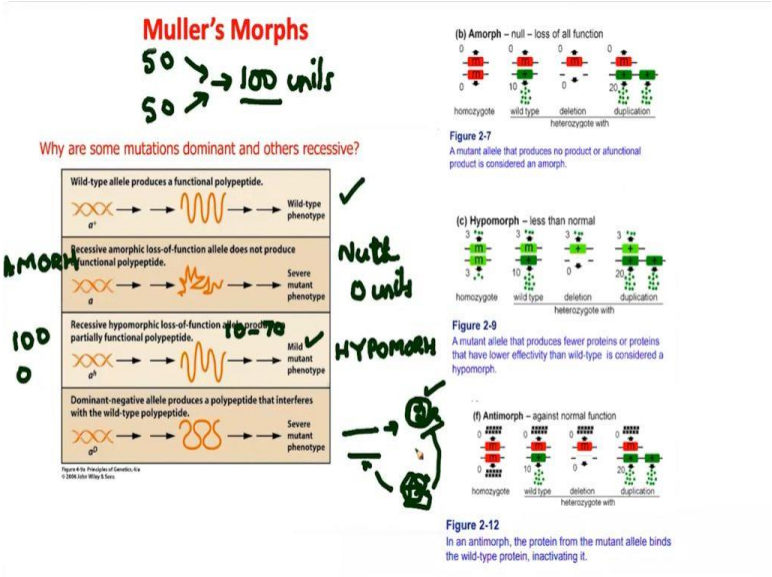
Introduction to Cell Biology
Professor Girish Ratnaparkhi and Nagraj Balasubramanian
Department of Biology
Indian Institute of Science Education and Research Pune
Mendilian and Non-Mendilian Genetics - Part 3

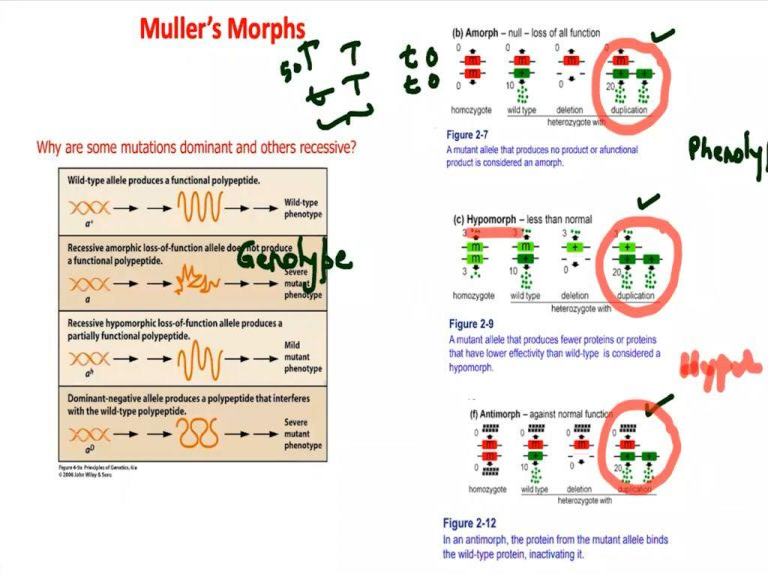
Now, let me just again, define these very generic terms; these are all genetic terms. And they are kind of related to the broad ideas I have been giving you about molecular biology in the first few lectures and genetics now. So, you already hopefully clearly understand the relationship about information on genes and the fact that functional entities; here we are talking about proteins. Remember RNA is also functional.

And you basically this gene influences a in the Mendelian world, one gene influences one trait. In the modern genetics term, one gene can influence multiple traits. One gene can control the length of your bones, and also the same gene can control how intelligent you are; or at least contribute to how intelligent you are. So, one gene can influence many many features.

And these are not necessarily morphological features; they can be behavioral features also. At the same time, multiple genes can influence one trait; and skin color, your height are examples of where multiple genes regulate the same trait.

(Refer Slide Time: 01:32)





So, what I am going to do in this slide is quickly define certain terms used by a person called Herman Muller many years ago; and I am sure you Mueller's face as the last slide of this talk. So, a gene makes a functional polypeptide which works to give you a phenotype.

