Introduction to Cell Biology
Professor Girish Ratnaparkhi and Nagraj Balasubramanian
Department of Biology
Indian Institute of Science Education and Research Pune
Mendilian and Non-Mendilian Genetics - Part 2

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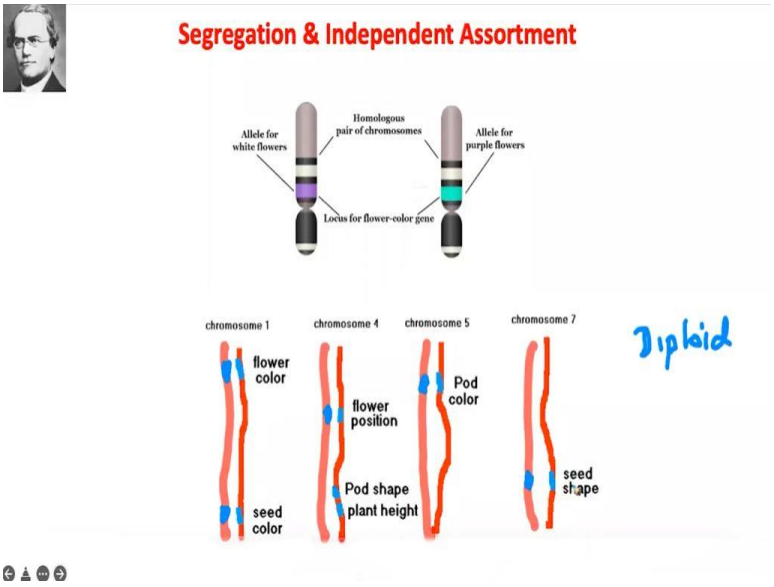

So, once more animals have chromosomes, chromosomes have genes. The Pea plant which Mendel worked on had genes on chromosomes. Pea plant is a diploid entity which means that we are not talking about a single chromosome; we are talking about two chromosomes in each case, something like this.

And for each chromosome, in Mendilian genetics, there is a gene which relates to trait, now that gene is always in the same location in both the chromosomes; because both chromosomes are in the effectively the same chromosome. One chromosome is coming from the male parent; one chromosome is coming from the female parent. Pea plant like we are is a diploid organism.

And these two alleles segregate when gametes are made. And each of these genes, the gene coding responsible for pod color and the gene responsible for the seed shape assort completely independently of each other in the Mendelian crosses, which he demonstrated in his paper.

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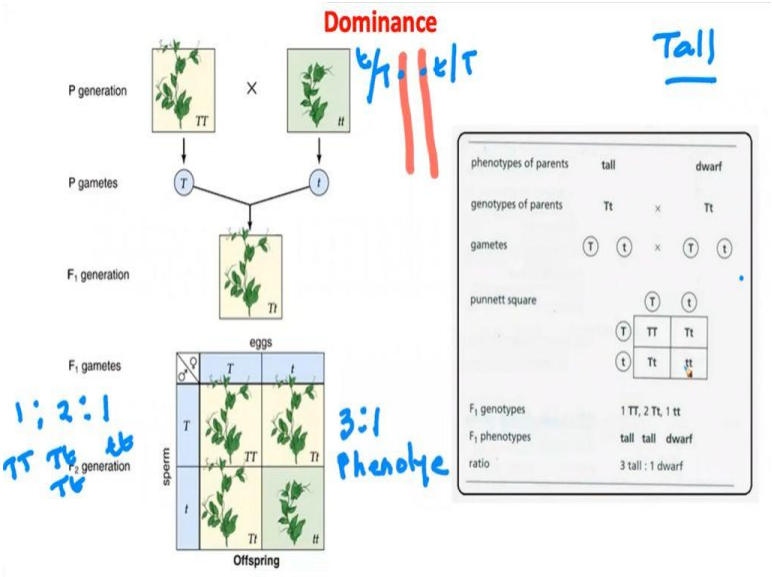

So, the idea of dominance is basically an observation by Mendel, that when he took two variants of the same trait, which is a tall plant versus a dwarf plant on a chromosome; so there is a chromosome over here. And on this chromosome, there is a single gene, it can either be T or it can be t or T. And when he took a plant, which was TT, he was basically taking inside the plant, the chromosomes in every cell had capital T; capital T, which is a representation of the gene. And in this particular dwarf plant, small t; small t, which is again a representation of two alleles in this plant of the gene, which we are now just labeling tall for the time being.

