Environmental Air Pollution

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Lecture No. # 14

Air Pollution and Health - 2

What we will do is still continue with the health effects and go a little bit beyond a few things that we talked about. If you recall, we had given you some idea about the lung functions and things like that. The vital thing to understand was that the parameters which are quickly affected because of air pollution were three: PEFR - peak expiratory flow rate; the second parameter was FVC - forced vital capacity, that is the capacity of lungs; the third one was FEV1 - that is the forced expiratory volume in 1 second. I also showed you the spirometry and I also showed you the volume-time curve - if you recall; that is very important.

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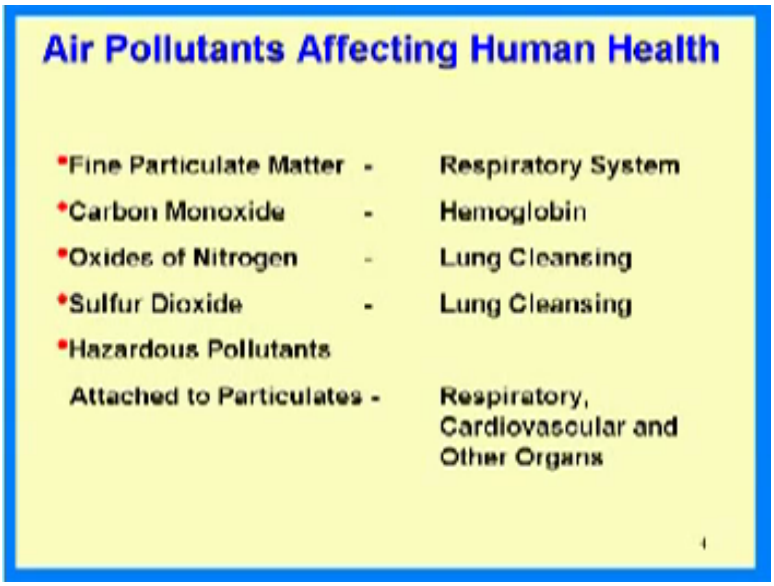

I also showed you how the air pollution - at least the results - affects the lung performance and the lung function. We will go more into the details. Oxygen and [01:35] of course it can cause breathlessness, it can cause headache, dizziness, irritability, nausea, vomiting, mental fatigue, bluish tinge on the skin, nail, lips and even death. Oxygen is important. The body needs oxygen; the mechanism through which oxygen is transferred is through the lungs. As the lung performs [02:00]. It is not only the lung which gets affected, it can affect your entire

body; because, then oxygen transfer will not be much and as a result it can affect even other vital organs. From air pollution we see the direct affect onto the lungs. People have directly correlated the cardiovascular diseases with the air pollution and the disease of the lungs also with the air pollution. People have even said that many of the heart attacks could be indirectly because of the air pollution. People have reported enlarged hearts in the areas where the air pollution is high.

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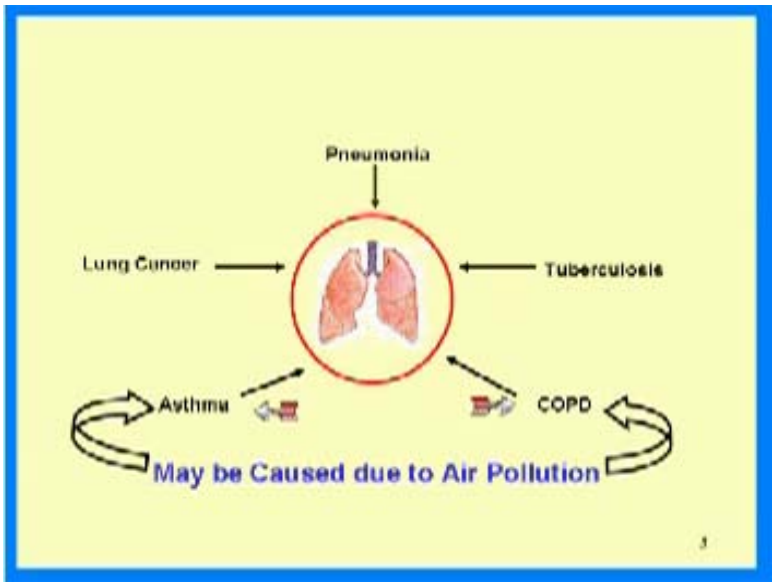

Health issues generally associated with lungs are: we have discussed about COPD, we had discussed little bit about asthma, pneumonia, lung cancer, tuberculosis and genetically induced things.

When we talk about air pollution we normally stick to these two things, but the point is, we will see is that once you have that problem caused because of the air pollutants what happens is your lung capacity, not only in terms of the vital capacity as we are seeing, the capacity of the lung to fight the other foreign elements which are largely the bacteria and virus that also goes down. Why does that go down? Your lung becomes very prone and it can be very easily attacked by the microorganisms. Tuberculosis as we know is a bacterial disease; it is treatable. People are now correlating even tuberculosis to air pollution not directly, but indirectly because, this could also be that, that has been found higher in the areas where the air pollution was high. We will see some of these things.

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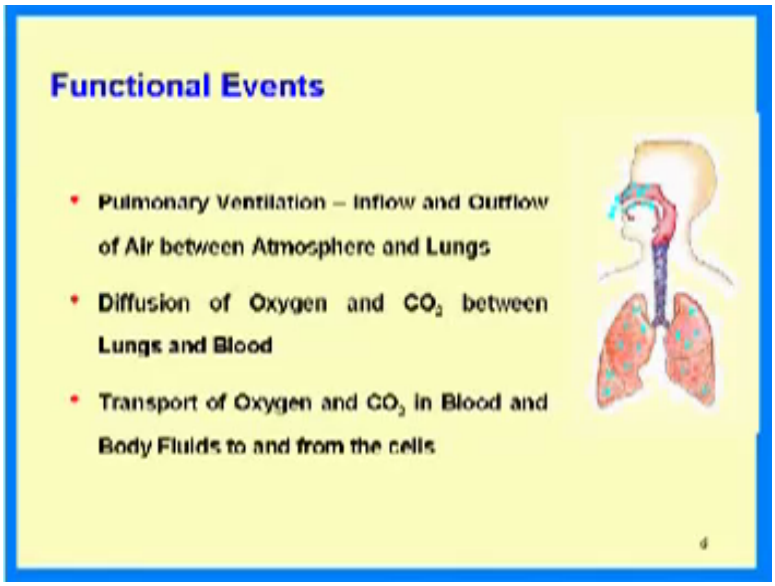

You can see that all things can affect the the lungs: dust, cigarette smoking, microorganisms, malfunction of the body fluids and genetically induced mechanisms, which, of course, depends on the individual or the particular case. Now, what about the other pollutants? What do they do? We will also see that very briefly; not so much in detail.

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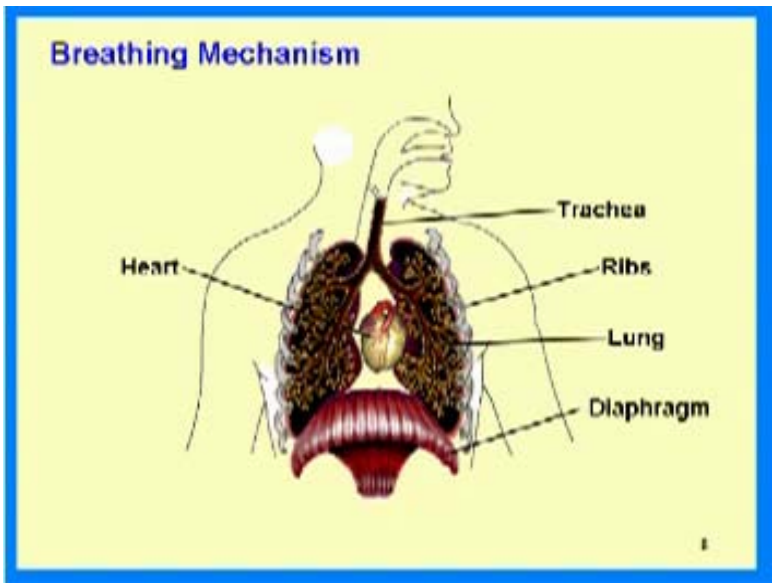

This fine particulate matter, respiratory system, carbon monoxide - you all have studied this in higher school; we will briefly touch upon this. Oxygen and sulphur dioxide - it also affects the lung cleansing mechanism. They also affect the lung, but they also make the lung reduced

in terms of its ability to fight with other issues. We will also see hazardous pollutants. What happens is these pollutants are either in the gaseous form, or they could be in the particulate form - which we have not studied so much: SO_2, beyond SO_2, NO_2, they are attached with the particulate matter and reach the lung. Sometimes, they cross the lung into the blood stream. We should have some idea not as as the toxicologist, but we should know.

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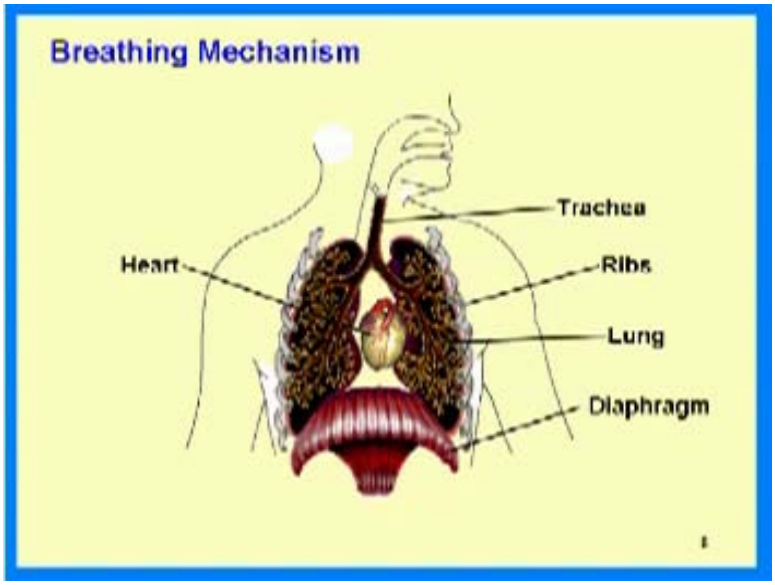

These are the issues with the lung: lung cancer, tuberculosis, COPD, asthma; COPD or asthma is largely responsible because of air pollution. Certainly COPD, but asthma may not be directly related to air pollution, but higher air pollution level can trigger asthmatic attacks. Many times people who have asthma would be advised not to live in polluted areas. People may have the asthma, even though the people may live in very clean areas also. The asthmatic attacks become very common because, they are somehow exposed to higher concentrations. The people who have asthma, they will be off work for a few days and things like that.

