Introduction to Biomimicry
Prof. Mrinalini
Department of Multidisciplinary
Indian Institute of Technology-Madras

Lecture - 02
What is Biomimicry?

Hello, I am Mrinalini. I am your faculty for this course, introduction to biomimicry. I am guest faculty at IIT Madras, where I have been part of several projects in renewable energy, battery technology, embedded systems, and information systems. I also co-teach the biomimicry course at IIT Madras. Now you heard from Shiva that this course is to get you started in your journey as a biomimic.

In this week, what we will do is we will look at the what, the why, and the how of biomimicry. So let us get started. What is biomimicry? Now you would have heard several explanations, seen several definitions, read several descriptions of what biomimicry is.

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What we would like to use is this what you see on the screen. What is biomimicry? It is a practice that learns from and imitates the strategies found in nature to solve human challenges. Let us look at it in a bit more in detail. It is a practice, which means that there is something that you do. It is not just theory that you are going to get from books, there is something that you are going to do with it.

Learns from nature. You are going to learn something from nature. What are you going to learn, the strategies and principles of nature of how it does something. And then you are going to mimic those strategies, you are going to copy those strategies in order to solve human challenges. So that is what biomimicry is in a nutshell. To give you an example, and you may have heard this before, of the lotus leaf.

So you go to a forest or a pond, and you see that the lotus leaf is clean, whereas the surroundings and the environment is a bit dirty. And you can wonder how that happens. You could just admire the lotus leaf and say, oh, that is great, nature has figured out how to keep the lotus leaf clean, and be done with it. Or you could ask the question, how does nature do that, how does the lotus leaf stay so clean?

And then you examine the lotus leaf and you will find that on the surface of the lotus leaf are these small microscopic bumps that are water repellent. So, therefore, when water falls on the lotus leaf, it gets, it just rolls off the surface of the leaf. And it so happens that as the water rolls off, it also washes away the dust and the dirt along with it and therefore the lotus leaf stays clean.

So that is a strategy that the lotus leaf employs in order to stay clean. Now as a biomimic, you have now learnt how the lotus leaf does that. You can now look at where can I use this. So this is the part about mimicking the strategies to solve human challenges. So you can ask the question, where is it in the human world that this principle and strategy can be used.

One example of course is fabric. So you could look at fabric that does not get dirty using the same principle of the lotus leaf. You will be very interested to learn that there is a company called Lotus and Paints that has employed this principle of the lotus leaf for paint. So when a building is painted, the exterior of the building is painted with this paint it stays clean.

And that is biomimicry for you, learning from and imitating the strategies found in nature to solve human challenges. Now the next part what you see on this screen, learning about nature and learning from nature. Now these are two phrases that you will encounter pretty often during this course.

Learning about nature is when you look at, you look at organisms and learn about the typical characteristics of the organism, what is its scientific name, how does it look? Where does it live? What are its typical behaviors? Is it nocturnal? Is it a daytime animal? What does it do typically? What are the uses of this animal etc. Now that is learning about nature.

And we are not going to do that in this course. What we are going to do is learning from nature. Go back to the example of the lotus leaf that I just gave you. That is learning from nature. So you take the lesson of the lotus leaf, how does it stay clean? You learn that lesson. And you use it to create something. You solve a problem in the human world. And that is learning from nature.

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Now here is just a couple of examples to help you get the hang of that. Ants do not get stuck in traffic jams, do they? But humans do get stuck in traffic jams all the time. And can we learn something from ants in order to manage a traffic problem? If you are living in any large city in this world, you have experienced traffic. I mean, why only large cities? Even small cities and towns have traffic jams, do they not?

But here we have ants, who can be our teachers in order to help us manage this better. All we have to do is just look.

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We use almost 750,000 metric tons. Think about that. 750,000 metric tons of dyes, potentially toxic, non-biodegradable dyes maybe to actually color textiles. And here we have insects that actually create many splendid, exquisite colors without the use of any toxic dye. Is there a lesson there? Can we learn from nature? Yes, of course, we can.

