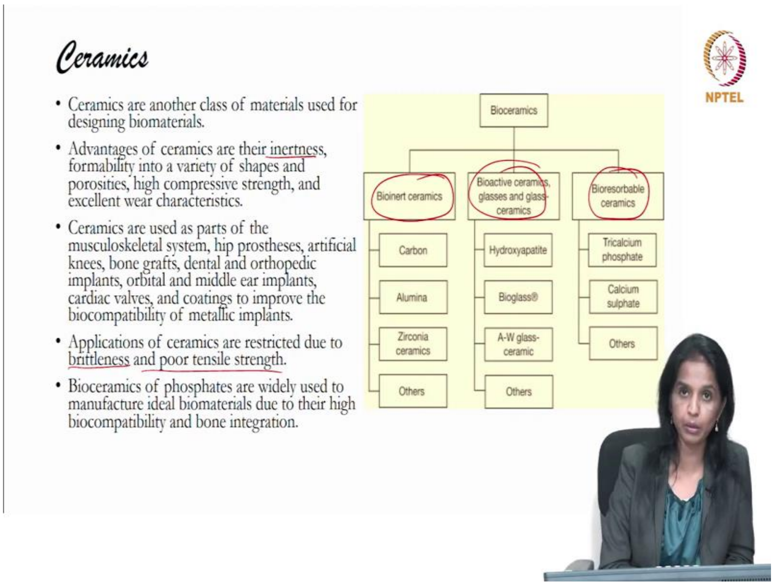
Oral Biology
Dr. R. Ramya
Department of Oral Biology
Indian Institute of Technology, Madras

Lecture - 25
Biomaterials - Ceramics and Colloids

(Refer Slide Time: 00:16)



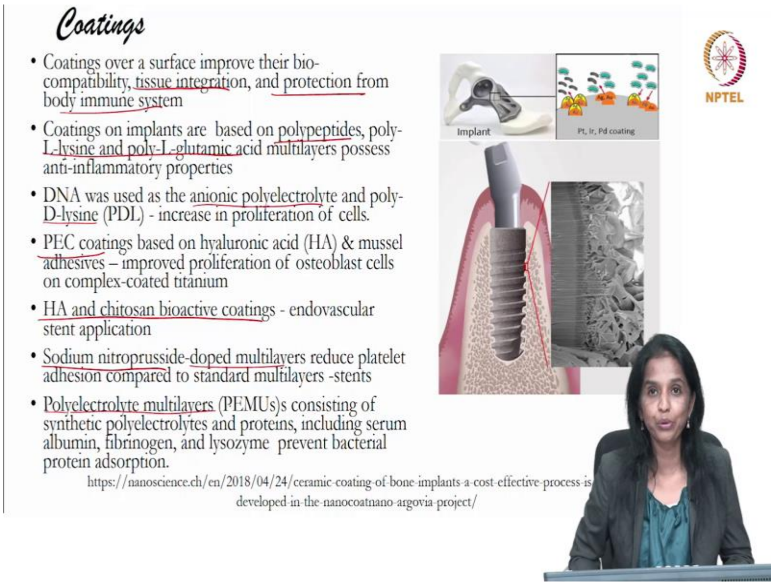
Next we go on to a very interesting area of biomaterials those are bioceramics. So, bioceramics are more sought after and they are broadly classified into bioinert, bioactive and bioresorbable ceramics, do not we read bioinert which means that they will not be reacting to the environmental area. They would not react and it will stay inert. So, they would be compatible, but they would be inert.

So, the examples being carbon, alumina, zirconia ceramics and, in bioactive ceramics we have to understand that the moment we see the word bioactive which means that particular element has the potential to induce bone induction or then it can also conduct. So, bone osteoinduction and osteoconduction is possible when the element is bioactive, not only for bone induction and conduction.

If a material is bioactive it also some materials also has the capacity to serve as antimicrobial agents as well. So, the examples of bioceramics are hydroxyapatite bioglass and then we have glass ceramics. Bioresorbable ceramics are tricalcium phosphate, calcium sulphates so all these are very important. So, advantages of ceramics are some of them are inert and then they can be formed into various structures depending on their porosities and their compressive strength.