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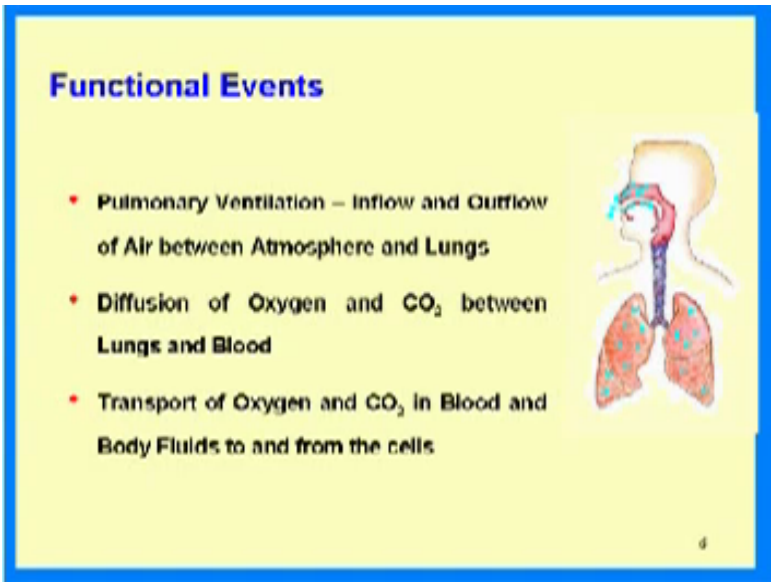

What our lungs are doing is pulmonary ventilation - that is, inflow and outflow of air between the atmosphere and lungs. It also is responsible not only for inflow and outflow, but also responsible for the diffusion of oxygen and CO_2 between the lung and blood; that is very important - transport of oxygen and CO_2 in the blood and body fluids to and from the cells. This is the lung cell; we will see how it happens, so that we have the clarity. This picture I showed you last time, but I want to show it again. It is not very clear, as I see it here.

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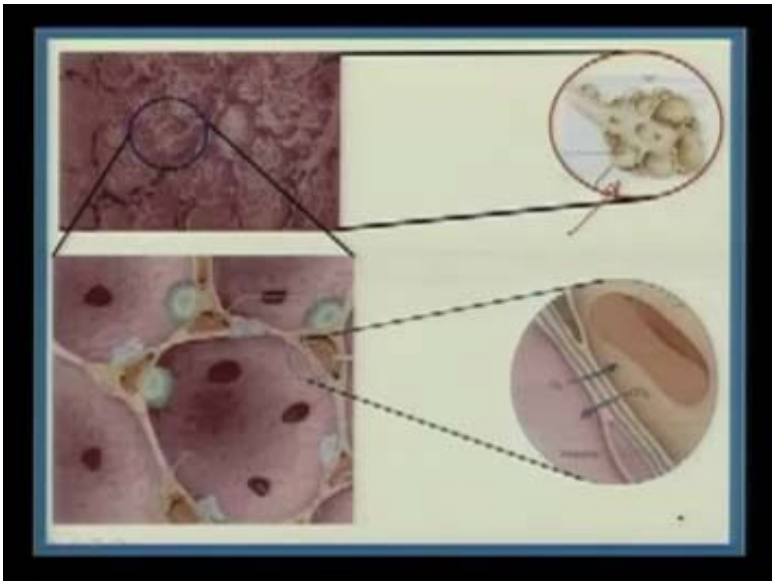

This is your alveolary sac, this one like a pocket here. Across this, these are our blood streams. Oxygen goes in there; the CO_2 comes here and CO_2 is driven out. There are many other things; we will talk about these things a little later. This is very important from the protection of the lungs and that is called macrophages. You may like to remember this.

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Macrophages - we will see its role in a moment. Your particles can reach right up to here. (Refer Slide Time: 07:30 min) What will be the interesting thing is that you will see the gases, particulates generally. There are ways they can even get across the blood stream as particulates generally cannot go. You will see the the gaseous pollutants that are going in there and which are reaching after this place. They will obviously get across and go to the blood stream; like the way the oxygen is going. This is simply a membrane; if the more partial pressure is there, then they will go this side. If the air pollution level is high in the air that you are breathing and that is in gaseous form that also will get across. It will go to the lungs, go to the blood stream and then it will be transported to various parts. Then it may not affect some parts, but it may affect some other parts. So, even the gaseous pollutants will go.

The most important gaseous pollutant which gets across is the carbon monoxide. As you will recall, carbon monoxide is a very un-reactive gas; nothing happens to this one.

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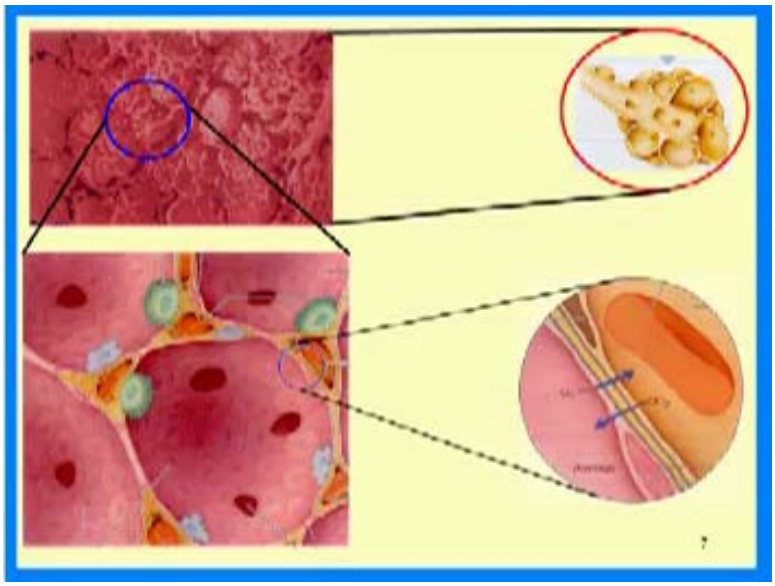

Some other gases - we will talk about them later; they sometimes are not even able to reach deeper because they react. For example: ozone; it is highly reactive. You cannot expect it to go all the way down here. You will see that ozone will destroy itself or destroy what it wants to destroy; it will destroy itself, as well as destroy something else in between. So, there is hardly a possibility of the ozone reaching here, but carbon monoxide - yes. So carbon monoxide will affect the blood stream. Let us see this. This is a little animation I have; you can just see this. There is nothing from air pollution point of view.

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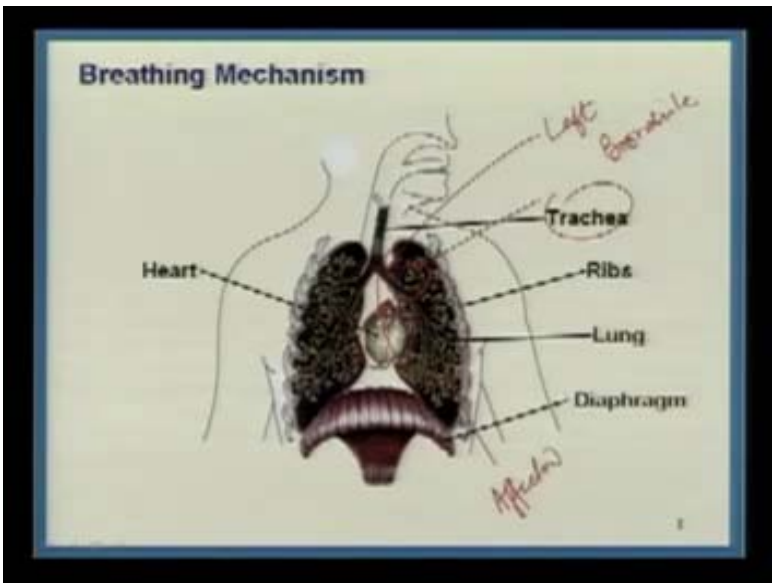

At the bottom, that is also part of the respiratory system, is the diaphragm. You can also see the air coming in and then the dirty air goes out. Then, as I told you last time this is called trachea and these are called bronchioles. Which one is the left bronchial? Which is the right bronchial? This is left bronchial and this is the right bronchial; they are very similar. Whatever the problem that you have here which is related to the bronchiole is called bronchitis - where you have the problem with the breathing and the constriction. We will see how the constriction happens in the bronchitis.

Largely, the effect what we see is in this one, but then we cannot say that air pollution does not affect it. It can even affect the cardiovascular system. Once, something enters the blood stream that can also affect the nervous system and the other systems. Let us be clear; largely it is this area, but then the other areas are also affected.

