Sensors and Actuators
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Lecture - 45
Clean room guidelines and Cancer Dianostic tool

Hi, welcome to this particular module. In the last module what we have seen? We have seen lithography and in particular front to back lithography. I told you that, it is very important to understand the backside alignment, because if you want to create a diaphragm and the diaphragm should be just below the pressure sensor then the backside lithography is extremely important.

So, if you; before we go in detail about how it will be useful, we will just quickly look at two videos which are about what is a clean room and a class type of cleanroom and the cleanroom protocol. As you have also seen or you may be looking at depending on our video number, that there are certain protocols that you need to follow when you have to use the clean room facility, ok.

So, this will also give you an overview of what exactly you need to what kind of protocols are there and how can you gown yourself before you enter the clean room, what you should do and what should not do when you work inside the clean room. And of course, it will also show you the types of cleaned room. And we will take very important example; which is a piezoresistive microcantilever, all right and in that, we will see the importance of your front to back lithography system.

So, there is a plan, so, let me show you the first video, actually, there are two conjugative videos, so first let me play the video.

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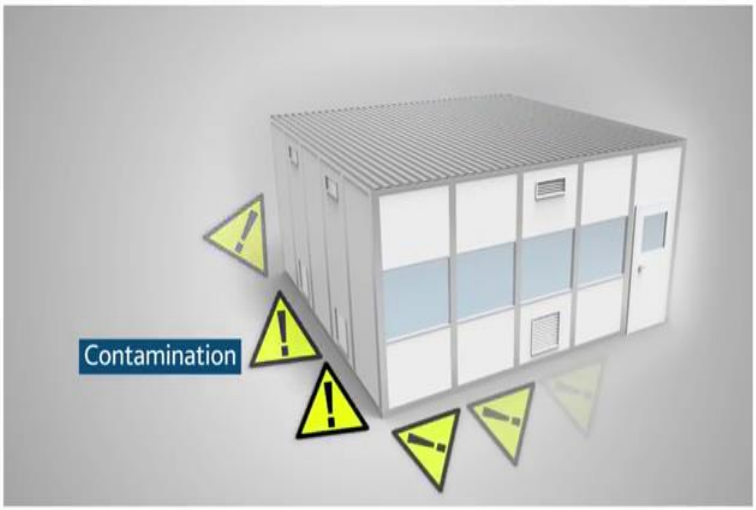

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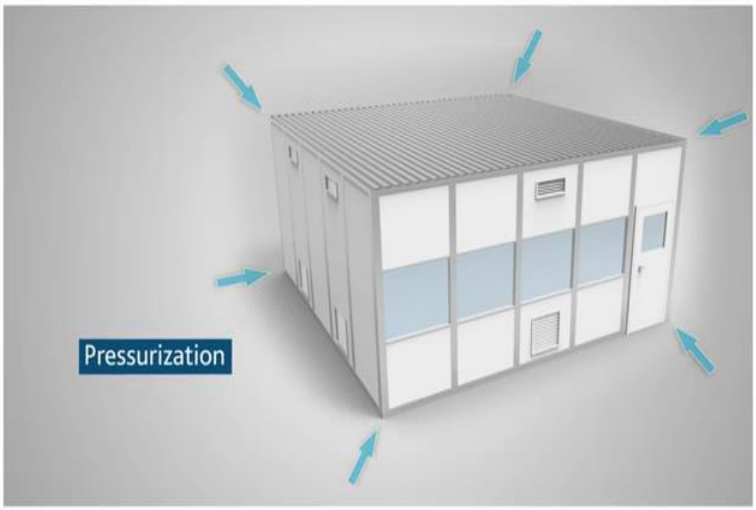

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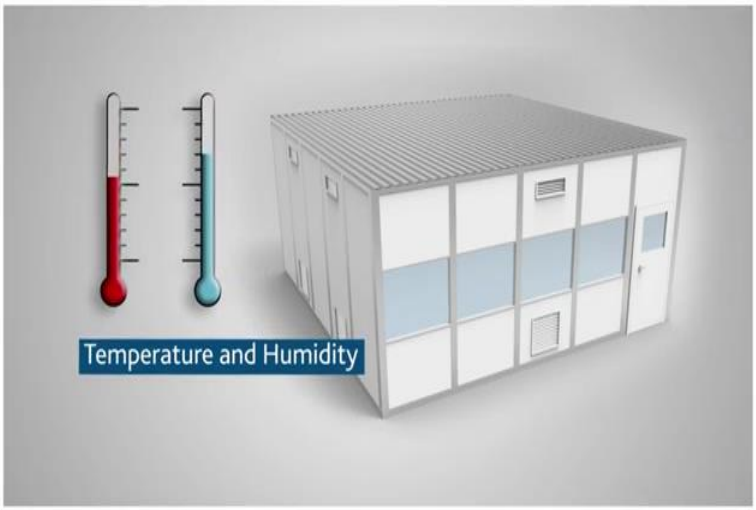