So, as how it is it was described for metallic biomaterials your ceramic biomaterials also has a very huge amount of applications similar to your bone metallic biomaterials. So, the application of ceramics are only the disadvantage when compared to bone when compared to metal is that it is more brittle and poor tensile strength, whereas, it is very high tensile strength in case of metals.

(Refer Slide Time: 02:29)



Bioceramics of phosphates are widely used in ideal biomaterials because of very high biocompatibility and bone integration. So, that is where your tricalcium phosphates are most preferred materials because of excellent biocompatibility and now, we move on to an area which is called as coating. So, when and where you need a coating? So, if there is a material suppose for example, which is made of a metal and this metallic surface is inert and it is not reacting it is biocompatible.

If it is just biocompatible we keep it inside the body and nothing happens it is just remaining inert, but we want the material to work some more, we want the material to be strong at the same time we want it to be bioactive. If you want to make it bioactive and we know that for example, it is this is a metal rod, but we need to make it bioactive so what do we do we coat the particular material with a coating. So, that it triggers the bioactivity or it makes the graft or it makes the implant bioactive.

So, why do we need bioactivity? We need bioactivity for that particular device to create an environment where it can be more stimulating as what is required for that particular application. So, coatings are usually to improve biocompatibility, to improve tissue integration, protection from body immune system.

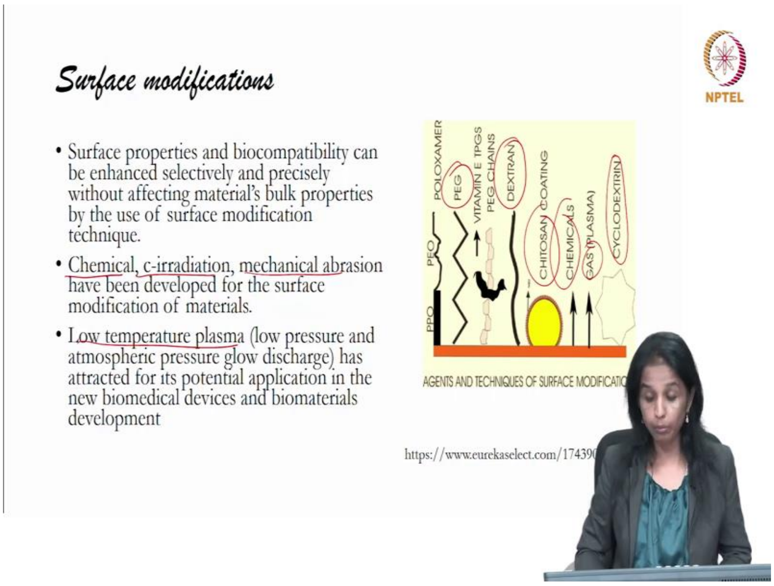
So, how one what are the coating systems which are commonly used? Commonly used are polypeptides poly-L-lysine these are all protein derived materials poly-L-glutamic acids and these are if it is going to be a protein derived coating, it is going to be giving anti inflammatory property and then we also have DNA used as anionic polyelectrolyte and poly-D-lysine increasing the proliferation of cells in implant based applications.

So, the moment we say implant based applications, implants are used in any part of the body of course, but it commonly refers to dental implants, but please do understand that orthopedic implants are also widely used.

And then we have this PEC coatings where which is again mixed with hyaluronic acid and mussel adhesives are used together to make it more stimulating. So, that the osteoblasts are coming to that site and then proliferating, the moment the material is going to be osteoblast friendly we know that bone formation is going to be very fast in that area and further we have hydroxyapatite and chitosan bioactive coatings which is widely used for endovascular stent application.

Anything related to cardiovascular application has huge scope and till date the cost involved in cardiovascular applications are very very high. So, any material if you can actually derive and give it to the society it would be of a great help. Additionally we have sodium nitroprusside doped multilayers which again are very useful for stents and then there is polyelectrolyte multilayers which are again made of polyelectrolytes, proteins, serum albumin, fibrinogen, lysozyme additionally to prevent bacterial entry.