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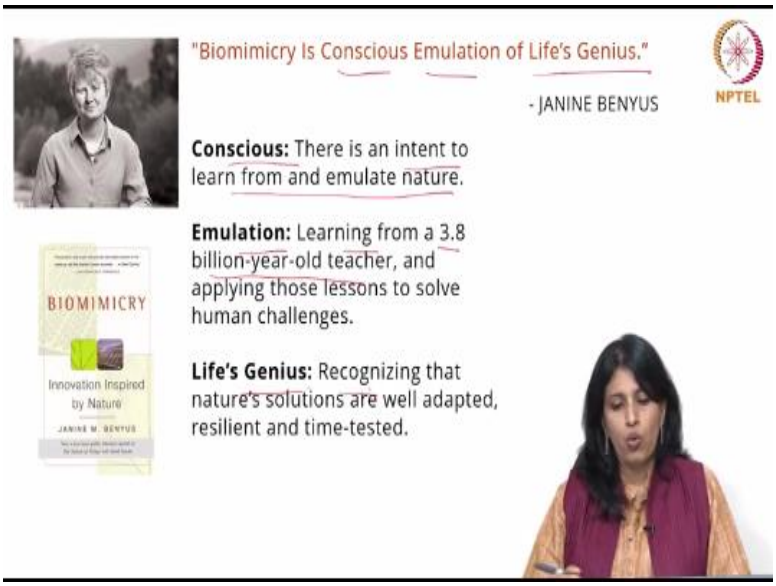

So next I would like to introduce you to a very important personality in this world of biomimicry, a person that you will encounter several times as you start learning the subject, exploring the subject. And that is Janine Benyus. Janine Benyus is who you see on the screen right here. She is the author of the book Biomimicry, Innovation Inspired by Nature. She is also credited with popularizing the term biomimicry.

And what Janine says about biomimicry is biomimicry is conscious emulation of life's genius. What does that mean? Let us just break that down a bit. Conscious means that there is an intent to learn from and emulate nature, which means that we recognize that there are lessons to learn from nature. If we are going to think that humans are the most intelligent, we have figured out everything that there is to figure out and therefore there is nothing that nature can offer us. That is really not going to help us as biomimics. We need to be aware, we need to acknowledge and recognize that there are lessons that nature can teach us, and we should be ready to receive them. You should be ready to look for them. You should be ready to examine them. Emulation, of course, is to learn from nature.

Remember, nature is a 3.8 billion-year-old teacher. Unfortunately, nature cannot speak. So, nature cannot come and tell you that you know, to solve this problem, you use this. To solve that problem you use that. Fortunately, nature cannot do that. But that does not stop us from looking for those solutions. All we have to do is right outside our windows, we have a 3.8 billion-year-old Research Lab.

An R&D facility that has stood the test of time, that has figured out what works and what does not work. And that part is the life's genius part. Because life on earth has figured out what works, what does not work. And therefore nature has figured out really the solutions to almost all problems that we can think of. We need to just look for the solutions.

And we need to recognize that these solutions have actually stood the test of time. These solutions work well. These solutions work well within the context of where life exists. And therefore we need to be ready to examine them, and understand them and apply them. And that is what conscious emulation of life's genius means.

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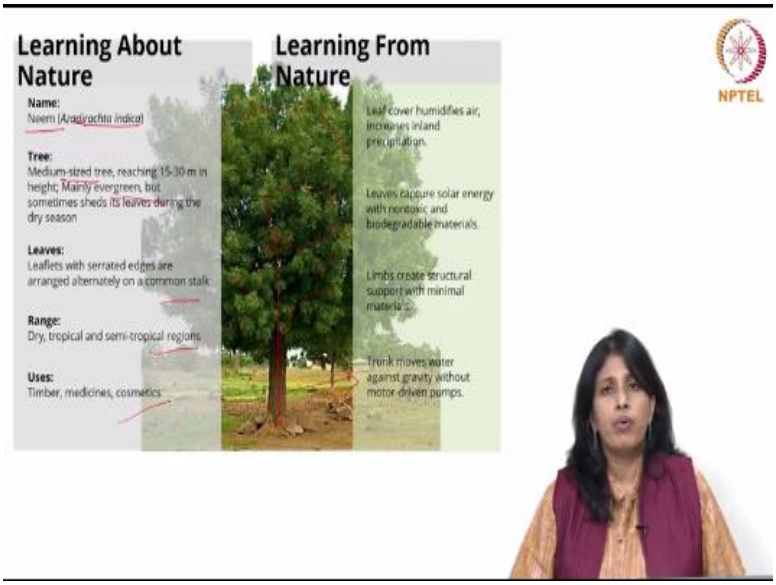

So learning about and learning from nature. We have spoken about this before. And I am going to use this example of the neem tree to help you understand what is learning about nature, and what is learning from nature. On the left, you see what is learning about nature. So you have the neem tree. Learning about nature would be understanding okay, this is the name of the tree.