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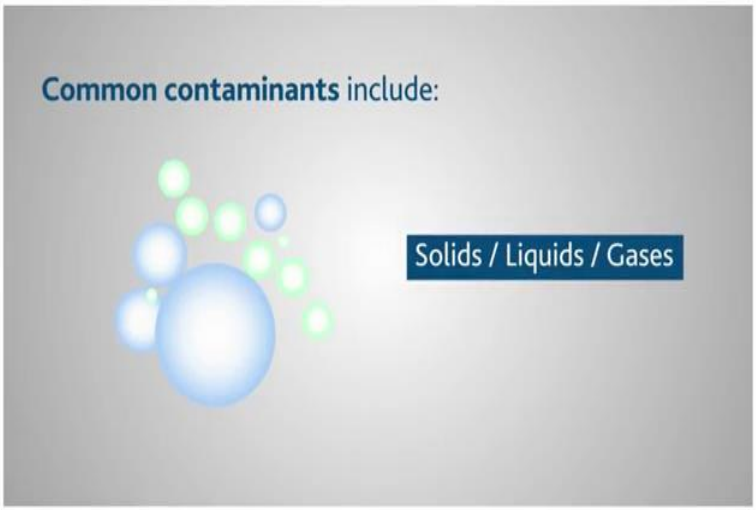

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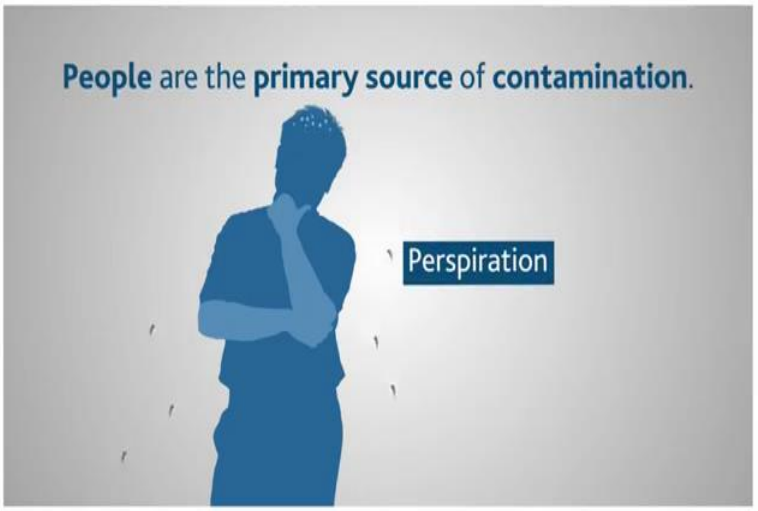

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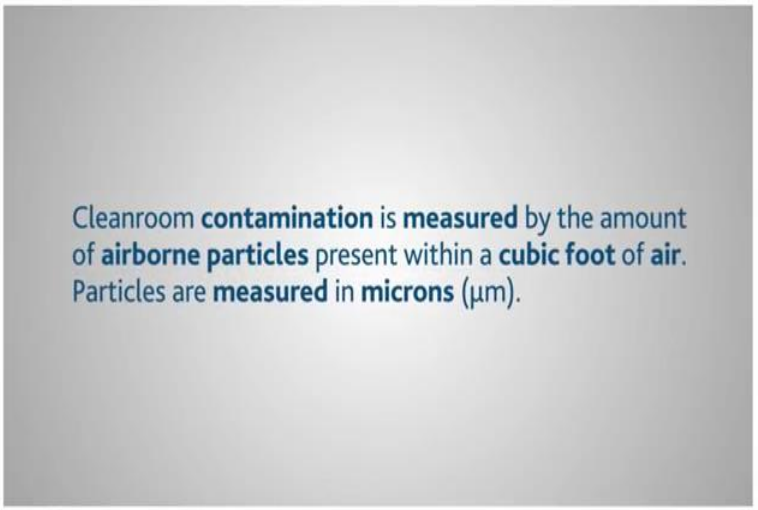

