, how come OSHA pushes wearing special NIOSH respiratory masks for workers cleaning mold infested buildings?

Mycotoxic Effects

- What is known: The presence of competitive organisms may play a role, as some molds grown in monoculture in the laboratory lose their toxic potency (Jarvis, 1995).
- Humans are not the primary targets of molds, are caught in a crossfire of biochemical warfare between mold species and their enemies in nature each fighting for similar ecological niches
- Human health is effected when exposed to this mycotoxic war in indoor air.
- The effects of multiple exposure to a mixture of these mycotoxins, combined with synergistic effects of these biochemicals is now being 'seen' in Indian country due to the indoor air quality crisis.

Direct and Indirect Effects

- Direct effects would include exposure to the mycotoxin through inhalation, skin contact, or ingestion.
- When sufficient levels of a mycotoxin or mycotoxins make one sick, we see the headaches, respiratory ailments, kidney problems, elevated glucose levels, nose bleeds, skin infections, digestive problems, tumors, and the list seems to grow with time.

Indirect Effect

- First being caught in the middle of the biological warfare between mold and their enemies in nature.
- Certain species will eat urea-formaldehyde insulation for dinner. When the fungi digest the urea portion to get its nitrogen source, the formaldehyde portion is left for you to breathe in the indoors. In this case the mold indirectly affects you by releasing concentrations of formaldehyde in the indoor air.

A Scenario in Indian Country

- Worsening the effects would be when a tribal member goes to the doctor for chronic sinusitis. Is prescribed an antibiotic for a condition caused by a mold/fungi. The antibiotic kills the good and bad bacteria, giving mold more opportunity to cause damage to their body because there are no good bacteria to keep the mold numbers in check.
- The digestive problems start, the immunosuppressive effects of the mold kick in and proliferate. This opens the door for opportunistic infection, and the situation makes the persons health decline even more. The weakened immune system no longer fights off infection, and internally within the genes and with carcinogenic effects of other mycotoxins, add in synergistic biochemical effects and you have a health crisis when the tumors appear.

Mycotoxin Overview

- We see that mycotoxins are cytotoxic, effecting protein synthesis, DNA, RNA synthesis, hepatotoxic, nephrotoxic, immunosuppressive, carcinogenic, mutagenic, teratogenic, neurotoxic, and is a new field of study.

The health effects are controversial at the present moment, but time will prove that a thorough study in indoor air quality focusing on mold and their mycotoxins will benefit all people.

CDC's Statement

During the past few years, there has been increased concern related to exposure to specific molds that produce substances called mycotoxins. Health effects related to mycotoxins are generally related to ingestion of (eating) large quantities of fungal-contaminated material. There is currently no conclusive evidence of a link between indoor exposure to airborne mycotoxin and human illness. It is important to note that many molds can potentially produce toxins, given the right conditions. Some molds that produce mycotoxins are commonly found in moisture-damaged buildings; research related to the importance of these findings is ongoing. Although the potential for health problems is an important reason to prevent or minimize indoor mold growth and to remediate any indoor mold contamination, currently there is inadequate evidence to support recommendations for greater urgency of remediation in cases where mycotoxin-producing fungi have been isolated.

(Prevention Strategies and Possible Health Effects in the Aftermath of Hurricanes Katrina and Rita, CDC, October 2005)

CONCLUSION

The fact that mold in Indian housing is a very big problem is no surprise, but the health of the Indian people being effected by the mold/fungi and their mycotoxins is to many outside Indian country.

The environmental impact of these organisms and their metabolites, how they affect indoor air quality, and human health is the primary concern of the EPA National Tribal Science Council. An organized effort needs to be launched in Indian Country to look into this issue which affects tribes across the United States.

Science Priorities: Mold

- Efforts to Address this Issue:
- The EPA's Office of Indoor Air and Radiation has developed a web site dedicated to the mold issue and has also produced two documents dealing with mold. The web site is located at <http://www.epa.gov/mold/moldresources.html>. The two documents are also located there and are (1) "**A Brief Guide to Mold, Moisture, and Your Home**" and (2) "**Mold Remediation in Schools and Commercial Buildings**". Both documents can be down loaded using the PDF format. The web site also lists other resources that are available.