And when we cross this, one of the traits disappeared in the F1 generation; and the traits which stayed, we call as the dominant trait which is the tall plant. And in the F2 generation in a self cross, you basically end up with a 3 is to 1 ratio between tall plants and short plants.

Now, this 3 is to 1 ratio is something we term as the phenotype; and what this means is when you visually look at the plant, there are three tall plants. The ratio is three plants, three tall plants to one short plant. And the genotype over here is actually 1 is to 2 is to 1. And what that means is that even though the ratio is 3 to 1, when you look closely, it is basically one TT, two TTs and one TT.

So at the level of the gene, in terms of the allele set, which is there inside this plant; it is 1 is to 2 is to 1. So, this is the genotype and this is the phenotype; and genes are responsible for

morphological features, so genotype relates to phenotype. I will again pause over here and see if there are any questions.

Student: Sir, please explain horizontal gene horizontal genetics that you told about.

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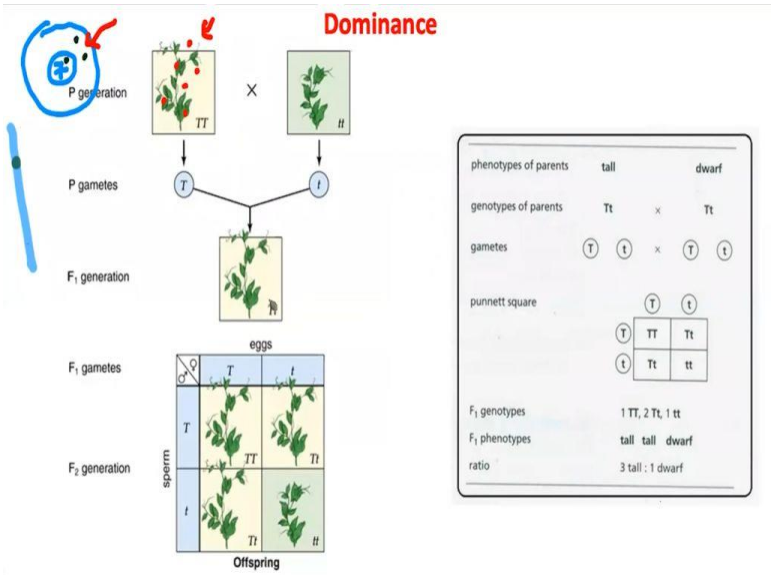

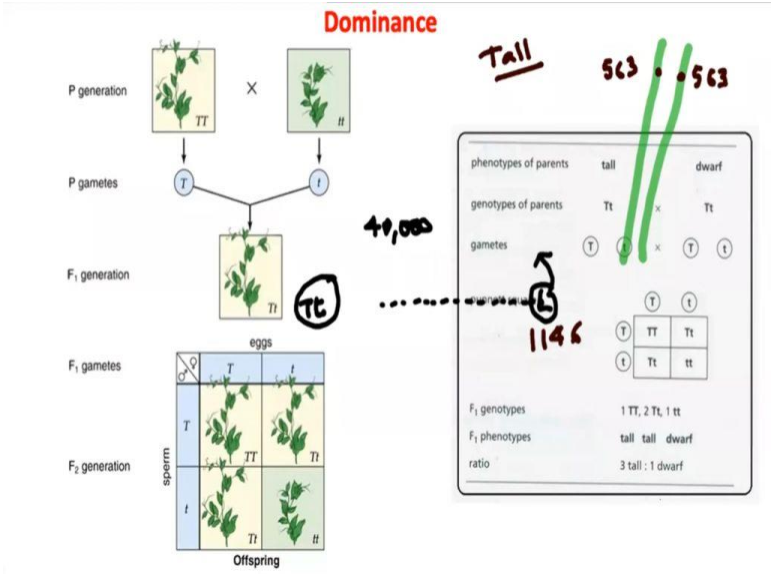

Professor: Let us say that this parent is maintained as a pure line. That this parent over here has cells inside the body and there is a nucleus over here; and inside this, let me just say that they are 7 chromosomes. Now, also take a sort of virtual example. There is a bacteria which comes over

here and it infects the plant; and it sits on the plant, and it basically is growing on the plant and using the nutrition of the plant.