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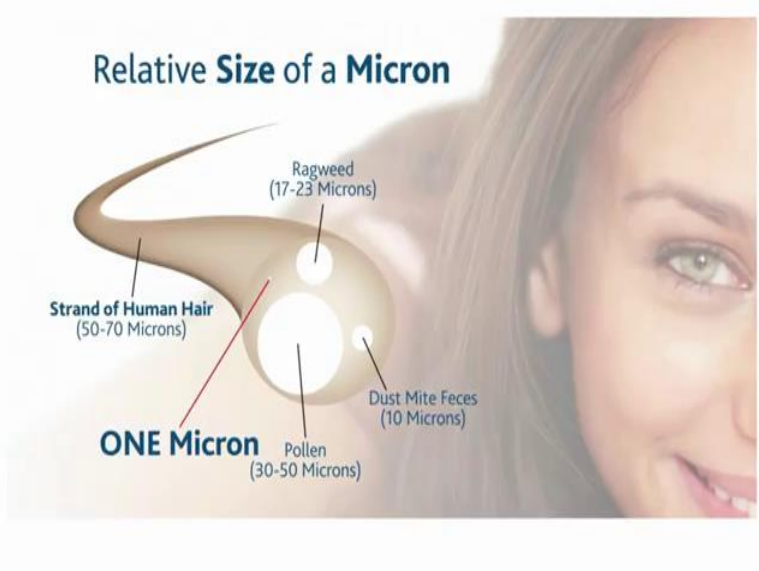

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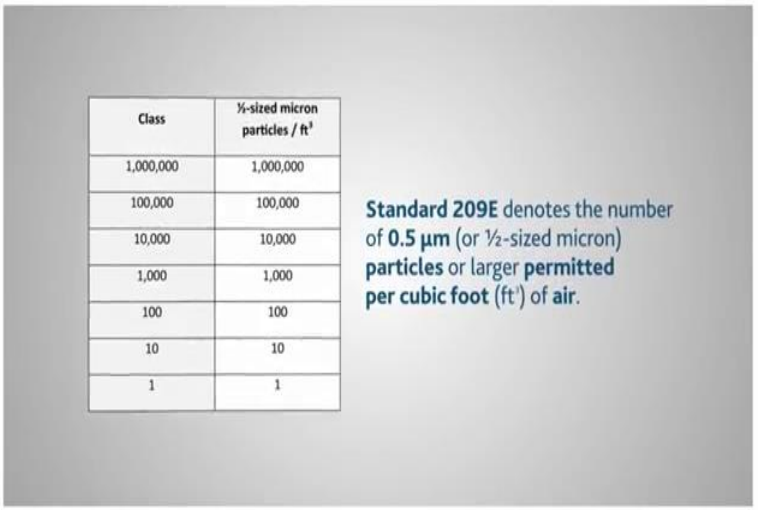

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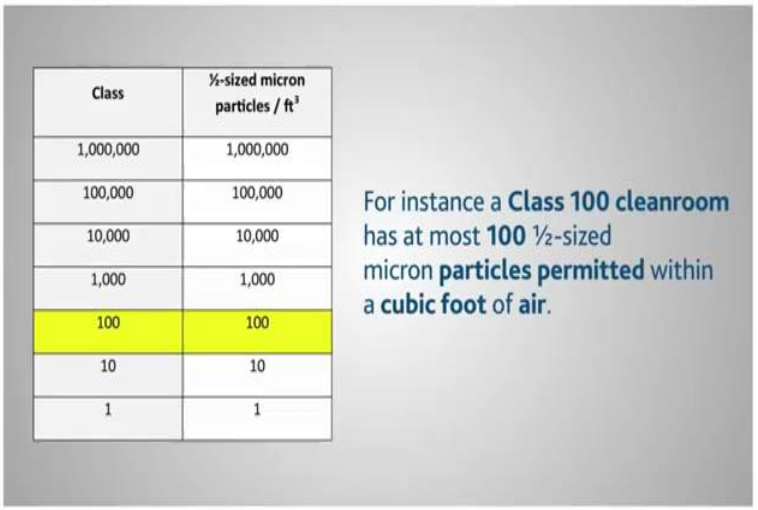