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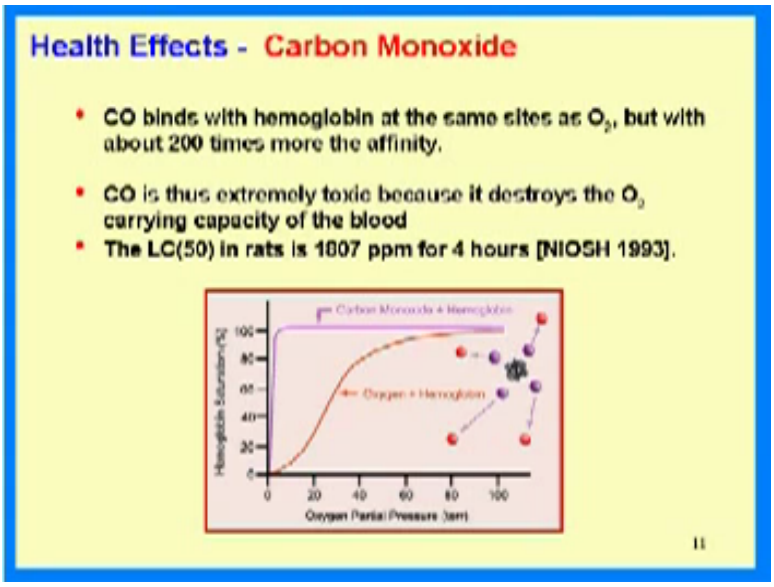

The CO that we are talking about, the particulate matter we have discussed little bit, but CO is the haemoglobin issue. We all know about that. We will just touch upon these, but the other issues of the oxides and nitrogen, sulphur dioxide is that it affects your lung cleansing. It affects the mechanisms of the lung through which lung can keep itself healthy. As a result the other problems that happen we will see. We will also see some of the hazardous pollutants and what affects they can cause.

Let us talk about the carbon monoxide. It binds with the haemoglobin at the same sites as our oxygen. What is Haemoglobin? Haemoglobin is a protein; it has the sites where the oxygen

can be attached, CO can be attached and even CO_2 can be attached. If oxygen does not attach with this one - with the haemoglobin - oxygen will not be transported in the form that the body needs. So what happens here with carbon monoxide? You see here, with so much of the partial pressure of the oxygen, you have some haemoglobin saturation with the oxygen - 40%, 60% and even you have little CO it can quickly saturate the site; it may be something similar to this.

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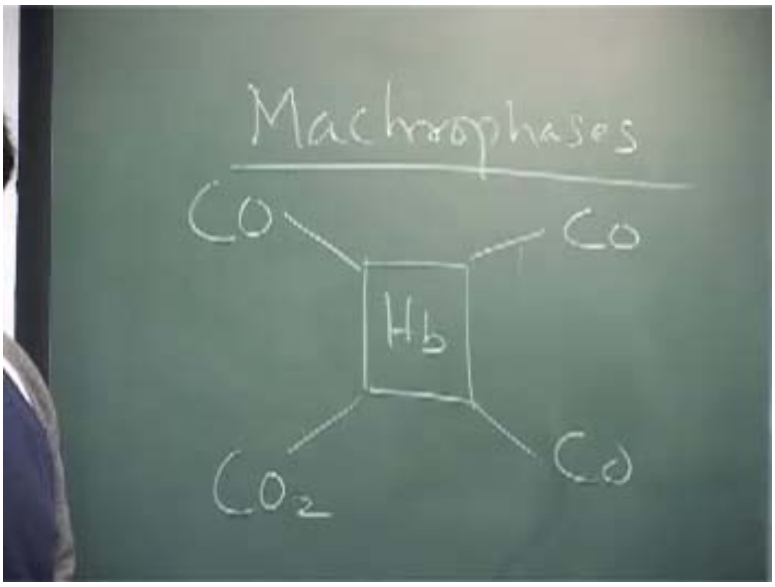

Not exactly in the molecular form, but in the sites may be CO_2 and may be CO. So the oxygen saturation cannot take place. The interesting part of the body is that as the blood goes into the various parts and various organs, it is balancing the things. It takes the oxygen and as oxygen is consumed, it attaches CO_2 with it. There is no way in between in the body that this CO_2 can break off and become free. The interesting part of the body, well I am not a biologist, we all just need to know the level. The moment the haemoglobin reaches the lung site, it sets the CO_2 free and the CO_2 can go across and oxygen can come in. Suppose, I am talking about some part of the knee or something, it will not let CO_2 go away; CO_2 will still be associated; CO_2 will be there in the body. If CO_2 is set free, the partial pressure of the CO_2 in the blood will go up. It is only when it comes to the lungs, the haemoglobin can set of the CO_2 free; CO_2 can go out and oxygen can come in; the oxygen can take the sites of this and your blood is purified.

The CO is seen in terms of what is the CO saturation level at the haemoglobin sites. If more and more of this there, it is a death because, there is no oxygen that is there. What you see is CO is then extremely toxic because it destroys your oxygen carrying capacity. Lethal concentration like 50%, the rates is this kind of ppm, for four hours, that is a standard. When the oxygen is not there, it affects you very quickly. The other parts may be working, but you lose your senses. Once it goes to the brain, it makes you feel dizzy.

Suppose, say this room is filled with the SO_2, I am sure I will stop you. You will go away from here; you will not listen to me and you will just break the door and go way; because, so irritating, so pungent and you will feel so suffocated. But the problem with carbon monoxide is not suffocating; it does not feel anything; you will rather feel very dizzy; you will feel like a nap or something. Then as a result the first thing affected is the brain. That oxygen is not reaching, so you lose control. As a result, suppose you are driving or you are doing something very important thing, you are working in the machine, and then you may probably end up in an accident. The problem is that it does not give any warning and you might still be affected by CO. Accidents can occur. Accidents can never occur because of SO_2, ozone or NO_2, for that matter.

In the houses sometimes the power is gone people are using the generators or the small stoves - little cylinders you may call them - because of the cold weather, let us keep it there. Then you think that little temperature will be there and CO will build up. You will not leave the room and you will feel rather feel sleepy and dizzy; then you probably will sleep and sleep forever; this is the issue with CO. Where as with the other gases you will escape and you will try to run away from there.

The best thing is suppose somebody is unconscious. You bring him in the air which is cleaner and take him out from the room. Do not try to treat him right inside the room, if that is the case. Many times the ventilation system is not very good; it is not good in the winter anyway. We all have heard that people die because of the carbon monoxide. This is what the issue is.

All of it is there in the literature in the book: At what levels what is happening? How is your response time? You reaction time goes down with the exposure and things like that. I will pass on the handouts to you, but let us not spend so much time on this one, but that one.

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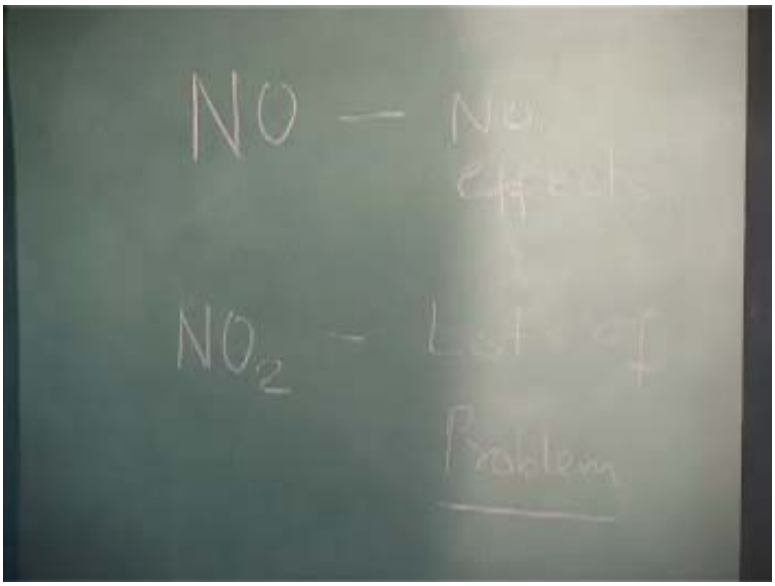

The funny part with the oxygen and oxides of nitrogen - let me tell you. You all know by this time there are two issues of NO and NO_2. NO - no effects because it does not cause any problem in the body. NO_2 - lots of effects and largely it is in the upper part of the lungs where NO_2 causes a problem. What is the problem that it is causing?

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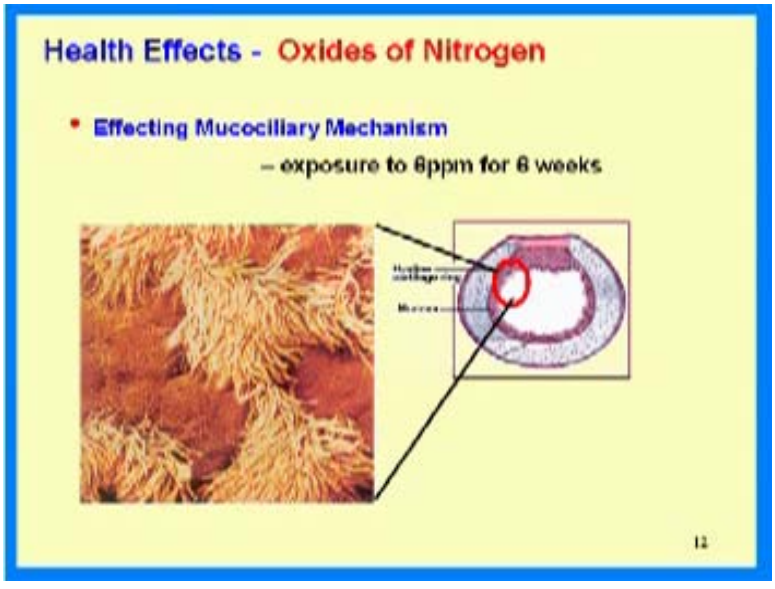

It affects the very function of the mucocillary mechanism through which you are generating the mucus and the cilia. It can affect the cilia; actually can you see it here, it is like a brush and the particles and other things are there. It just keeps on moving like the way you hair is

blowing when you are in the air, when the wind is blowing your hair moves, so is this cilia is moving. The mucus is there, though some particles are being trapped in the mucus. The NO_2 very much affects this mucocillary mechanism itself. As a result of which the capacity to fight is gone.