Now, let us also imagine this is all hypothetical Khayali Pulao is the term I will use over here, that this bacteria somehow manages to transfer some of its DNA into the gametes specifically; which is either the male sperm or the female egg in this plant.

And let us say that the DNA which I am going to represent as green dots over here. Let us say this DNA goes inside the nucleus, and it integrates into the chromosome of the animal. Let us say it goes and sits, a couple of genes from the bacteria go and sit inside over here. Now, because these gametes are going to fuse to form the next generation, the foreign DNA which has entered into the genome into one chromosome will go to the next generation.

And because it has integrated inside and refuses to leave, it continues to stay from generation to generation inside that plant. That would be horizontal gene transfer and that would be horizontal genetics; because you have bacteria handing over a piece of its DNA to a plant.

Student: So, it is basically the transfer of character from a different species.

Professor: It is the transfer of information in the form of a gene. Same thing you are saying I am just using different words. Any more questions?

Student: Like a capital T and capital T, small t, you said that two genotypes have the same phenotype of tall. Is there any example where two phenotypes have the same genotype?

Professor: Two Phenotypes have the same genotype. All examples are where the phenotype has the same genotype; so, maybe I did not understand your question. So if the phenotype is tall, we always assume that it has either capital T capital T or capital T small t. Can you repeat what you are asking?

Student: Like capital T and small t, and capital T and capital T are two different genotypes; and they give the same phenotype of tall. So, is there any example in like all of the biological literature where two different phenotypes arise from the same genotype? Like, is that even possible?

Professor: So you see, it is how you define the genotype. Now, we are using this nomenclature for this cross. And for the moment, let us assume that the Pea plant has 40000 genes; I do not know, I am guessing. Now, when we say TT, we are talking about one of these 40000 genes.

So, the nomenclature is only talking about the one thing we are focusing on that the tall gene or the gene coding for tallness, and talking about its genotype. If we had to write the complete genotype of this plant, we had to put 40000 alphabets, because the other genes are also there. So now, taking this into consideration, what you are asking me is, can you have the same phenotype, different phenotypes with the same genotype is it?

Student: Yes.

Professor: It is effectively if there is TT over here. And there is another gene called; I will use Hindi over here, lamba-chota. Let us call it L, which also influences tallness as an independent gene, which is a Non-Mendelian thing. Then, you will find that sometimes when this gene is mutated, if this gene can support the same feature, you will actually not see any effect at all. Because if either this is working or this is working, you will still get a tall plant; but that is effectively the same phenotype being affected by two genes. So, that is normally, so it exists having multiple genes, influence a single trait is kind of multi-genic inheritance.

Student: Sir, so can we say in a chromosomes, like the number of genes somehow will dominate? Like if I say in Hindi agar yaha par capital T right me kuch genes hai to small t ke bhi kuch honge. And that will dominate like capital t ke jyada honge and small t ke kum honge.

Professor: So, you are now confusing things because when we talk about a gene, we are talking about a physical location in space in a chromosome. And if I call this gene number 563; and the gene number 563 is a gene which I am calling instead of calling the gene Tommy or Pappu, I am calling it tall. But, it is gene number 563.

Student: Yes.

Professor: The T and t refer only to that gene; and there is only one gene which is 563.

Student: So, the case is not possible, which I am saying.

Professor: So, if there is the L gene, then this is gene number 1146. This is a completely different location, either on the same chromosome or completely or another chromosome.

Student: Yes, sir. One more doubt sir, can you please open that slide of horizontal genetics.