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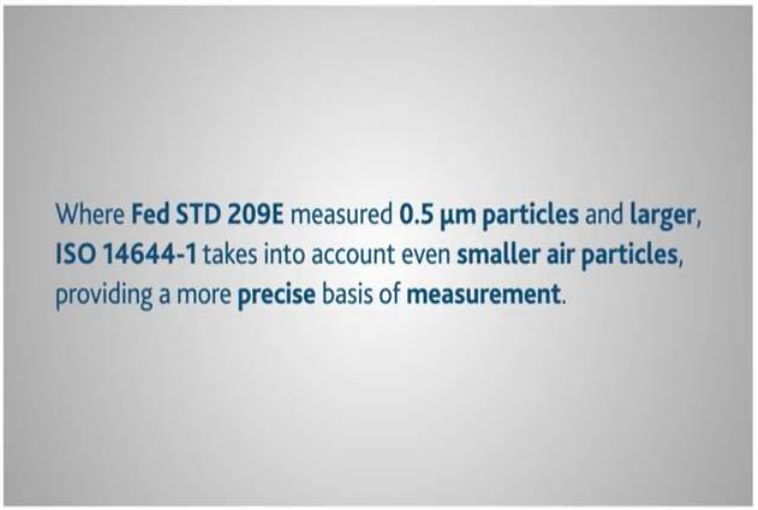

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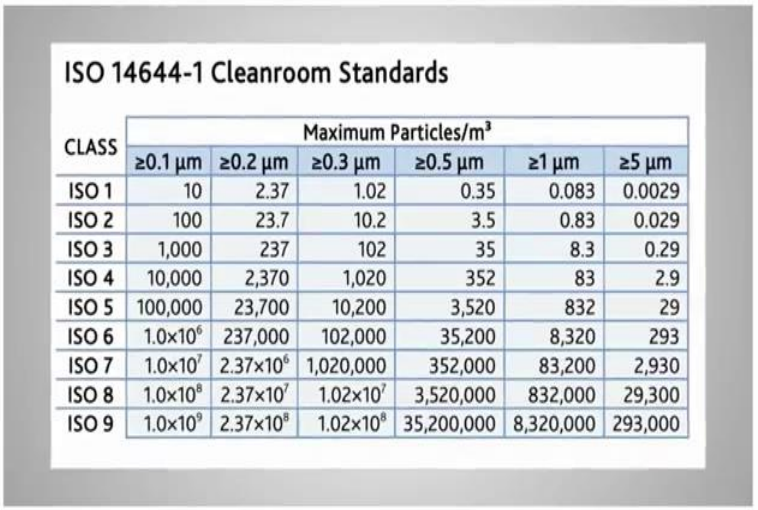

CLASS	Maximum Particles/m^3					
	≥0.1 µm	≥0.2 µm	≥0.3 µm	≥0.5 µm	≥1 µm	≥5 µm
ISO 1	10	2.37	1.02	0.35	0.083	0.0029
ISO 2	100	23.7	10.2	3.5	0.83	0.029
ISO 3	1,000	237	102	35	8.3	0.29
ISO 4	10,000	2,370	1,020	352	83	2.9
ISO 5	100,000	23,700	10,200	3,520	832	29
ISO 6	1.0×10^6	237,000	102,000	35,200	8,320	293
ISO 7	1.0×10^7	2.37×10^6	1,020,000	352,000	83,200	2,930
ISO 8	1.0×10^8	2.37×10^7	1.02×10^7	3,520,000	832,000	29,300
ISO 9	1.0×10^9	2.37×10^8	1.02×10^8	35,200,000	8,320,000	293,000