Now, if the gene cannot make that functional polypeptide because of a mutation which interferes with folding, or interferes with the complete production of the folded functional polypeptide. You get a very severe mutant phenotype and the severous mutant phenotype. If so, now I am going to use arbitrary mathematics as I call it, let us say; now, this is a little different from what I did yesterday but similar.

Let us say that your phenotype is defined by 100 units; 100 units of whatever we are talking about. And let us assume that these 100 units are given by two alleles, and 50 plus 50 gives you 100. Now, this is your wild-type phenotype; not everything is mathematical, but it is the simplest way to explain it to you. In the case of a very strong phenotype, which we call as a null, we define this as 0 units. Basically, there is no activity of the functional entity of the gene; so both alleles are not contributing, that is a null.

The word Amorph, is also used instead of; this looks like nuts; it is not nuts, it is null. We also use the term amorphic that is does not give morphology. Sometimes the allele, maybe one allele functions, the second does not, or both alleles are giving partial functions. It gives you a milder phenotype; this we called as a Hypomorph, these are genetic terms.

But, basically, what you have to understand is the function is not 100 units, but it is not 0 units either. So, it is let us say in the range, roughly speaking 10 units to 70 units; so it is functioning but not efficient. And the last thing which is sort of interesting is that if you have two alleles of a gene; one allele gives you a protein. The second allele has a mutation; it also gives you a protein.

But, this mutant protein is misbehaving and it misbehaves not only here, it also influences the other normal protein; and causes it to misbehave also. This is called as a dominant negative allele, in the sense that one allele not only does not contribute; it chats to the other protein, which is made by the either allele which is normal; but somehow influences it not to function. This is called the dominant negative allele.

So, now here is a sort of representation, a homozygous mutant tt can be 0; because it is a null. Or, it can be acting as a wild-type, which is either TT or it is Tt; both of these will act as wild-types, because here even 50 dose is enough to give you the wild-type function. If tt is both null, you will have 0 plus 0 which is 0; and you will have absolutely no function at all.

So, you have an Amorph which has no function; you have a Hypomorph, which has partial function; and you have an Antimorph or a dominant negative, in which one allele influences the other allele to not behave in a wild-type and makes the phenotype worse. Is this clear? So, Antimorph, Hypomorph and Amorph are phenotypic terms, this is what we see. And what we are trying to understand from using the term 50, 100 amount of activity is actually genotype.

Student: Excuse me sir. Sir, in the last one, is it are three alleles, like there are two green parts shown? So the wild-type has like why is it three?

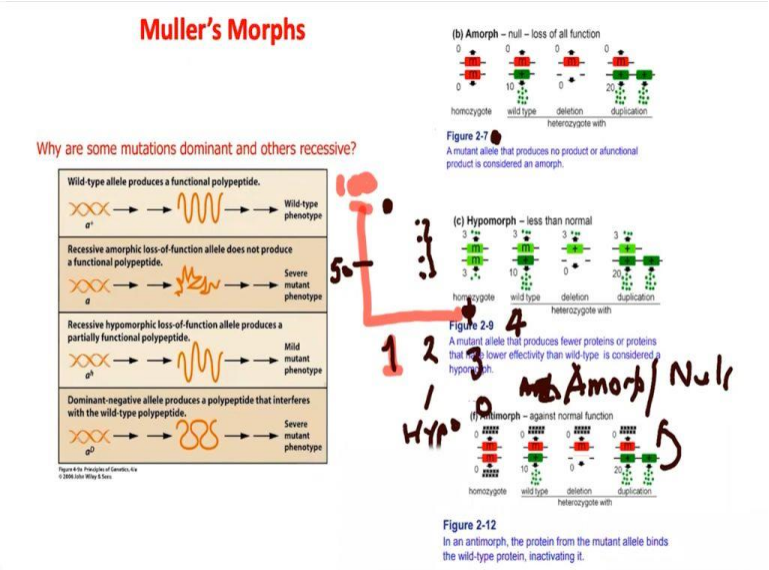
Professor: So, there are cases in which a gene during DNA replication, there is a mistake; and the gene duplicates. If the gene duplicates, you have two copies of the same gene, usually right next to each other in the genome; this is not as often as you would think. And in that kind of scenario, you basically have double one gene giving you double the amount of protein. That is called as a Hypermorph. So, he is getting more activity, Hypermorph, Antimorph, Hypomorph.