This is the scientific name of the tree. What are the characteristics of the tree? It is a medium-sized tree. It is an evergreen tree. How does it, you know what seasons does it grow best in etc. And then common attributes of the tree. What do the leaves look like? What is the shape of the leaves? Where do they, you know, how do they grow etc. What geographical regions of the world does the tree inhabit?

And what are the uses of this tree? So this is typically learning about nature. On the other hand, learning from nature, what would that entail? Learning from nature would be you look at the tree, you find out what all it does. And then ask the question, how does it actually do that? Let us see it with an example. So you have this leaf cover that the tree has, and this leaf cover humidifies the air around it.

It also brings rains. You ask the question, how does the tree do that? How does the leaf cover, how does the canopy of the tree bring rains? Then you have leaves, these leaves that capture solar energy. And they do it without having any toxic materials, any non-biodegradable materials. And you ask the question, how does the tree do that? How does the tree have these million little solar cells that are capturing solar energy?

And that too doing it without toxic, non-biodegradable materials? How does it do that? Then you have these limbs, the branches of the tree, which are giving it structural support, and they do it with minimal materials. You do not have 1000 scaffolds and a million things supporting the tree. With minimal materials, it creates the support the tree is standing upright because of it.

How does the tree do that? And the trunk. The trunk actually moves water right from the bottom to the top of the tree without the use of any electricity, or any electric driven pumps. How does it do that? So that is learning from nature for you. Looking at nature, finding out what it does, and understanding how it does that, and seeing if those lessons can be applied to solve human challenges.

So that is learning from nature for you. I am going to take you to some examples of what is not biomimicry and what is biomimicry.

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For example this, what you see here. Take a minute to see what is on the screen. You have this lovely building, which has got a green cover on it on the balconies. Or inside the home you have potted plants and greenery. Is this biomimicry because there is some bio inspiration here, right? But is this biomimicry? Yeah, the answer is no. This is not biomimicry.

This is what is called biophilia or biophilic design. What is biophilia or biophilic design? Philia means liking. So biophilia or biophilic design is design which helps us remain close or connected to nature. And this is something that you will see a lot in the design of our apartment complexes, the office buildings, workspaces, etc. Because we innately like to be close to nature.

So you will have water fountains and gardens and greenery. So that is biophilia. That is biophilic design. It is a bio-inspired methodology but it is not biomimicry.

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Is this biomimicry? You see the beautiful Lotus Temple in New Delhi, India here and also you see a couple of lamps that are shaped like flowers, leaves. Is this biomimicry because you are certainly imitating something from nature here, right? So is this biomimicry? Yes, this is not biomimicry, this is biomorphism. Biomorphism, morph means form. Form as in structure of something.

So in biomorphism, you are imitating the form of nature, the visual elements of nature, the visual structure of nature. So biomorphism is something that looks like nature. And you will see a lot of examples of this in architecture, in design, you will see a lot of examples of this. You may have seen a chair that looks like a shell to give that cocoon kind of shape.

You may have seen, you know buildings that, you have buildings that look like the wings, the columns of the building look like the wings of a bird. So all these are

examples of biomorphism, very typically encountered in architecture and design because we are naturally attracted to these forms.

Again it is a bio-inspired methodology, which uses the fact that we are naturally attracted to these organic flowing forms and tries to use that in our, in design, in spaces that we live in, etc. So that is biomorphism for you.

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Now is this biomimicry? Now we get these questions, we get these questions asked many times. So I am deriving medicines from plant extracts or we are producing a vaccine using plant extracts. We are creating biofuels using plants. Is that biomimicry? You are creating vegan leather using mushrooms? Is that biomimicry? Well, the answer is no. This is what is called bio-utilization.

Bio utilization is when you are using materials directly derived from nature. You are using the material in the same form and using it to make something that is useful. So that is bioutilization.