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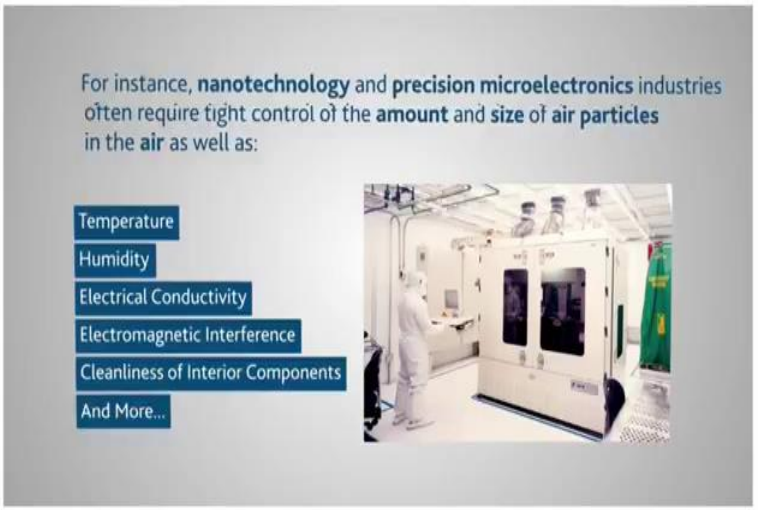

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So, now, let me play the second video as well, if you see the screen.

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Welcome to keeping it clean, how to properly use cleanrooms provided by NASA Langley Research Center.

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Clean rooms are one of the most valuable tools in limiting contamination of sensitive hardware such as optics, science instruments and spacecraft.

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In this video, you will learn about clean rooms, how to enter an existing clean room properly in correct procedures for operating in a clean room to ensure minimum contamination.

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Introduction to clean rooms; what is a clean room? A clean room is a room in which the quantity and size of airborne particles are controlled in order to limit contamination. A clean room is also constructed and operated in a manner to control the introduction generation and retention of contaminants inside the space.

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Filtered air flows into the room through high efficiency particulate air or HEPA filters. Clean rooms are classified based on the amount of allowed airborne particles in the room at any given time.

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The fewer particles allowed the more precautions that must be taken in order to prevent contamination.

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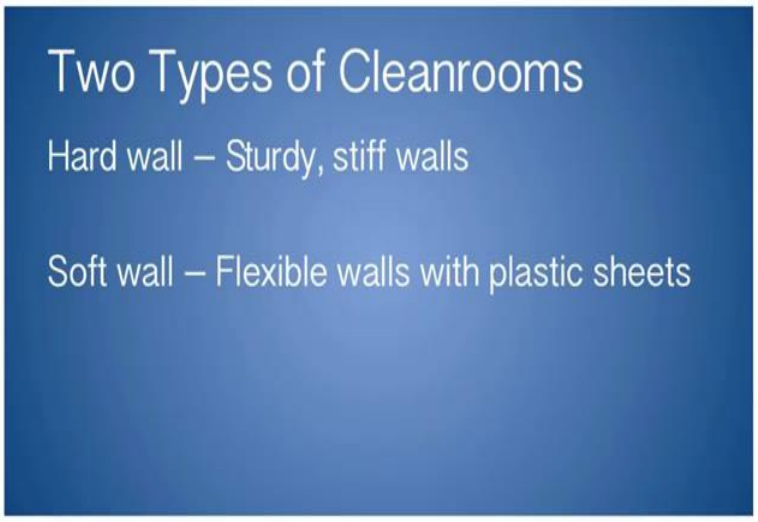

There are two different types of clean rooms; hard wall clean rooms have steadily constructed rigid walls, soft wall clean rooms have flexible walls, such as plastic sheets or strips. Hard wall clean rooms are typically cleaner than soft wall, but the processes to avoid contamination are similar in both.

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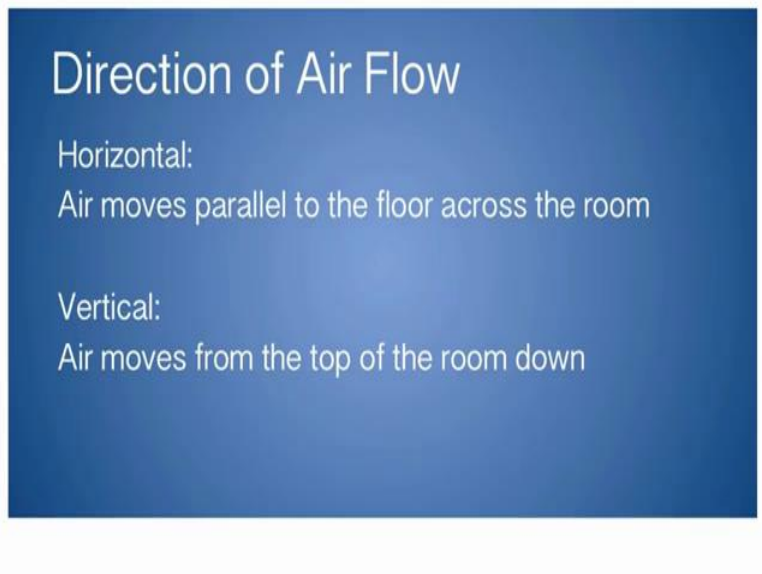