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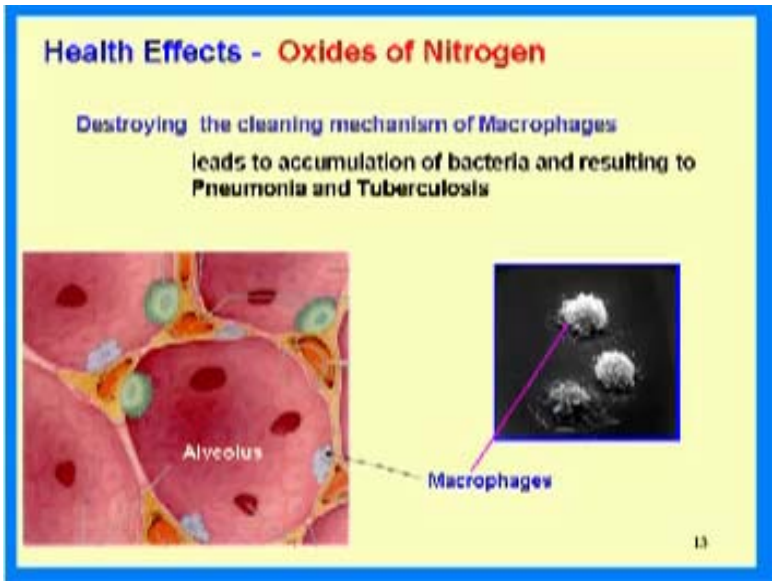

Another thing what it does is - we are going to the same thing where the oxygen transfer was taking place; you see the macrophages. What do macrophages do? Macrophages is a very interesting thing. You have a macrophages, it is basically a cell kind of structure and some foreign particles comes in, it just traps it; catches it. It catches it and then it destroys somehow. If you are exposed to some area, for example, you go to a hospital and then lot of bacterial infection is there, but then if you have the macrophages, it will just trap them and then make them inactivate; this is a body mechanism. For a person who is living in more polluted area, the body itself will generate more and more macrophages, but then there is a limit up to which it can do.

You will see the person living in a clean area, their macrophages count, it will be fewer; you can count these. Well there is a mechanism, you can drive out the this thing somehow outside, through the mechanism and there is no fluid here; at this level there is no fluid; there is no mucus; mucus is only on the top, the upper part; if here the mucus is there, then death is certain (Refer Slide Time: 19:34 min). So, the macrophages - that is what it does.

The oxides, the nitrogen - it very much affects the macrophages itself. Destroying of the cleansing mechanism of the macrophages leads to accumulation of the bacteria and resulting in pneumonia and tuberculosis. This is one of the direct effects of oxides and nitrogen. We will also see the other effects in a moment.

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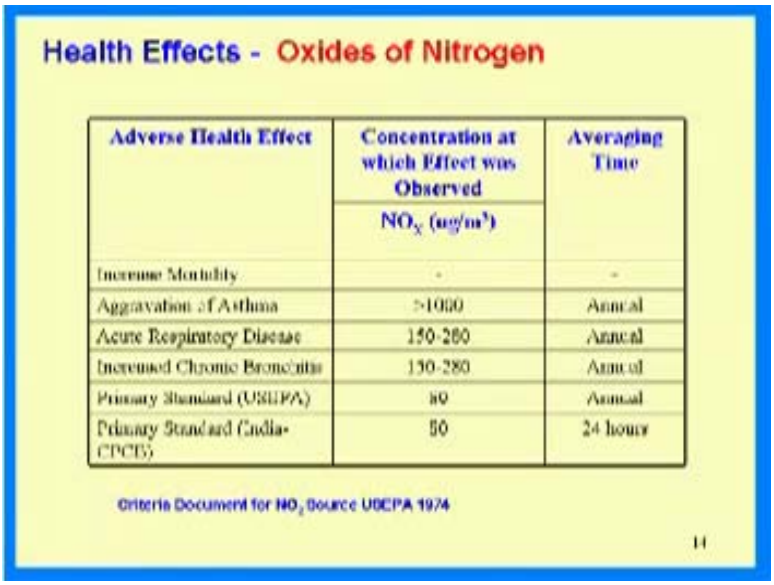

At that what levels it can? It can enhance the or aggravate the asthma, it can also cause acute respiratory diseases, increased in chronic bronchitis - bronchitis is again a bacterial infection which you see. There are standard like the NO standard in India; well this is the NO standard of UACP and this is Indian standard. At this level normally the effect is not so significant. You see can that how NOx indirectly, it can affect directly also, but indirectly it attacks the very mechanism of the defence mechanism of the lungs.

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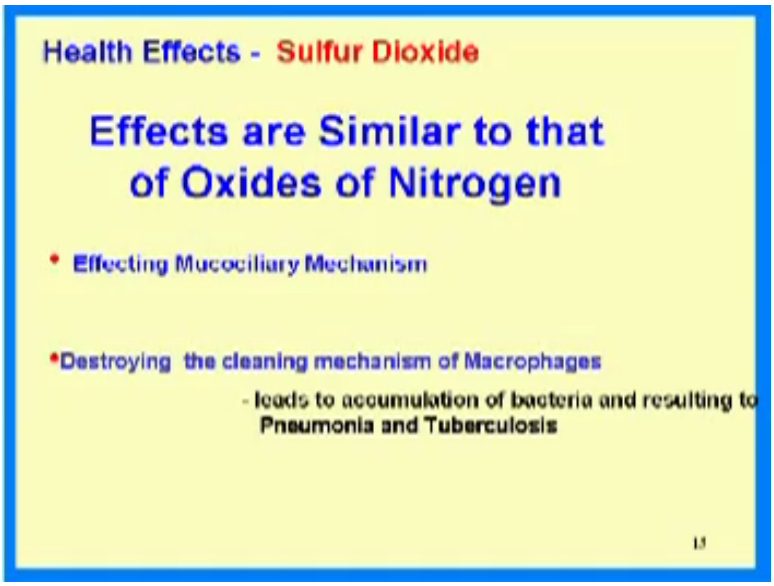

When you talk about sulphur dioxide, this also is similar. We should not forget that SO_2 is an irritant in the lungs as well as it effects the mucocillary mechanism. What does it do? It destroys the cleaning cleansing mechanism of the macrophages, it leads to accumulation of the bacteria and resulting in pneumonia and tuberculosis.

What can SO_2 do? SO_2 is largely responsible for the problem in the upper part because SO_2 is also very reactive gas; let us see how it happens. These are the levels which I will pass on to you.

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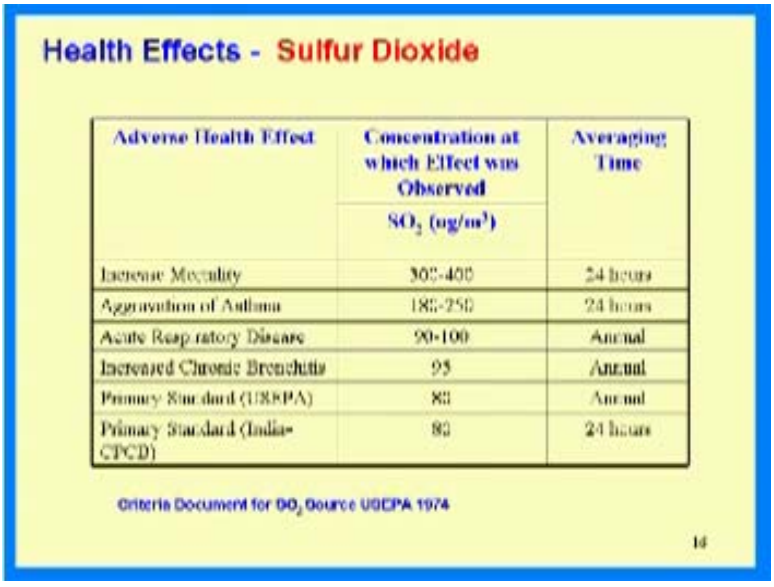

The mortality levels have gone up, reported asthma acute respiratory diseases increase, chronic bronchitis. So why bronchitis? Bronchitis is still in upper part of the lungs; not so deeper part of the lungs. The standards are there for the safe guard of this one.

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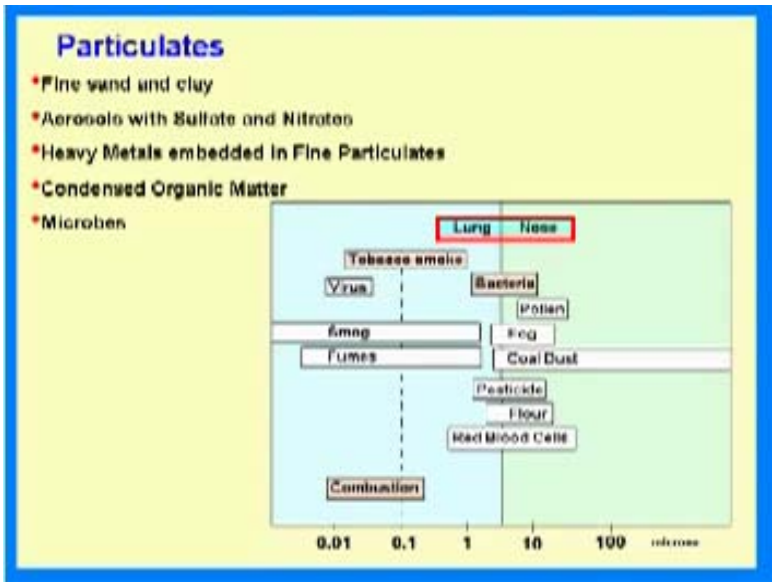

Next particles and size of the particles: Tobacco smoke, the bacterial size, here the pollen is a little larger - they can also trigger the allergy. Coal dust, pesticide, flour which is this, red blood cells, the combustion particles are very small. in the fumes. These are the sizes that you see here.