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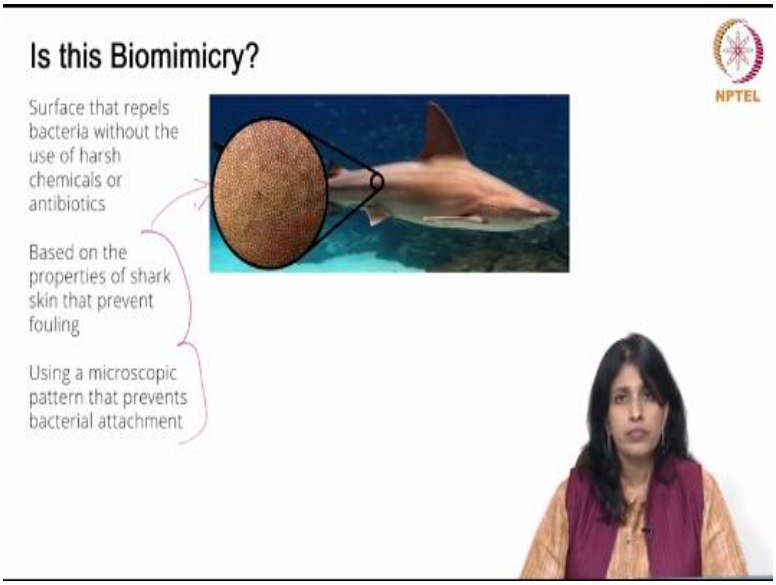

Is this biomimicry? What you have here is a surface, this surface that repels bacteria without the use of any harsh chemicals or antibiotics. How does it do that? It is based on the properties of shark skin. Shark skin has a property that prevents fouling. What is that? It prevents bacteria from attaching to the surface by the use of a microscopic pattern.

And you have a surface that uses this property of the shark skin in order to create an antibacterial surface. Is this biomimicry?

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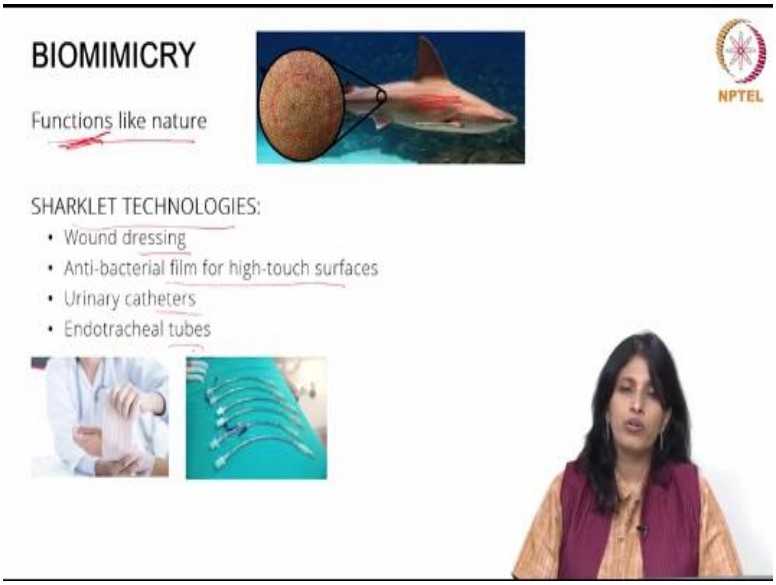

Well, the answer is yes, this is biomimicry. Because it does what we call functioning like nature. It is not just about looking like nature. It is about, it is not about using materials from nature. It is not about just having forms of nature. It is doing something

that functions like nature. And this word function is something that we will come back to time and again.

So just remember that biomimicry is actually when something functions like nature. So, in this case you have a surface that functions like the skin of the shark by preventing any bacteria from attaching to it. And a company has actually imitated that- sharklet technologies. They have imitated this principle in order to create surfaces where the chance of bacterial attachment is high.

So they are doing wound dressing, anti-bacterial film for high-touch surfaces like in hospitals and restaurants, etc. And surfaces again, where bacterial attachment is likely to be high like the insides of urinary catheters and endotracheal tubes. So they are using this technology in order to create antibacterial surfaces. And this is biomimicry for you where something functions like nature.