Clean rooms can also be classified by the direction of the air flow. Some clean rooms have horizontal air flow, in which the filtered air enters at one wall and exits through an opposite wall. Vertical flow clean rooms provide filtered air from the ceiling and the air flows downwards towards the floor.

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Clean rooms are classified under the ISO Standard 14644. The classifications are based upon the amount and size of airborne particles in a clean room at any given time. The

ISO standard covers nine classes of clean rooms with class 1 being the cleanest and class 9 being the least clean.

This video primarily covers ISO Class 7 and ISO Class 5 clean rooms. As these are some of the most common classes of clean rooms used. ISO 5 clean rooms are much cleaner than ISO 7 clean rooms and hence, more precautions must be taken to limit contamination.

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Preparing for work in the clean room; the clean room is not an office or a general lab area certain items that are perfectly fine in other areas are prohibited in clean rooms. We have to properly prepare before gowning up and entering the clean area. First remove any cardboard, paper or other fibrous outer packaging from items. Paper and cardboard excessively shed particles and fibers are prohibited in clean rooms.

Only clean room notebooks and clean room paper may be used in the clean room. If regular paper must be used; it should be sealed in plastic sheet protectors or plastic bags. Only ballpoint pens without caps should be used in the clean room. Graphite pencils create particles next dispose of any prohibited items such as paper, trash etcetera. Food and drink are also prohibited in clean rooms.

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If you do not know, whether or not an item is prohibited; consult the contamination control engineer or the manager in charge of your clean room. Next, wipe done the outer surfaces of any tools and hardware that you plan on bringing into the clean room, this will reduce the amount of particles you introduce to the room.

If you are carrying the items in a container such as a tote, the outer surfaces of the tote must also be wipe done. Use the wipes and solvents provided for your clean room area. Wipes may be pre moistened where dry wipes with solvents such as isopropyl alcohol may be used, once a wipe becomes visibly dirty discarded in the required container and use a new wipe.

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If shoe cleaners are provided then use them as demonstrated.

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Put booties on your feet to prevent tracking in particles. As you enter the clean room, take care of the step on the adhesive sticky mat, which further prevents particulate contamination.

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If the adhesive sticky mat is dirty, remove the dirty layer to expose a clean layer before entering the room.

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Cleanroom gowning, ISO class 7 or 8; we are now ready to gown up for the cleanroom. First, we will go over the gowning typically used for an ISO class 7 or 8 cleanroom environment.

However, your specific environment may require more stringent controls always check with your contamination control engineer or manager. After entering the gowning room, clean room users should always gown up in a top down manner starting at the head.

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First, place the bouffant cap over your hair and ears, make sure the cap covers all of your hair. People with long hair should tie their hair back, before putting on a bouffant cap. Next, put on a face mask completely covering your nose and mouth, this limits particles being introduced to the environment or hardware from our breathing.

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Next, obtain a smock, which will usually be provided in a clean sealed bag. Cut up in the bag with scissors and throw the bag in the trash. Unzip the smock and put the smock on one sleeve at a time, taking care to make sure the smock does not touch the ground or other surfaces. Zip the smock all the way up and secure any snaps at the neck. Be sure to choose a smock size that fits comfortably, not too big and not too small.

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Finally, obtain clean gloves. The specific type of glove approved for your area; depends on the hardware and operations, you will be performing always handle bluffs by the gauntlet and do not touch the finger and thumb portion of the glove. Pull the gloves on and make sure the gauntlet of the glove covers the wrist of your smock.

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Some areas require additional control and require taping the glove gauntlet to smock with the proof tape.

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Again check with your contamination control engineer or manager for this requirement. Check yourself in the mirror to ensure you are dressed properly for the clean room, if entering the clean room with someone else use the buddy system and check each other to make sure you are both properly dressed. You are now prepared to enter the clean room.