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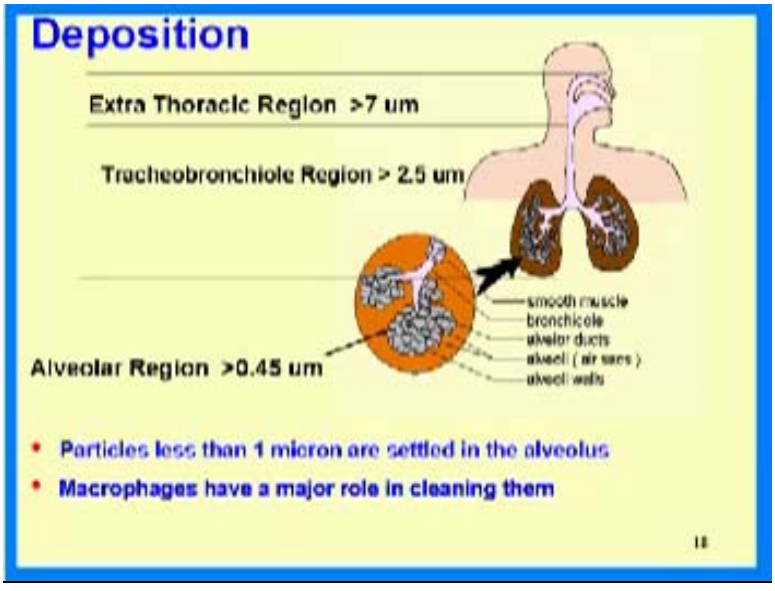

These particles deposit at different places; this is called - up to this one - extra thoracic region where particles larger than 7 microns will deposit. This region, almost up to the bronchiole region, is called the thoracic region. The particles which are greater than 2.5 and 7 microns, they will be trapped here. The finer or smaller particles will come in this region, which is greater than 0.45 micron; particle less than 1 micron will settle in the alveolus or even at the lower end.

As I told you last time, because of these things the walls are destroyed. Once these are destroyed, then the the lungs loses elasticity and if it cannot hold down to something then it cannot create enough partial pressure. Slowly more and more space become within that space, as a result your lung capacity reduces.

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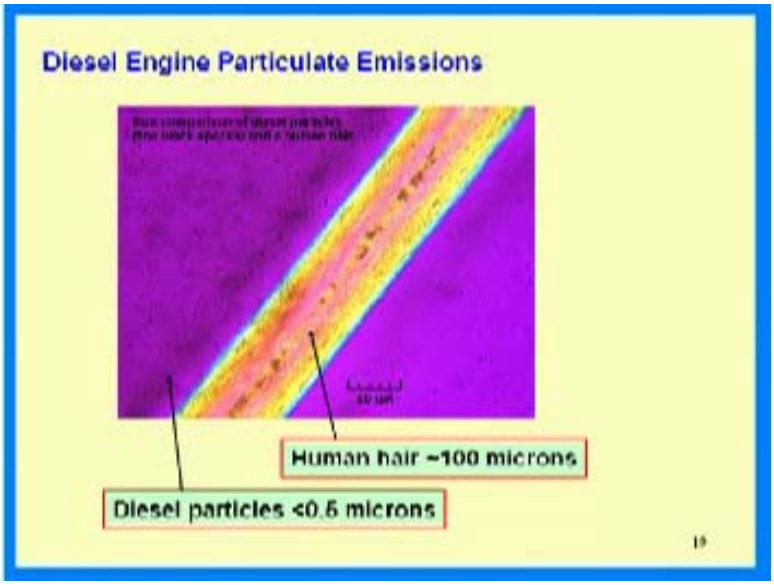

Just to give you a little feel of how small it is - the little dot that you cannot see here is the diesel particle which is in this size range. The diesel particles will go deep in the lungs and this is the hair size. That is about 15 micron or close to 15 micron. So I showed this to you to see how small these diesel particles are. The other problem with diesel particle it is just not the particle itself. The tiny particles can carry many other small things.

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If the particle was not there - the native particle which could be diesel or anything; it can attach the other highly toxic compounds along with this one; it could be the phs, it could be the pesticides and it could be the metals, and this, and this. We are not discussing that. There are mechanisms even through the lungs, for example - the gases - it can get across in the blood stream - that we are not discussing. You can see how these other hazardous pollutants also can get into the body through this route from the particles. Large surface area and the carbon surface provide more absorption of the metals and other things. So this slide I have shown you already.

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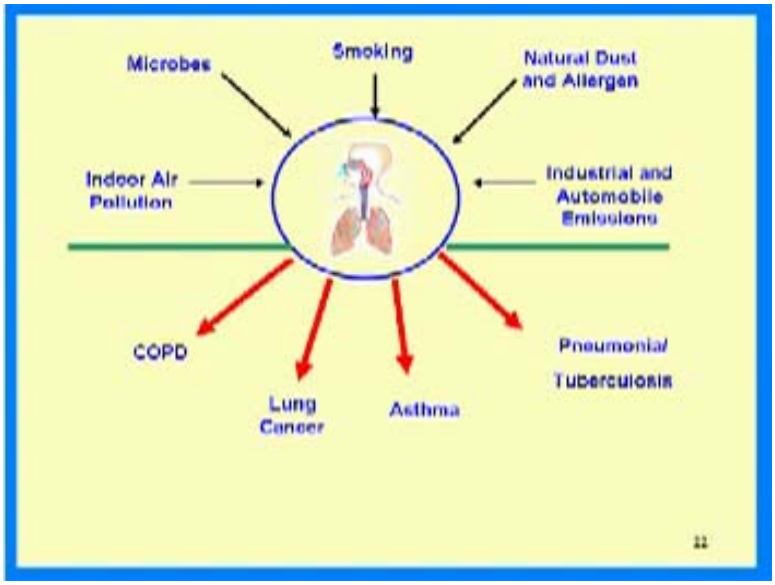

Then it could be exposed to various routes - here the indoor air pollution. We should not forget about the indoor air pollution. This sometimes can be very significant. Microbes, smoking - both active and passive smoking is a serious problem, natural dust and the allergens can also effect the lungs, industrial and automobile emissions can also effect the lungs; all these will be a problem. COPD - again and again I say is more a problem related with the air pollution. Then I also showed you a slide last time that the mortality or deaths was on rise because of COPD. Do not misunderstand that people are dying largely because of COPD, but more and more people - in numbers - in the relative sense are dying more because of COPD, then the other diseases. The numbers are much higher because of some other reasons.

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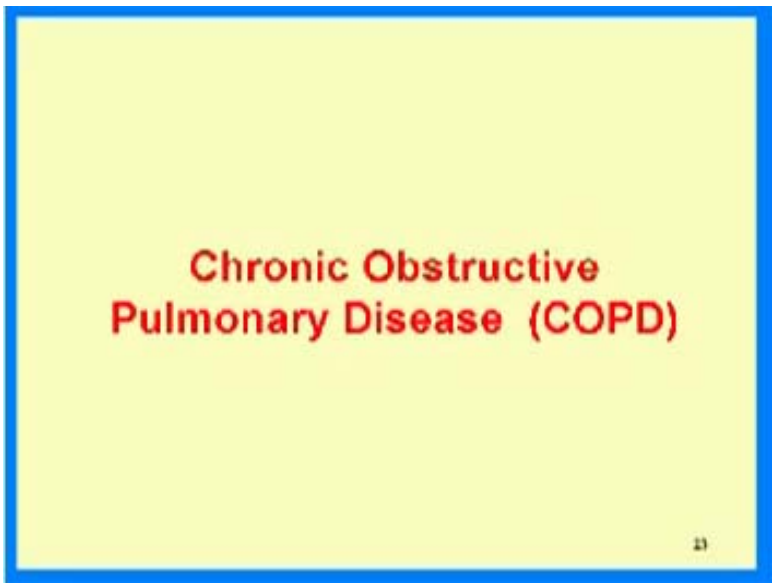

See we are talking about COPD. These are the causes of COPD.

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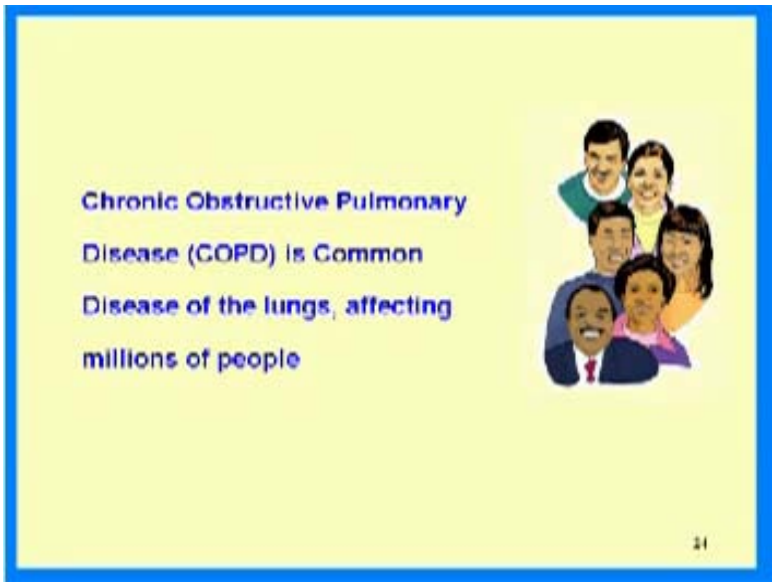

It could be air pollution or exposure or from the cigarette

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I thought it might be a good idea to put this slide as if there are some smokers to see what kind of contents the cigarette really have.

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Constituent	Weight (mg/Cigarette)	% of total effluent
Particulate Matter	40.6	8.2
Nitrogen	295.4	59.9
Oxygen	66.6	13.4
Carbon Monoxide	16.2	3.2
Carbon Dioxide	68.1	13.6
Hydrogen	0.7	0.1
Argon	5.0	1.0
Methane	1.3	0.3
Water vapor	5.9	1.2
Hydrocarbons	2.5	0.5
Carbonyl Compounds	1.9	0.4
Hydrogen cyanide	0.3	0.1
Other Toxic trace elements	1.0	0.2

It is a percent of total effluent, of course, significant amount of particulate; nitrogen is a major component; normal air will have 21% of oxygen, we have 13, reduced significantly; carbon monoxide is 3.2%. We are talking of the air some PPM level, here we are talking about the percentage in cigarette. Carbon dioxide is of course that is fine 13.6 and hydrogen, argon and that is fine, water vapour, hydrocarbons. You will also be surprised that it might contain a little bit of cyanide as well; not so much to really worry about, but then these are the issues.