(Refer Slide Time: 05:33)



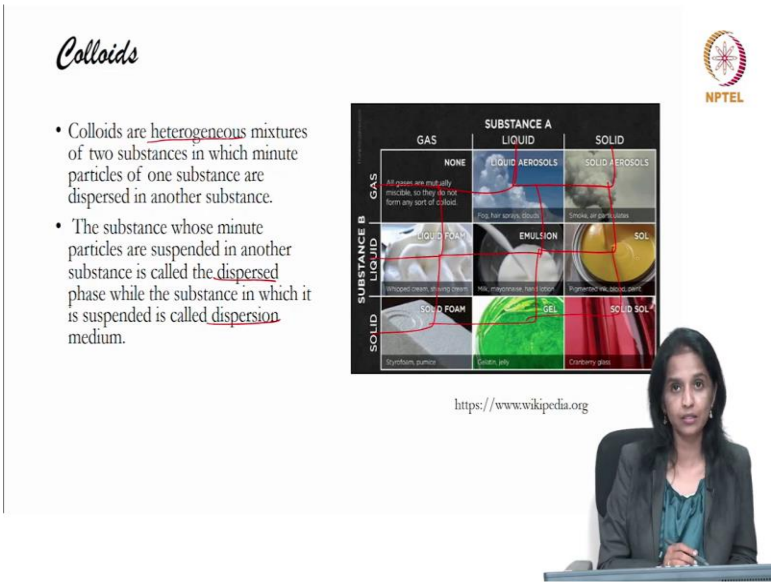
We just saw metals, we saw polymers, we saw polymer blends and composites, we saw coatings and what does surface modification do. Remember I told you that imagine this to be a rod and we are just coating, surface modification is different. So, surface modification is altering the surface itself by doing of course, coating is one modification, but instead you can make the surface simple modification would be to just make the surface a rough as its made rougher you increase the surface area.

So, as the surface area is increased the attachment of the cells to this particular surface becomes better and the proliferation becomes better and so on. So, implant based application surface modifications are very helpful. So, how are these surface modifications are helping.

So, they improve the biocompatibility and they are done by doing a chemical treatment or by irradiating or by doing a mechanical abrasion and also by applying low temperature plasma to the surfaces to derive whatever is required for that application.

Other examples being are polyethylene glycol and then you have dextrans, we have chitosan, chemicals, gas as plasma and cyclodextrin. Cyclodextrin is very widely used for in drug delivery systems. So, all these are dependent on whichever application is suitable for them. So, coatings and surface modifications are there to add on to or to make the existing biomaterial even better and hence increasing the biocompatibility their bio integration the bio conductivity and so on.

(Refer Slide Time: 07:17)

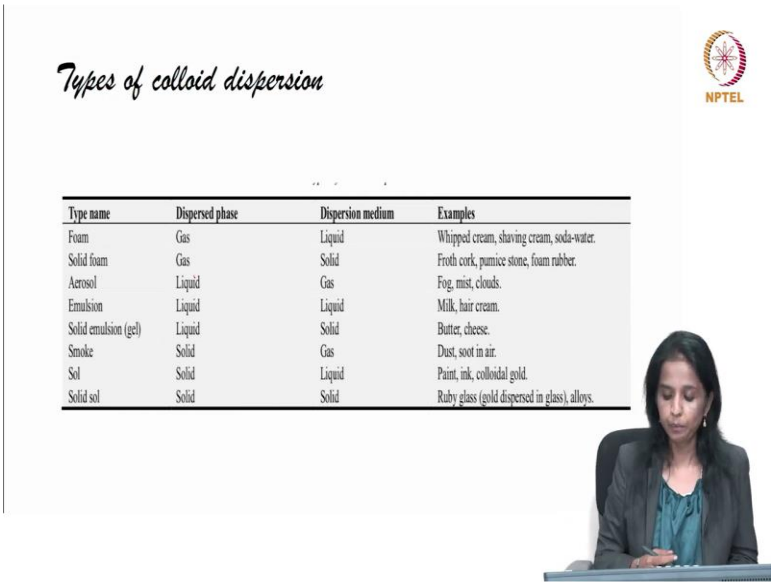


And, now we move on to another material next to ceramics is colloids. So, colloids again are very widely used especially the colloids which are widely used are your alginate. Alginates are preferred preferably used in wound dressings, they are used as a scaffold material, they are used as drug delivery systems and so on. So, before going into their applications what are colloids and what are they made of?