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Cleanroom gowning ISO class 5 or 6; gowning for an ISO class 5 or 6 clean room is slightly different than gowning up for an ISO class 7 or 8 clean room.

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Instead of a smock, a full set of coveralls or bunny suit must be worn. However, the same principle as before follows and the gowning process should go from the top down starting at the head.

First, place the bouffant cap over your hair and ears, make sure the cap covers all of your hair; people with long hair should tie their hair back before putting on the bouffant cap. Next put on a face mask completely covering your nose and mouth. The next steps are different for gowning up for an ISO class 5 or 6 clean room compared to an ISO class 7 or 8 clean room. Obtain a clean hood and open any bag in with scissors. Throw the old bag away.

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Place the hood over the head, on top of the bouffant cap and facemask; adjust the cover using the buttons in the back if it does not fit properly. Be sure to choose a hood size that fits comfortably.

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Obtain a set of clean room coveralls or bunny suit. Gather up the coveralls and sit on the dirty side of the bench, it is absolutely important that the coveralls do not drag on the floor while dressing. Carefully step into one leg of the coveralls and then the other leg. Stand up and put your arms in the sleeves, again making sure the sleeves do not touch the ground, zip the zipper all the way up and secure any snaps of the neck. Tuck the bottom of the hood into the top of the coveralls. Make sure you have chosen a comfortable size and the coveralls are not too big or small.

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Choose the correct size clean room boots; boots that are too large can cause a trip hazard. Carefully step into the boot, the disposable bootie will remain on your shoes and will be worn inside the clean room boot. The leg of the boot is worn over the coveralls, secure any snaps and tighten all straps for a proper fit then, swing one leg over to the clean side and then the next, then stand up.

Follow the same procedure for putting on clean room gloves, making sure to handle them by the gauntlet and avoid touching the fingers and palm region. The gauntlet of the glove will cover the cuff of the coveralls. Tape gloves as necessary for the requirements of your area. Finally, check yourself in the mirror and check your buddy if you have one. You are now prepared to enter the clean room.

Working in the clean room, when entering the clean room there might be another adhesive sticky mat in front of the door, be sure to step on it before entering. When in the clean room, practice slow and methodical movements, so, as to minimize the number of particles, you release in the air by moving. Moving around quickly; you can introduce nearly 50 times as many particles as moving slowly. Be sure to check your gloves regularly from any rips tears or contamination, if your gloves are damaged or contaminated exit the cleaner and change out of your gloves in the gowning room.

Your skin can introduce large quantities of contamination so, properly covering your hands is essential for protecting the hardware. If you have to sneeze or cough, be sure to do it facing away from the equipment. Do not cough or sneeze into your gloves.

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Prohibited actions; while in the clean room, a number of behaviours are prohibited as they introduce unnecessary contamination. Smoking is prohibited in the clean rooms, as it introduces a vast number of unnecessary particles into a clean room. Applying makeup in the clear room is also prohibited as makeup is a huge source of contamination.

Touching once face with gloved hands introduces skin and oil to gloves which then gets transferred to hardware and other surfaces. Removing gloves face masks for any clean room garments is prohibited in the clean room and should only be removed in the gowning room. It does not open your smock or coveralls to pull items out of your pockets, such as cell phones. Eating, drinking and chewing gum or tobacco are not allowed in the clean room.

Do not enter the clean room wearing street clothes, only proper clean room garments may be worn in the clean room. Do not wear clean room garments outside of the clean rooms and then return to the clean room, this is especially true for soft wall cleaners.

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Exiting the cleanroom; when finished in the clean room, your next step should be to de-gown in the gowning room.

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The De-Gowning process goes in reverse order as the gowning process from bottom to top. Here is the de-gowning process for an ISO 7 or 8 clean room.

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Take off your gloves and dispose of them in the proper receptacle. Remove your smock, if your only leaving the clean room for a short period of time, you can hang your smock in the cabinet. If not place your smock in the hamper, so that it may be washed and reused. Remove the facemask and bouffant cap and dispose of them as well. Finally, exit the clean room take off your booties and throw them away.

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The process is similar for an ISO class 5 or 6 clean room. Once again take off everything in the reverse order.

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Remove gloves and place them in the trash.

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Remove each clean room boot.

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Unset the coveralls, remove the sleeves from your arms and sit on the clean room bench.