So much has been reported about cigarettes and cigarette smoking problems. If you are smoking cigarettes, you not only affect the people around you, you also affect yourself and the people around you; that is why the issue of the passive smoking becomes so serious - you are not smoking but you are affected because somebody else is smoking. That is how you have all the rules, regulations and the laws you cannot smoke in the parks, in the public buildings, you need to go out and things like that. Maybe you have taken a voluntarily risk, but because of you, no one else is put onto the risk or the trouble.

A lot of studies have been done on this. In fact the levels have come down as I understand. There are smoking habits [27:55 min]. One of the projects was done in this course where one student modelled the effect of smoking in the hostel. He did not get very good results, but then he says that about 40% of students were smoking in his wing and then he said how it could possibly effect the other students living in the wings. This he did in this very same

course for his research; that was very interesting. The idea of the project we want to do: we can do a literature survey and all; if you can apply something somewhere; it does not matter what kind of results we shall get - you are getting horrible results; it is just a thought; let us find out [the time the person is likely to smoke is this; this room is open or that room is open Audio not clear: 28:47 to 28:58 min] It was just a small project, but very nicely done; not that it can be published somewhere, but it was very well thought and well executed. Maybe someone would leave smoking, if somebody smoking in class.

Aerobatic fraction - let us forget about this.

Now that we talk about the oxides and nitrogen - how does it really impact us? Why does it happen that it is able to destroy the system of the mucocillary system.

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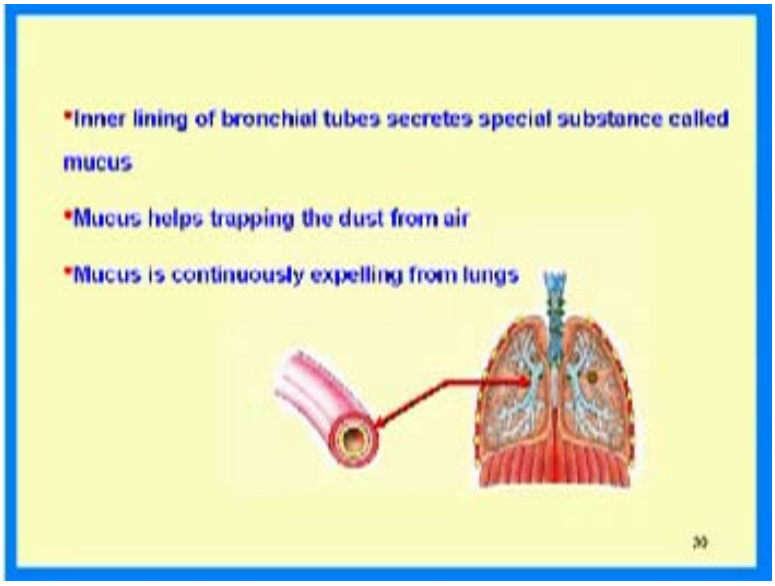

When we look at this - right now you are looking at right bronchi - and we see that the body is in a very controlled way, it will it releases mucus. Mucus helps trapping the dust from the air because of the particle, it can trap the particles. You remember I used a word - mucocillary elevator. In the lungs, the direction through which the mucus is travelling is in the opposite direction - against the gravity. It slowly pushes and can come up to here and then we swallow. The particle which where there here, they will eventually come into your stomach or whatever and then come out from there, from the body.

You see normally we will see the structure like this. What happens, the moment you are attacked by the smoking or the air pollution - does not matter - or oxides of nitrogen, the body says it is in trouble.

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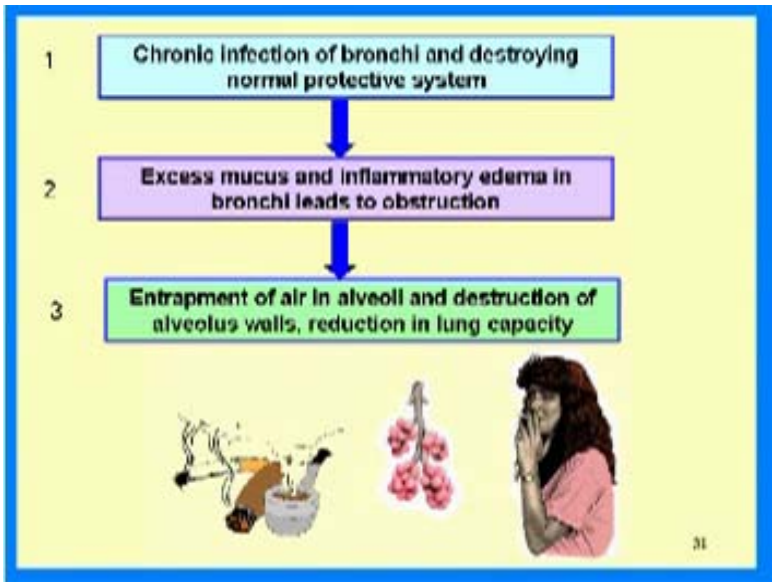

Then it tends to move produce more and more mucus; because, that is what we understand this is the defence mechanism it has. It will produce excess mucus and then an inflammatory edema; edema is again more of the moisture which is present here. Inflammatory edema in bronchi leads to the obstruction; after all, the diameter of the pipe is the same. Then more of mucus will come, then we fill the obstruction, the moment you fill the obstruction your breathing becomes a serious problem and it can become so much.

I will show you the some picture. This is at the at the mucus level. The entrapment of air in alveoli and destruction of alveolus walls leads to reduction in the lung capacity. I was talking about this one. We have talked already, but you will see some of the pictures. This is what is normally things look like in aligning of the normal bronchi and further the details of this.

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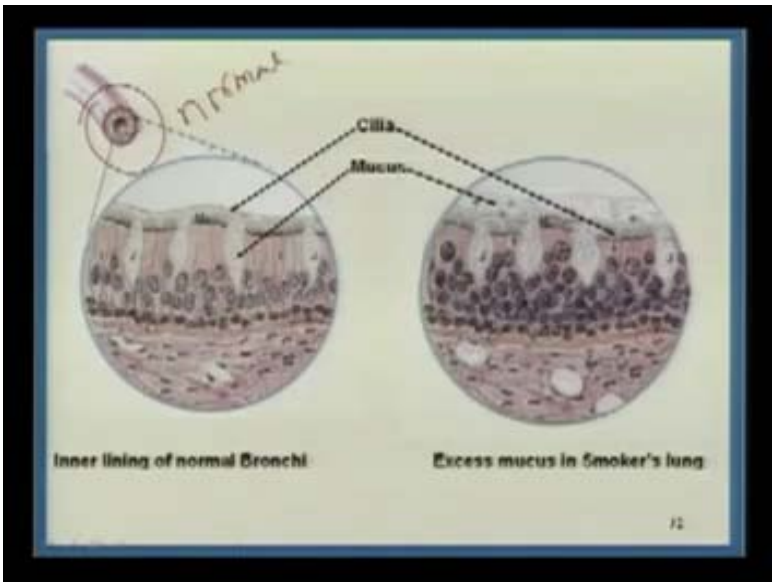

This is a normal thing. This is a mucus which little bit comes onto the surface from here and this is your cilia - little hairy structure. When the person is exposed to air pollution of the particles and realise an NO_x - for example. Here you cannot see, but this is the layer.

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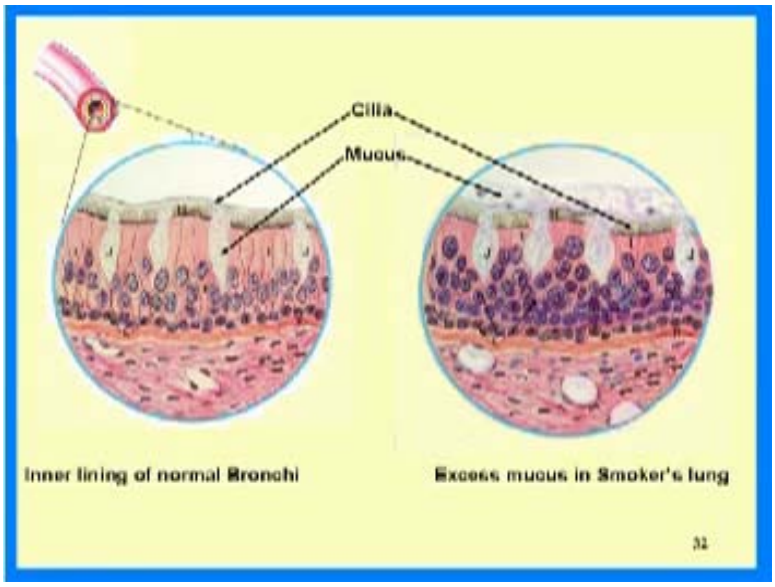

This is the little mucus here; so it can really release lots of mucus; [32:09] it is in trouble, whereas among it is a NO_x or the particles and as a result what happens? You will see here.

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Then the cilia also - because of so much mucus - become unable to expel the dirt accumulated in the lungs. This causes a thick sputum to develop and then as a result of this this mucus also travel. It is not stationary, it takes the particles and it travels like a mucocillary elevator against the gravity, but then it becomes so thick, then it stops there. Then you have the obstruction you have to cough and then cough and then you have to take your body mechanism; then you try very hard to take this one out and if it becomes dry and thickens, it becomes more of a problem.