So, they are heterogeneous mixture the moment we say heterogeneous, it means that two materials are mixed up and there are two agents which are together. So, what exactly is there is that there is a dispersed phase and there is a dispersion medium. So, this dispersed phase and dispersion medium tend to form a newer agent.

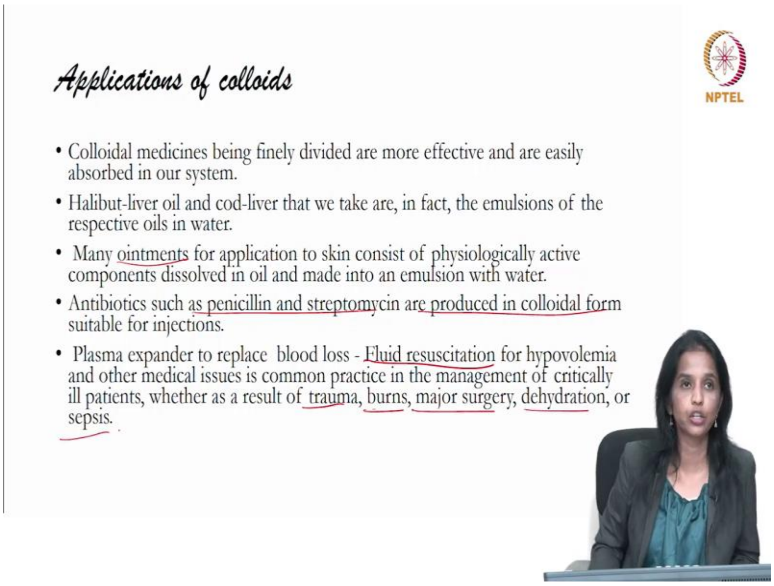
So, this dispersion agent can be mixed with another agent and then we form newer structures for example, gas can be mixed with liquid to form a liquid aerosol can be mixed with solid to form a solid aerosol, liquid can be mixed with gas to form foam and then liquid can be mixed with liquid to form an emulsion, liquid can be mixed with solid to form a sol, solid can be mixed with solid to form a solid foam can be mixed with liquid to form a gel can be mixed with solid again to form a solid sol.

(Refer Slide Time: 08:42)



So, all these are types of colloids which are available, the ones which are very highly or very frequently used biomaterial and biomedical science is that it is your hydro colloids. So, here again this is a these are examples of what we saw in that schematic diagram. So, this again tells you which is the dispersed phase and which would be the dispersion media and what would be the final product.

(Refer Slide Time: 09:06)

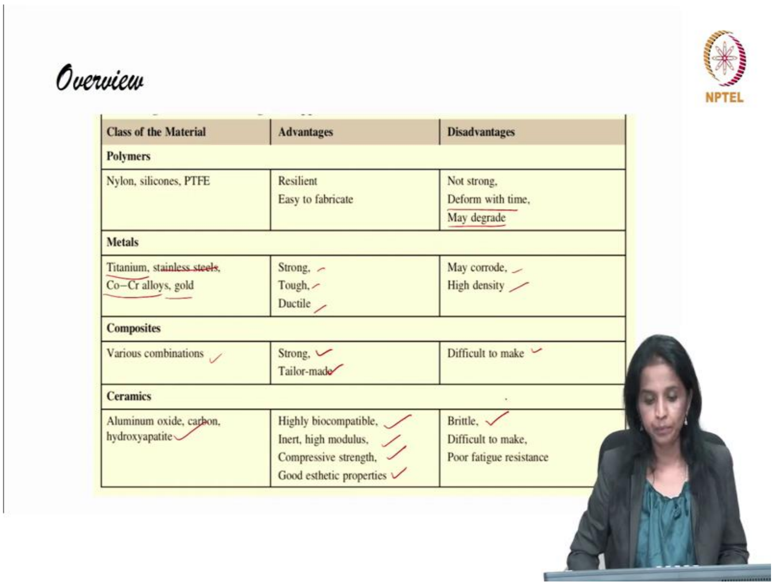


So, all these have lot of applications. So, where and how we do we use it. So, we use them in day to day life as liver oil or cod liver oil which is frequently taken as health care supplements then there are ointments, all these ointments or gel based ointments are all colloid based ointments and then we have antibiotics penicillin and streptomycin are all produced in colloidal forms.