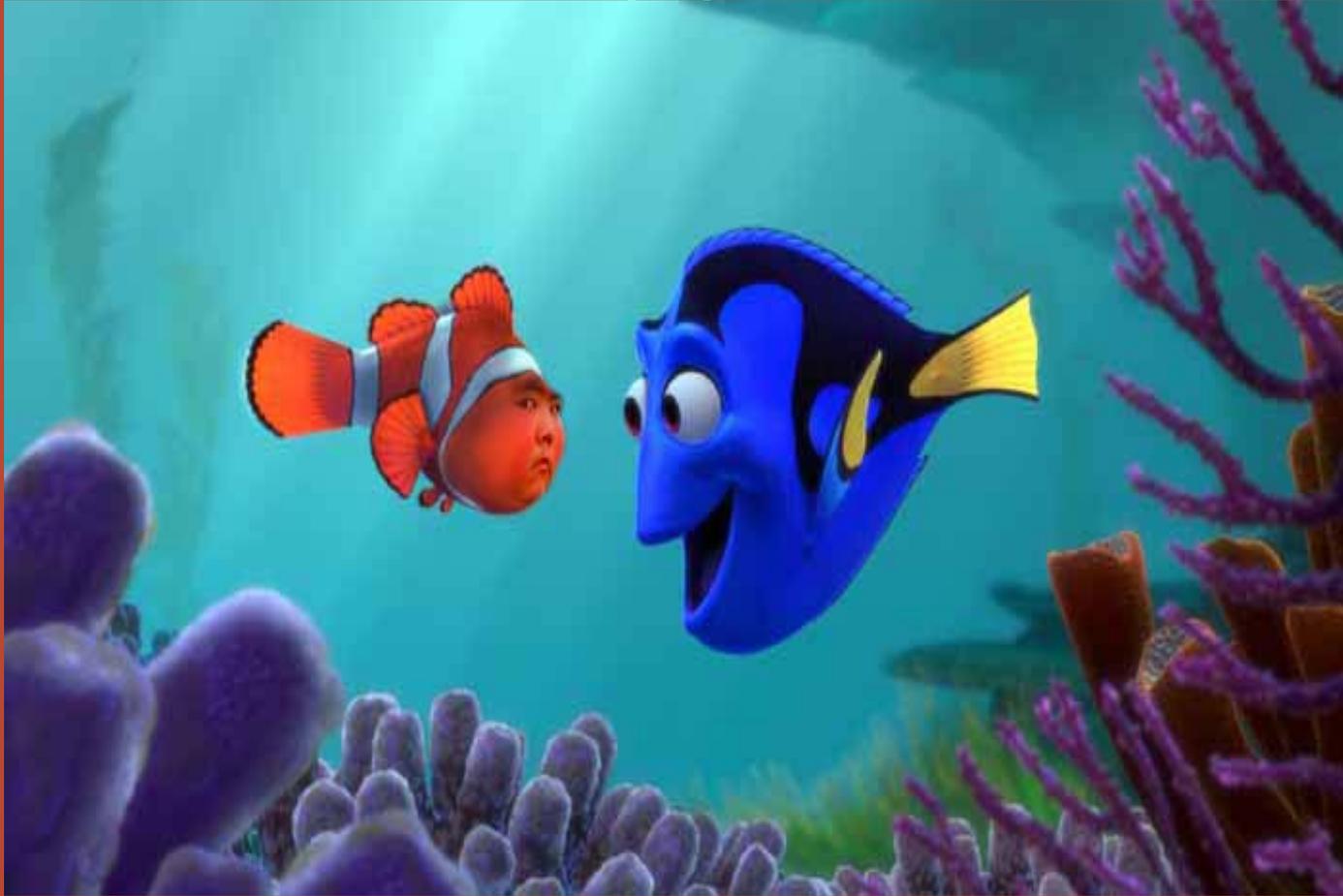
Resources

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What happens to fish when they do not get enough dissolved oxygen.



Questions and Answers