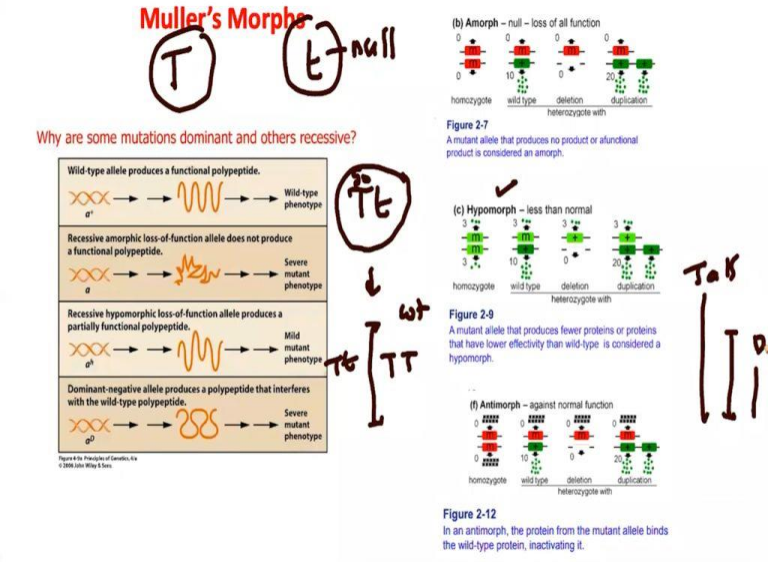
Student: So, can you explain Hypomorph once more?

Professor: Hypo?

Student: Yes sir.

(Refer Slide Time: 06:40)





Professor: Let me try it in a different way. So, if this is an XY plot, this is activity; now, one is a wild-type. So, one is a wild-type, this is wild-type; and this is what the normal activity is. If you see activity, either here or here or here or here; that is 2 that is a Hypomorph. That is activity less than 100; 3 is a here, activity 0. That is a Amorph or a null, 0 activity; and a Hypermorph goes above 100 that is number 4. So, if you have more activity than normal, that will be a Hypermorph.

Student: Sir in the Hypomorph actually nothing is going to work now; so because this one.

Professor: No, so Hypomorph because it is giving you partial activity.

Student: Yes sir, but Hypermorph will basically stop the functional one also to become dysfunctional.

Professor: No, Hypermorph is more than 100 activity. Antimorph will give you less than 100 activity because one allele is influencing the other allele.

Student: Sir, in evolution when we say a gene is deleted, then it is just Amorph.

Professor: For that gene, if that entire locus is deleted, both alleles are deleted. The organism no longer has that gene. So, even using the term Amorph has no meaning, because the gene does not exist. You can say, between chimpanzees and humans; the gene number 4646 is no longer there. But you do not call it amorph, because we do not have it. But, if you go out in the sun, and you have a mutation in both the alleles of your gene 4646; so that, that gene is exists, but does not produce functional protein, you will call it an Amorph.

Student: In case of capital T and small t can we consider small t as Amorph?

Professor: So, this is a Mendelian term right? If you have gametes like this, capital T and small t, the small t we say is a null; then it is Amorphic allele. But, it is not Amorphic gene, because in the next in the plant, it will be T and t. This plant we cannot call a Hypomorph, even though 50 percent of the product is being formed; because the plant shows exactly the same height as a TT. So, from a phenotypic view, even though one allele is not functional, you do not see a phenotype; the animal is the plant is tall.

So, we call it a normal wild-type plant; we do not call it a Hypomorph. If in Non-Mendelian genetics, a hybrid between a capital T and a small t gave you a plant which was between a tall and dwarf; somewhere over here, we could have called it a Hypomorph.

Student: In case of incomplete dominance, this happens.

Professor: In case of incomplete dominance, you are very right; it has a hypomorphic feature.