Plasma expanders which are very important plasma expanders play a great role as fluid replacement therapies whenever there is a hemorrhage, whenever there is fluid loss. These colloids are of a great help and when they are supplemented instead of transfusing blood you can manage with application or supplying the body with colloids.

What do they do? They expand the plasma and by then the body would be able to manage the fluid loss. So, fluid resuscitation management for hypovolemic shock is very commonly used especially in cases of critically ill patient's trauma where there is blood loss, burns, where there is fluid loss, major surgery, dehydration or sepsis. So, they form a very important application in all these areas.

(Refer Slide Time: 10:19)

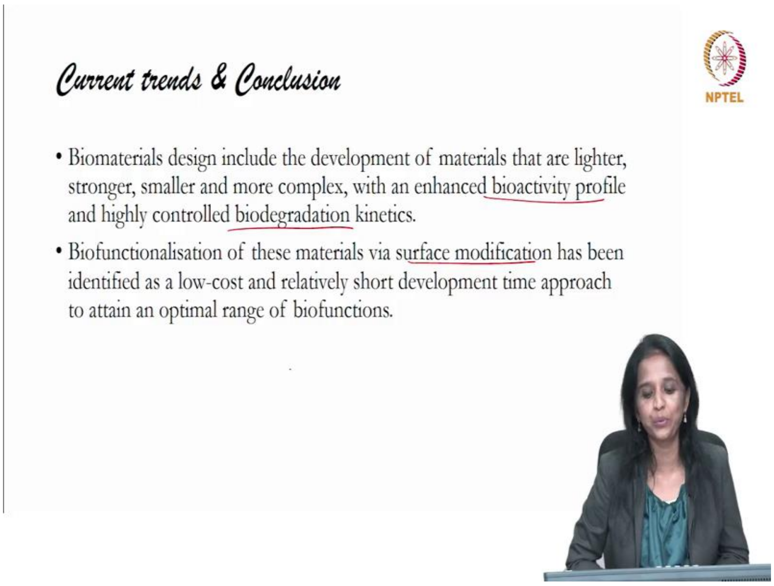


So, now we come into the complete overview of biomaterials and quick look at what are the ones and what are the ones which are most important to remember and what are the advantages and what are the disadvantages a quick look. So, polymers we know what are the materials we have nylon, silicones, polytetrafluoroethylene the advantages are that they are very resilient we know it is versatile and easy to fabricate.

Disadvantages is, that they are not as strong as metals and they deform with time and they may degrade. Metals we know they are very strong, titanium stainless steel, cobalt chromium gold they are very strong tough and ductile. They may corrode and high provide very high density. Composites are of various combinations they are also strong and they can be tailor made, but they are not that easy, they require more higher fabrication and formulation techniques.

Then we have ceramics aluminum oxides, carbon and hydroxyapatite these are highly biocompatible. They are inert high modulus, compressive strength and good esthetics, but it is brittle low tensile strength compression is high, but tensile strength is low. So in that way metals are superior as far as strength is concerned.

(Refer Slide Time: 11:38)



And with that we come to the end of biomaterials topic. So, the current trends and the most important thing which biomaterial advantages has to happen is that we need even more lighter, stronger, smaller and more complex materials which would exactly fit into the what to say the body tissues and which would also have a very bioactive profile and biodegradation should be controllable.

All these are most desired features of a biomaterial and if we can bring them all together, it would be a great contribution to the mankind where there are lot of things which has to be applied for and bio functionalization in the form of surface modifications can be kept on be improvising and we can keep on thinking of newer formulations and deriving better biomaterials in the service of mankind, in curing lot of incurable diseases, deriving lot of solutions for the service of mankind.

Thank you.