Introduction to Cell Biology
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Structure of the Cell: Discussion Session

So, let us see if we can take a few. There are a few comments. And let me see. Deep has a comment which says, what generates energy in the prokaryotes? Since we say that the mitochondria is the powerhouse of the cell, but mitochondria does not generate does not exist in prokaryotes? This is a good question.

So, for prokaryotes, a lot of the energy is obtained from the environment directly, which is kind of a huge rate limiting step for them. There is some amount of energy generation that happens within the cell, the energy sources are rather ineffective in keeping and storing and providing a large amount of energy, which becomes a rate limiting step for how they are able to grow and divide as well.

So, sugars, for example, could contribute in a big way to the energy that, prokaryotes could acquire, and grow with. And the existence of sugars. And their use, is also kind of visible from the fact that a lot of the architecture, in these bacteria is also put together, in some cases with sugars. So, that is the source of energy as far as prokaryotes are concerned. The tail is hydrophobic, did I say the other way around.

The outside the heads are hydrophilic in nature, so they kind of like the water environment. And so, they ensure that, the cell is in contact with the water. And the tails are hydrophobic, indeed, which allows them to be hidden on the inside and allows for that architecture to now come together in such a way that the cell can be in contact on either side with the aqueous environment. But at the same time for something to go through it.

It has to make it through this hydrophobic core. And so, mechanisms by which molecules can make it through, become important rate limiting steps and cells have evolved, ways to be able to kind of take things through as well. There are questions from people who raise their hands as well, deep, I took your query. So, I am going to go to Sarthak. Next, we will try and cover as many as we can, Sarthak go ahead.

Student: My doubt was regarding endosymbiotic theory; I understand that the bacteria is in the mitochondria is considered as bacteria that has been engulfed. But what gave the idea that the host was in archaea?

Professor: So, I am not sure there is very clear evidence, it may have to do with the fact that the ability of a cell to be able to take this up. And the fact that certain archaea, for example, have, properties characteristics that we know of now, especially at the level of their membrane, for example, that might suggest that they are actually that some of that is actually visible in the eukaryotic cell as we know it today.

So, I am not sure there is very definitive evidence for this. I mean, there are a lot of people who still put question marks on the endosymbiotic theory as well. And so, so that is the idea in suggesting that there could have been a sell one, which is slightly bigger in size, and had the capability to engulf a bacteria.

And so, the possibility that that is very likely to be an archaea. But I do not think there is evidence to suggest yes, it indeed was an archaea. Next question, Vinu Kumar, can you please go?

Student: Sir my name is Gadha.

Professor: Okay, sorry go for it.

Student: Sir with respect to the endosymbiotic theory, is there any evidence whether the plants cell or the animal cell evolved first from the prokaryotes?

Professor: So, good question. Actually, I do not know the answer to this. And I can find this out. Whether there is evidence, so if I remember correctly, in the kind of evolutionary scheme of things, the trees that have been built, evolutionary maps that have been built, the prokaryotic, the plant cell probably may have come earlier.

I could be wrong about this. Let me check this. It is a good question. I will come back to you. I think others should also know about this.

Student: Yes, sir.

Professor: Next question Vaishnavi?

Student: Sir, How would anaerobic eukaryotes have evolved then would they have just not taken in the oxygen utilizing bacteria?

Professor: Are there anaerobic eukaryotes?

Student: There are, Chlamydomonas are…

Professor: Are they entirely anaerobic?

Student: I am not sure sir.

Professor: So, so why do not you look this up whether there is really something that is completely anaerobic. And, has the same level of complexity as to be called the eukaryotes. Ishwar next to you.

Student: Yes, sir. You mentioned that mitochondria is an endosymbiont. So, it first entered a cell. But what I did not understand was, even though it first entered the cell, how did the DNA of the cell develop in a manner so that it was later able to produce the same sort of structure on its own, rather than something coming from outside again?

Professor: So, the nucleus to in part is also thought to be an endosymbiont. So it is highly possible that, so there are three things that and that is why, the existence of this event in like, very specific forms, like the fact that there is there could be that could have been a mitochondria, there could have been chloroplasts, there could have been plastids, and there could have been the nucleus.

And the nucleus also has a double membrane. And so, it is highly possible that, what became the nucleus and the DNA that came as part of the nucleus, came from a different source. But essentially, these two have existed, with their own DNA. Why exactly this became the more prominent DNA content of the cell, why it evolved to become the common acquire the complexity of chromosomes and everything else.

It is not clear as to, why this was chosen as the genetic material, while mitochondria essentially kept their genetic material, but, did not necessarily integrate that genetic material into this, there is something called maternal inheritance for mitochondria. And I did not talk about this, it is kind of clearly beyond the preview of what we are discussing here.

But if any of you are interested, go read a little bit about mitochondria inheritance and how DNA, how mitochondria and mitochondrial DNA is carried forward is very interesting as well. So, the nucleus could have been this alternate structure. Think a bit about? So what do I want you to think a little bit about?

Obviously, the endosymbiotic theory, and what that complexity means? The second thing to consider here is because we have touched upon the plasma membrane, and we have touched upon the perimeter of the cell, one of the questions that I want you to think a little bit about

is, if you had to build a cell and build a perimeter, what kind of properties you will put in that perimeter?

That is one property that we have already brought up, which is the fact that it is it has to have this hydrophilicity, hydrophobicity built in, which becomes beneficial. And it is, it is possible that there could have been a membrane that is just one thing that has two surfaces that are hydrophilic, and a code that is hydrophobic. Instead, we have two membranes, which are kind of assemble this way.

So, that is an interesting thing that has happened, why do you think that has happened this way? Why not one membrane, which has two sites, which are hydrophilic, and a central code that is hydrophobic? So, the boundary of the cell is what I want you to think a little bit about as to how you will construct it? And what kind of properties are required for that. So, think a bit about this, and then we will continue this discussion in tomorrow's class.