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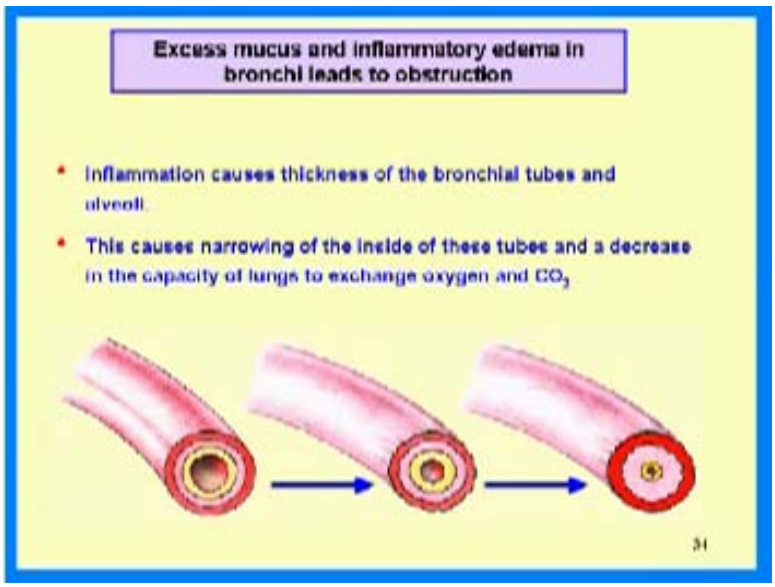

Because of this the first level the mucus there will go on increasing; then, the diameter that are available for air to travel or air to pass through, it becomes smaller and very smaller. Here you see and then you have all kinds of obstruction problems. You feel you cannot breathe and you have lots of difficulty, you cough and it becomes very difficult. That is what I was referring to. That leads to the obstruction.

So trachea has the bronchiole tubes and the alveoli. Then this causes narrowing of inside of the tubes and a decrease in the capacity of the lungs to exchange the oxygen and CO_2 and then we breathe more and more. You breathe more and more; you remember the heart is the heart is pumping the things on two sides. One side it is pumping the impure blood towards the lung. The other side is pumping it to the body and then you see that the heart also finds obstruction on the lungs side. It finds the obstruction, and then it has to work hard. You want to clean it; so it tends to work harder to push the blood towards the lung side. Lung is obstructed. Things are not happening there. So sometimes if the portion – which is the right portion of the lung can be enlarged because it has to work hard and then there are related issues.

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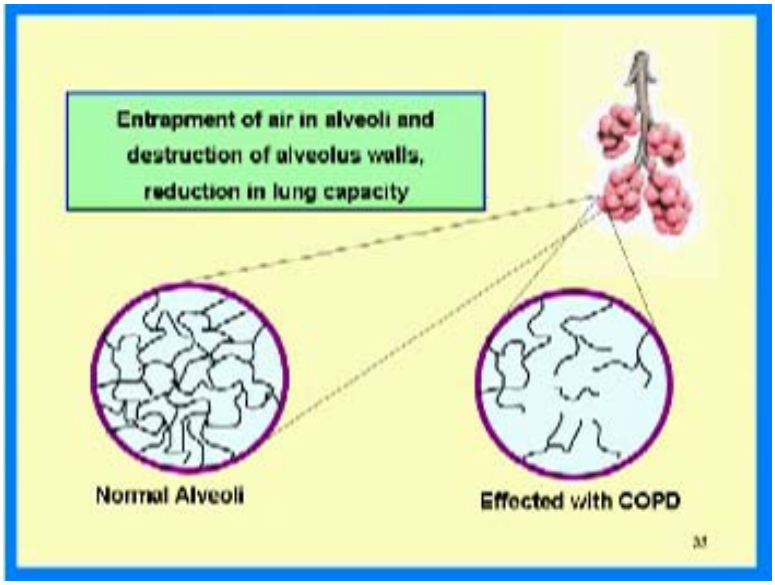

Now what happens at the alveoli level? There is the nice looking normal alveoli, but the particles come and deposit here. Then these walls are broken. So many pockets you had been over there; things can be stored and partial pressure could be developed. Suppose, I have small pockets which are like balloons. Suppose I will break the 2, 3, 4 balloons; I break them.

They cannot hold on to the air. It cannot develop the partial pressure, the elasticity is gone. Then what symbolically can happen in the COPD is that you have broken the walls and then become more of dead cells and the elasticity is gone. Your capacity of the lung is gone.

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This is the typical picture where the walls are gone. There is no way you can regenerate them, but it happens with the age as well as with the pollution problem.

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These are clean lungs, these are little dirty lungs - the smokers' lung and then you can see that one affected by the COPD. This is an extreme situation; person has been smoking for the long time.

Before we end I want talk about lead. What was the serious problem with lead? It still it is a serious problem. Lead is versatile heavy metal, extensively used. You would be surprised that even this cable will have a lot of lead in it.

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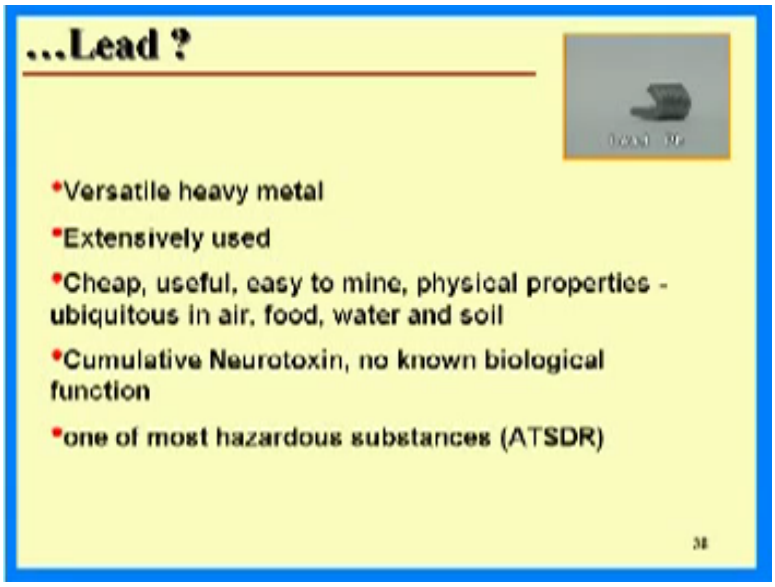

Idea of lead was it was very cheap, useful, easy to mine, physical properties and which are very useful. You can find it air, food, water and soil, everywhere, but the problem it is a cumulative neurotoxin. For example, it has no biological function in the body.

I will tell you a little story; you will be surprised. I was in Delhi yesterday and we were discussing some standards. You can see how different people will argue about different things. We were trying to say the emissions of arsenic and tin and we need to reduce from a particular process. People were sitting, people were from industries they were there and that is that is how the people argue for their case. The point which I am trying to make here is that even the cigarette smokers argue from the point that the body needs nicotine. In fact, we have nicotine in the body, but where can we get nicotine from the normal diet and things like that. Lead, it has no beneficial effect in the body or at least not known or something is there. In fact, to the contrary it is causing a serious problem. Let us see what the serious problems are.

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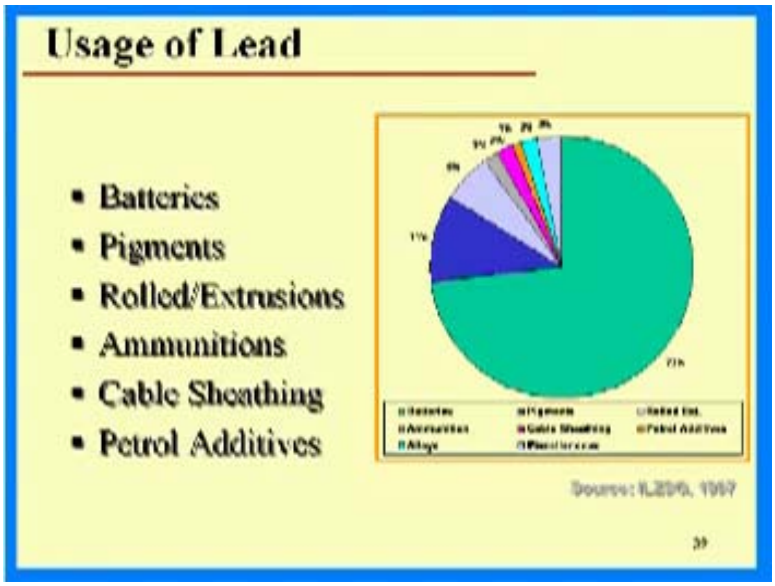

Largely we have lead in the batteries - huge amount and then pigments and things like that. Cable sheathing I was talking about. This cable probably will have lead. Ammunitions - we all know lead is used. Then petrol additives; it is a really small quantity somewhere here. The problem is because it comes into the environment.

The way you tackle the hazardous pollutants or hazardous metal, these metals will be there. I mean you cannot change lead into something else; that is out of question, unless the nuclear engineers can do something; so that is out of question. What you do is control of the management of hazardous metal is of course, prevent the emissions, but somehow fix them so that they do not come back to environment - that is all hazardous management is. You cannot destroy it; sometimes these things you can destroy, but the elementary thing you cannot destroy. Somehow this hazardous waste put in the cement industry; putting in the cement and cement making process. They will be part of the cement. Once it is cement, it does not come out so easily. Hazardous waste and even metals are put in cement. The metals become part of the cement and they are very strong in the cement; it will never come out. How can it come out from the cement; whereas, asbestos will come out very easily; so asbestos is again a serious problem.

This is the problem because this comes out in the environment; whereas, the huge amount of the lead that we use is in the batteries; not much of a serious problem and we all know these

are all recycled and things like that. The thing which we were talking about the health effects of this is the topic and I will just talk about these four points.