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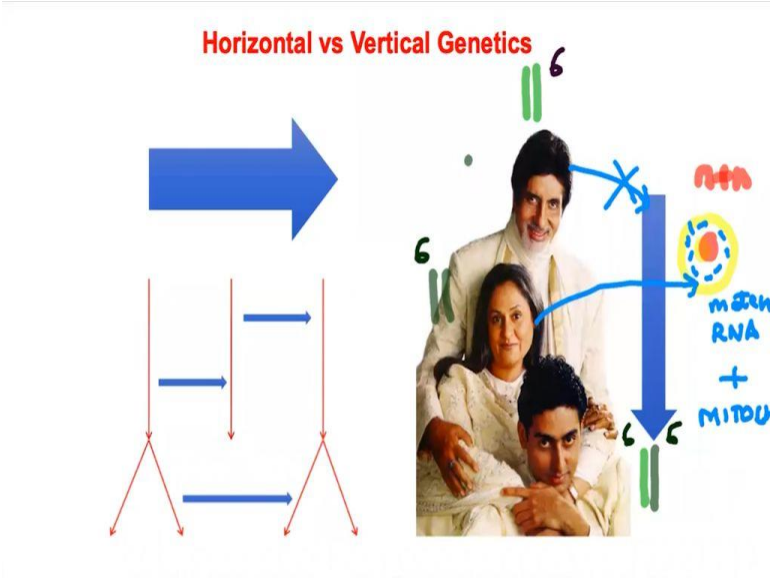

Professor: You want to see Amitabh Bachchan again.

Student: Yes. So, basically what we are saying here is, if for someone like one of the member is suffering from some kind of disease, that disease is passing over to another family member and another family member. So, the next generation will also get that disease; this is what we are saying in this.

Professor: You are saying is information is transferred from one generation to another. So, what we are saying is Amitabh Bachchan has chromosome 6 like this, and Jaya Bahaduri's chromosome is something like this; and again remember it is chromosome 6. Then, all we are saying is that the information; see focus on the information, not on the disease. All we are saying is that the chromosome 6. So, Abhishek is getting one chromosome from his mother, and he is getting one chromosome from his father.

Student: And that will also be 6?

Professor: That will be 6. But, do remember it is not about disease; it is about information. Whether that information leads to disease or whether it leads to better acting abilities. Whether it leads to excellence in football or Kabbadi is completely dependent on the two alleles he gets; one from his mother, one from his father. So, rather than saying disease is passed on; its information is passed on. And the information is used to generate Abhishek.

Student: Thank you sir, I got it.

Professor: A comment, which again is Non-Mendelian genetics, is that these two genomes haploid, haploid plus haploid fused to give you this information. In addition, and this is a generic mammalian feature, a generic feature for many vertebrates for many diploid organisms. In addition, Jaya gave Abhishek what is called as genetic information through maternal RNA, which came only from Jaya and did not come from Amitabh. So, in addition to giving her genome, she also gave material nucleic acid material in the egg, which was very very useful in the development of Abhishek for the first few hours of development.

And all that information is purely maternal; there is no paternal contribution in humans and many other mammals. So, genetic information is transferred from parents to child through the genome, which is the nuclear genome, which is chromosomal, and extra nuclear which is RNA; and extra nuclear, which is mitochondria.

Now, Mendelian genetics is not all genetics, there is maternal genetics; there is mitochondrial genetics. All this genetics is part of who we are. So, we are our parents, and in the very initial important stages of our development, we are our mother effectively is what I am trying to tell you.