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Remove the hood, blitz coveralls and boots maybe hung up in the cabinet for a short period of time if you will be returning to the clean room later that day otherwise place the garments in the laundry hamper.

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Remove the bouffant cap and facemask and dispose of them in the trash. Exit the gowning room and throw the booties away.

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Special topics; depending on the project and clean room special equipment and procedures may be required.

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If you are required to wear an electrostatic discharge or ESD wrist strap.

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The ESD strap must be worn on your wrist under both the garment sleeve cuff and the glove gauntlet.

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If your project requires safety glasses, be sure to put these on over top of your facemask and bouffant cap and under your head cover.

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If your clean room has an air shower, be sure to use it prior to entering the clean room. This shower blows pressurized air over the garments as a final cleaning method to remove particles before one enters the clean room, only one person at a time may use the air shower. To review practising proper clean room procedures is integral to maintain a clean room environment, it helps to ensure the safety and success of a given project.

When entering a clean room, you should dress up from the top down, while in the clean room be sure to move slowly and deliberately and check your gloves regularly, when exiting the clean room de-gown in the reverse order. This concludes keeping it clean, how to properly use clean rooms. Thank you for watching and for following proper cleanroom procedures to keep our sensitive science instruments and spacecraft clean.

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All right; so, now, as you have seen in the videos, right. So, you now have an idea of some clean room protocol. Let us talk about a very innovative cancer diagnostic tool. Now when I talk about cancer, we will talk about tissue related cancer, and when you talk about tissue related cancer there will be many cancers, starting from breast cancer, oral cancer, cervical cancer, lung cancer, prostate cancer and many more, ok.

So, cancer that affects the tissue is called tissue related cancer. I am just giving you an easy way of identifying cancer, otherwise, the technical way is there is metastatic cancer, there is nonmetastatic cancer which is like there is an invasive, non-invasive, we dont to worry about that. Right now, what we are looking at is, can we develop sensor that can diagnose a change in the tissue properties, alright. And, what are the changes in a tissue property and right now, how the cancer is diagnosed? Now, I have taken an example of cancer because, you are developing a sensor, right.

So, can you use sensor to diagnose the stage of cancer or type of cancer? So, the current way of identifying the diagnosis in cancer, it is two ways; one is screening called screening and the second one is called the diagnosis. Screening is the ASHA work or the primary care healthcare worker's, we will take the cells from the region which is affected. It the cells would be smeared; that means, you take glass slide, load the cell take another glass slide and smear it. Then the individual cells they are stained with H and E before you smear diagnostic it with H and E which is a staining reagent. And then

each cell is observed under the microscope by a trained Onco Pathologist for its morphology.

So, the change in the shape of a cell, right, can result in a next step in the cancer diagnosis. If the cells are same; it is ok. If there is double nucleation, cell to cytoplasm ratio, change in the shape of the cell, as I said earlier and there are 6 different parameters that people have to understand, and if one of the parameter is identified on the glass slide which is smeared with cells, then the outcome or the report says atypical. atypical cells are typical; atypical that is the diagnosis.

The diagnosis is not that a patient has cancer, the patient has pre malignant which is pre cancer or patient is normal? No, is a for sure it is it does not look like normal right, whether it is benign or whether it is pre malignant or whether it is malignant, right. Oncopathologist cannot tell based on just a screening report.

This study of cells right, for screening is called cytology, all right. Now, in screening if we identify that the cells are changing its morphology and the report is saying that it is atypical this particular subject, cells of the subject show atypical properties, then the subject is asked to go for the next stage, and that stage is called histology. Histology is study of tissues.

And histology, the area which is suspected the tissue is removed from that area and it is sliced with a system called microtome right, and then further after slicing it with a microtome, different biomarkers are applied to study the presence of cancer cells on the tissues or there are no cancer cells and vice versa. So, you understand let us say this is the tissue, slice the tissue, look at the biomarkers and understand whether the set of biomarkers for that particular cancers are present or not. This is how right now the cancer is diagnosed, alright.

Now, one is cell study, right; one is cell study cytology, but if you talk about type of cancer, then the screening method may be different, but the diagnosis more or less, when it is tissue related cancer it is histology and immunohistochemistry which is also called IHC, alright. Now, we will look at one particular cancer which is breast cancer and the reason for talking about or discussing this particular cancer is that it is the second largest cause of cancer-related death in women.