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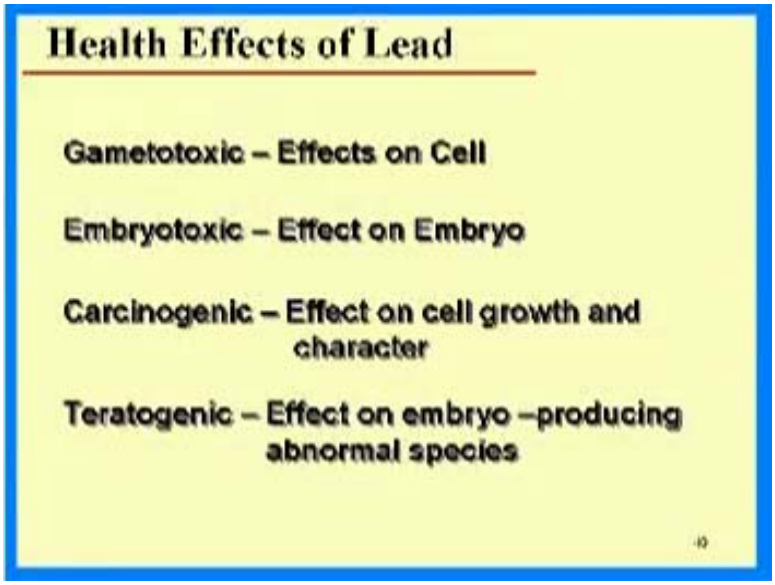

Whatever toxic that you can think of, lead has. It is gametotoxic it means if at the cell, it can destroy the cell. Embryotoxic it affects the embryo; so the very embryo is affected. It is a carcinogenic; it causes the cancer which is uncontrolled cell growth; cancer is uncontrolled cell growth which the cell performs something other than what it is suppose to do; that is what the cancer is. You have a cell; it has a particular function; it does not do that function, but it does something else. That is why you have the cancer. So it a proven carcinogenic. It is also called teratogenic, which means effect on embryo; it can produce abnormal species. This is what is the effect that you can clearly see, like the long-term effects and things like that.

The other thing is - well I am going little bit on to the little details - the body and the bones; lead is also called bone seeking element. The body's understanding is that when it comes to absorbing calcium, the body cannot understand the difference between the calcium and lead. If at all, in fact, it has a slightly more affirmative towards leads. So you have the doses high in the lead as well as the calcium because more you need the calcium, not only for its growth, but also the bones will store calcium. At this age suppose I am want take lots of calcium, my body will still not retain calcium, but in the childhood whatever the calcium is taken that is proven more important than what I can take the calcium now; that is the bones absorbed it.

But then suppose at the same time you also have the lead. So body would absorb lead or the bones will absorb lead rather than absorb the calcium. The person will be weak on the bones.

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Apart from that there are confusions of lead. Bones will store in the bone marrow, I do not know how much you understand about the bone marrow. It is there. A very interesting part about the lead is that it stops at the bone; then at now at the older age, the bones tend to leave out the calcium. A person in the older age may realize now the lead is being given out by the bones. In pregnancy, the lead levels in the blood goes up because, whatever the lead is there it tend to come out from the bones and things like that during that time. These are the effects. I will pass from this one.

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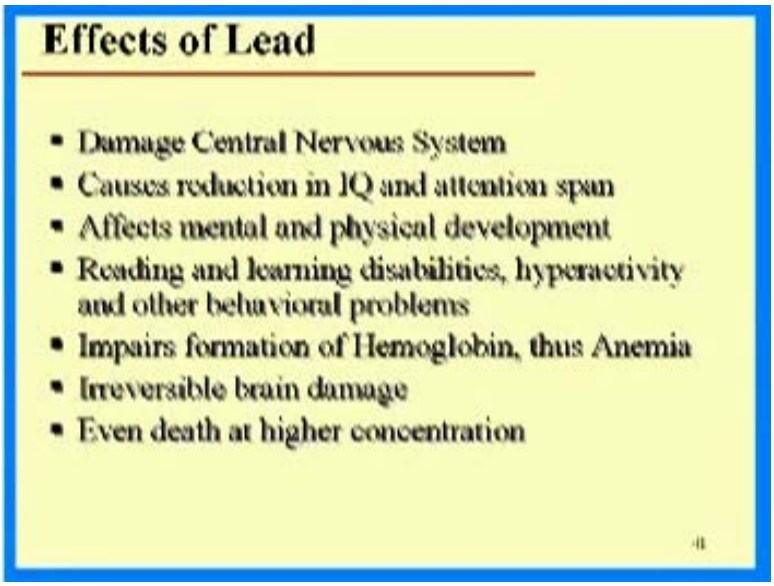

Other immediate effects are the damages to the central nervous system; all these are documented, published, established; so we are not talking about it. Then it causes reduction in IQ, example poor children, they will be close to the lead on the roadside and their IQ levels are low. Attention span has gone; I mean it reduces; if somebody can study for like 2 hours with concentration and if people are affected by lead pollution then their attention span will be low. It affects the mental and physical development, reading and learning disabilities, hyperactivity and other behavioural problem. It impairs the formation of haemoglobin. It can also cause anaemia. Irreversible brain damage because of the lead, it can even cause a death at higher concentration.

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Children have the larger problem because they take the greater lead intake per unit body weight because they always take more. Greater lead respiratory intake; they also take more air per unit body weight. Greater absorption; because, their body is growing the body mechanism if they eat more and they absorb more. So if the pollution is there then they can absorb more; greater absorption and retention in the digestive system. Certain defence mechanism is not yet developed in the children; so it will become a very serious problem. Expectant mothers they also their body tends to absorb more and more because that is the time they need more nutrition and things like that. The lead has been again proven has caused miscarriages, still birth, that we have seen about the teratogenic as well as the gameatotoxic; death of the new born also have been related to the lead pollution. The lead had caused all kind of serious problems and therefore all the countries in the world have gone unleaded. Let us not discuss this, but then the roots can be from the food, water, soil and air. The air also, of course, air level has come down, but we still have some lead in the food and water. Let me also tell you that blood lead level - just for more full information - is a indicator as to how far a person would be affected because of lead. Blood samples are really taken and seen what is the blood level.

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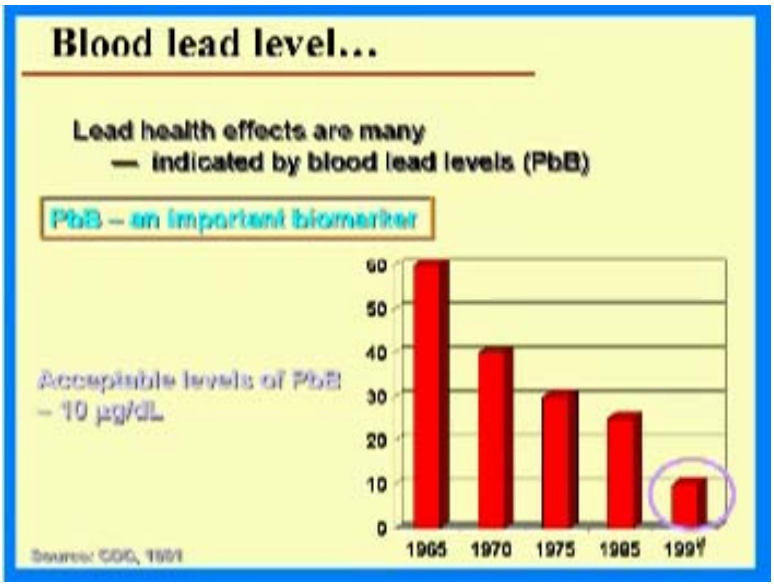

Look at how the science has changed. This is a reference from CBC and you see here in 1965 people thought if the blood lead levels are lower than 60 microgram per decilitre everything was fine; the person will not suffer because of the lead toxicity and adverse affects of the lead. People do more and more science, your instrument goes up, your technology goes up and then your techniques improve. In 1975 they said well 60 is no good, the blood level should be less than 40 microgram per decilitre. It happened that in 1975 it was 30. It stayed at 30 for many years. In 1985 it was around 24. In 1991 more science came up and said it should be 10. A recent paper in 2003 - now they are talking even below 10 micron per decilitre; may be adults are safe, but children get affected because of this one. Acceptable level in 1991 which is still acceptable, but it is now believed that even we need to go below 10 micron per decilitre. This is the story of lead and that is how you see here. Even lead exposure let me quickly give this one.

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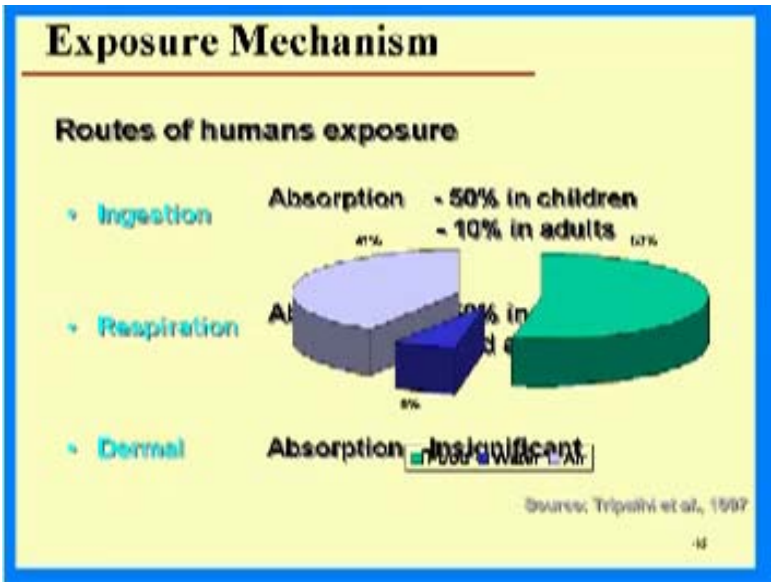

It is from the air route. This is food, this is water and air route; it is not small; I mean the air route was one of this. So with a leaded thing, this part has mostly gone, but this is still there. We have lots of lead in the soil and things like that. So argument of the industrial person is not tenable. They will always have enough into the soil that it will reduce the required amount of metal and things like that, but anyway lead is not required for the body; no useful biological function lead has.

We will stop there. We can just go on, but we will stop there, but what I will do is I will pass over some more material for you to read. Pollution also affects buildings, properties and textiles. It also affects the plants and the crops. We cannot go so much into details in this course. You should read from some books information as to how it can affect plants, [47:50] is there and that sort of thing [Audio not clear 47:50 – 48:02]. Either I will pass on that to you, but we will not cover it in this course, but you still read those because that is very important; because, that is the part of the course - the facts and other things. It is an interesting area, but then we cannot go on more than two lectures on this one and we stop here.