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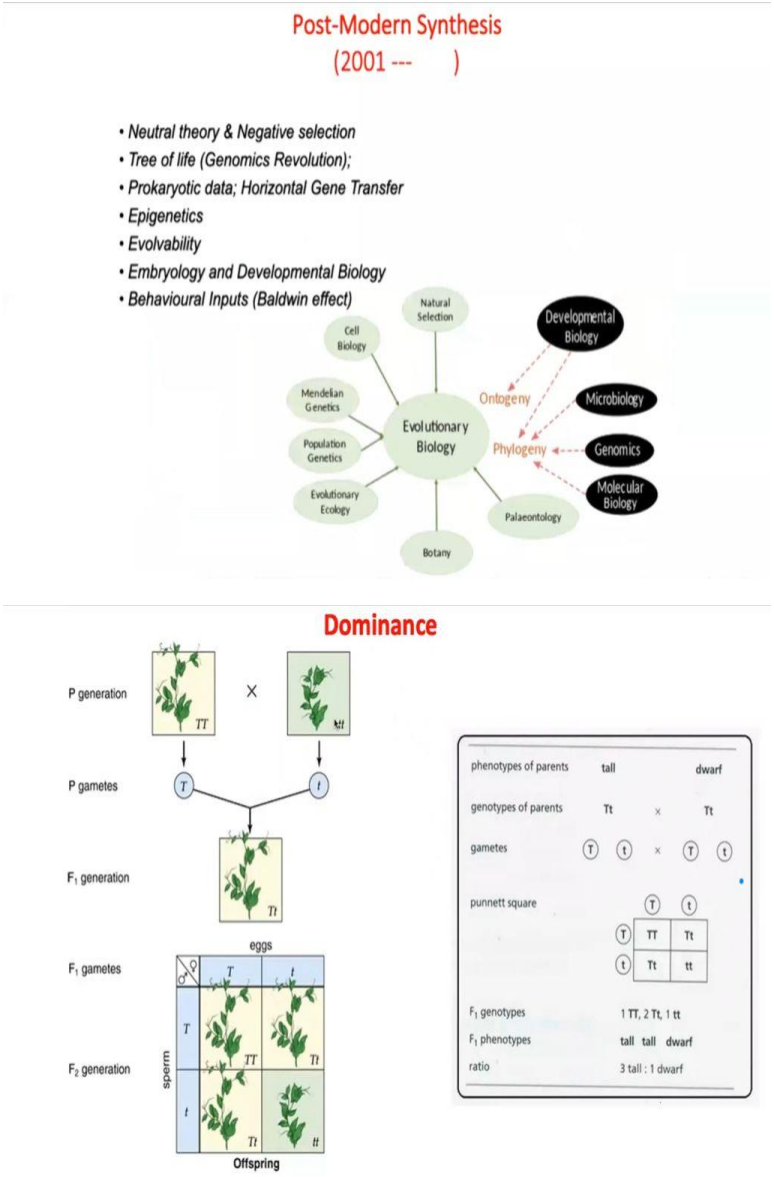

Student: In the previous slide, I mean, where you were talking about Non-Mendelian genetics. There was a term called the the Baldwin effect.

Professor: Baldwin effect has to do with behavior, and it is very complicated; and it cannot really be explained in a few minutes. So do a search, Google search, figure out what the Baldwin effect is.

Student: Can horizontal gene transfer be called a sort of mutation, because it is sudden; it is sudden change in the genome essentially.

Professor: So, it is a sudden change in the genome. But, I will again use the term addition of information which was natively not there in the population before the horizontal gene transfer took place. So, talk about information, it is easier to use, it easier to be generic. When you use the term information transfer this information is nucleic acid information, which can be converted through transcription translation into functional information.

Student: Thank you sir.

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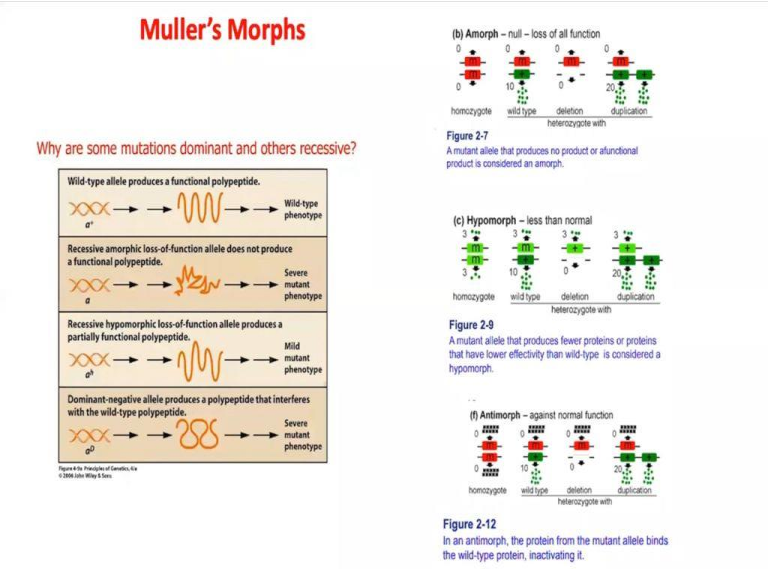

Student: Excuse me sir, also this information that we receive like, does it give rise to a new gene in the genome like a new gene is found.

Professor: So, a foreign invasion of DNA into your genome, can be used, can be discarded, can be kept without being used. The information exists, by the way whether it is retained, whether it is used whether it influences you is up to your genome.