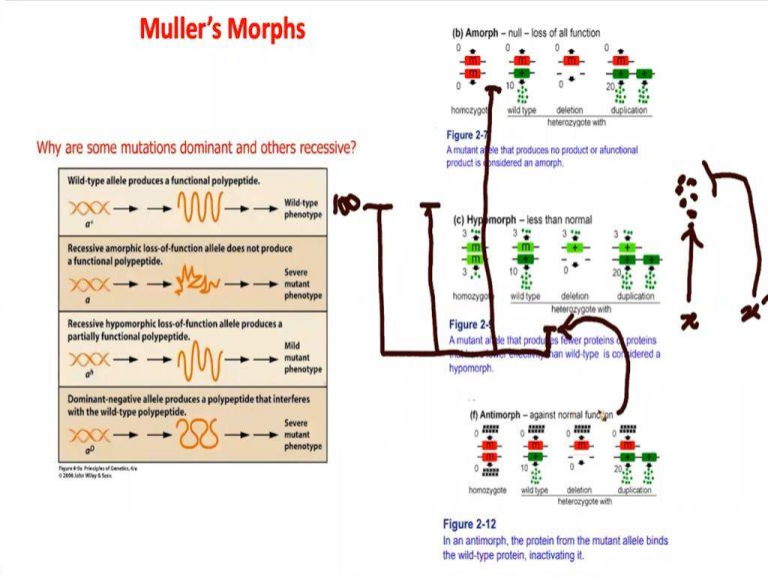
Student: Sir, activity of Antimorph will also be 0 unit?

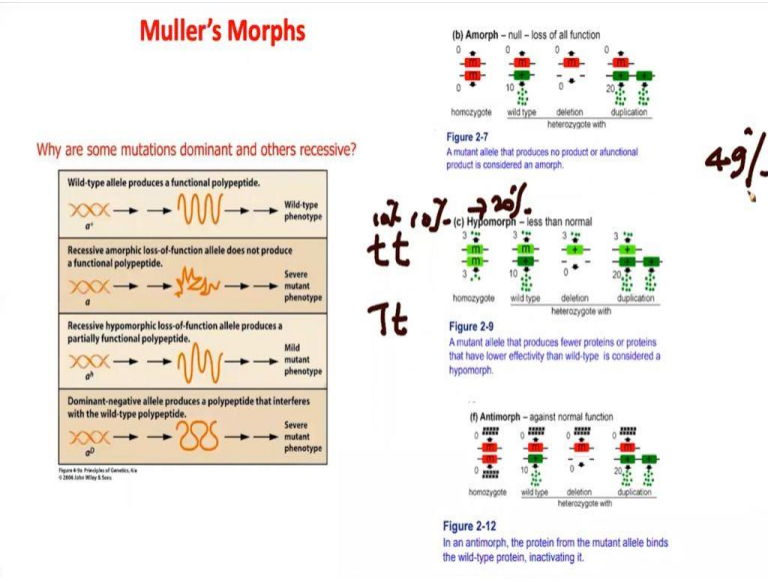
Professor: It will be 0 unit. It can be 0 units because one allele is trying to work; it is like twins. One twin wants to work; the other twin says I do not want you to work. So, you will try and stop

other twin from working. This means that the activity will be lower than it should be based on a single allele; and that is an Antimorph.

Student: So, could you be distinguish between in Antimorph and Hypermorph?

(Refer Slide Time: 10:19)





Professor: So in a Hypermorph, so this is what we called as so called normal activity; and wild-type is this, a Hypermorph is this. And an Antimorph is when you have protein being produced by one allele. Let us call this allele x, and your other allele x prime is blocking the activity of this protein. So, the actual activity will be low; that is a Antimorph or a dominant negative. Is that clear?

Student: Sir, what about when both the alleles are mutated in Antimorph at the first case?

Professor: No, no Antimorph can only work when you have one allele which has functional and one allele which is stopping the other. Both are not working when it is Amorph.

Student: Sir, in the case of small t small t, so you said that when it is capital T small t; we say it is Amorph because it is tall. There is no effect of the small t; small t is not producing anything.

Professor: That is one explanation, simplest explanation; small t small t is dysfunctional.

Student: But, what if when small t small t is producing some amount; but it is not the same as capital T. but, somewhere in between like the capital T is for red color, then small t small t would be for pink color or something.

Professor: You are bringing complicated things into the discussion. Let us say for a plant to be tall; there is a certain threshold of let us say T gene codes for growth hormone. Let us say the small t small t were giving you 10 percent 10 percent activity; together it is 20 percent.

Now, if this 20 percent is below a threshold; let us call that threshold as 49 percent. And if you do not cross the threshold, you are not going to get a tall plant. So, it is a each allele is a Hypomorph; but it is not contributing to a tall plant because the threshold has not been reached. So, this is now we are becoming a little complicated in our discussion.

Student: ok sir, I understood.