

Role of RNAs in Animal Growth and Development

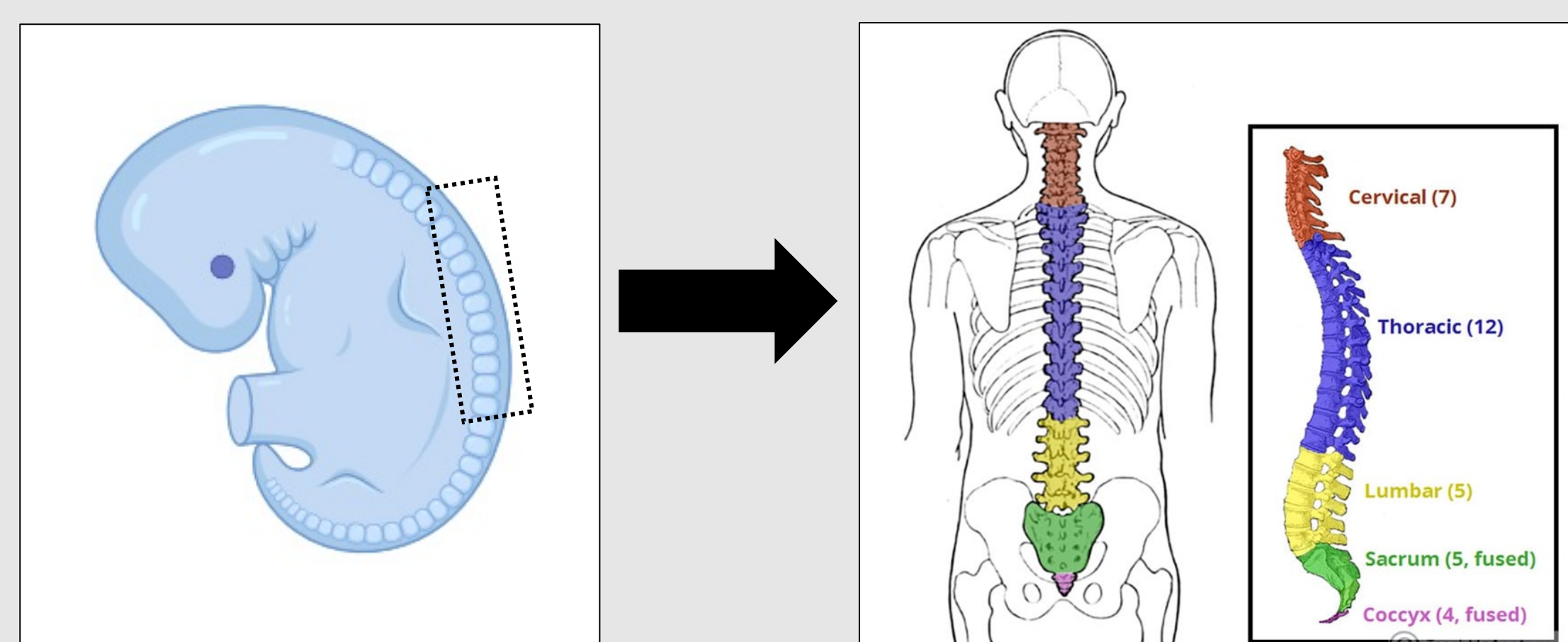


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Development of the Ribs and Vertebrae

The Question

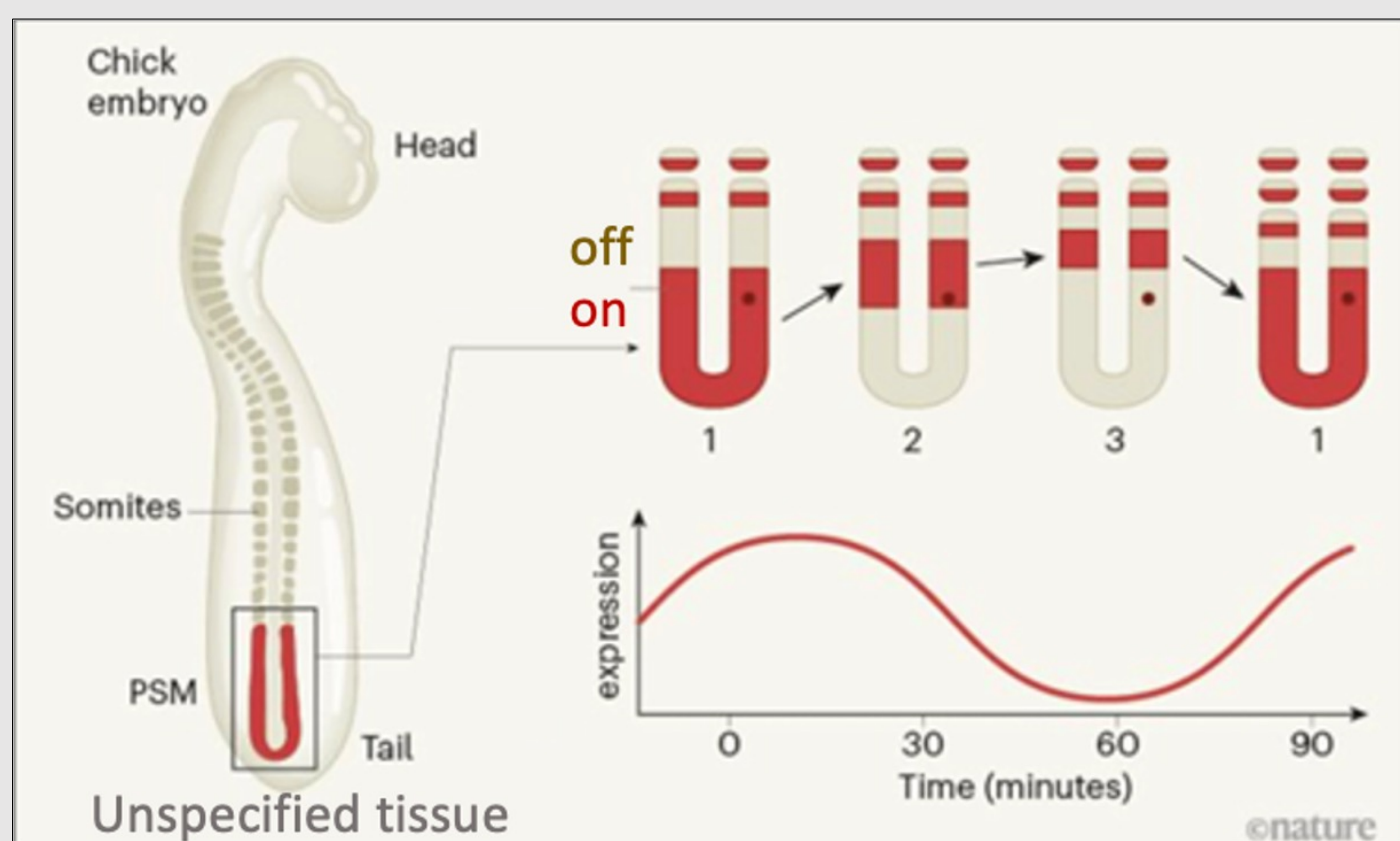
Embryos form segments which develop into the ribs and vertebrae. How does the embryo form these segments?



<https://teachmeanatomy.info/back/bones/vertebral-column/>

The embryo's solution:

Various RNAs need to be made and then degraded in the unspecified tissue region which tells these cells to become a segment of the ribs.



Ryoichiro Kageyama (2022) *Nature*

The Segmentation Clock

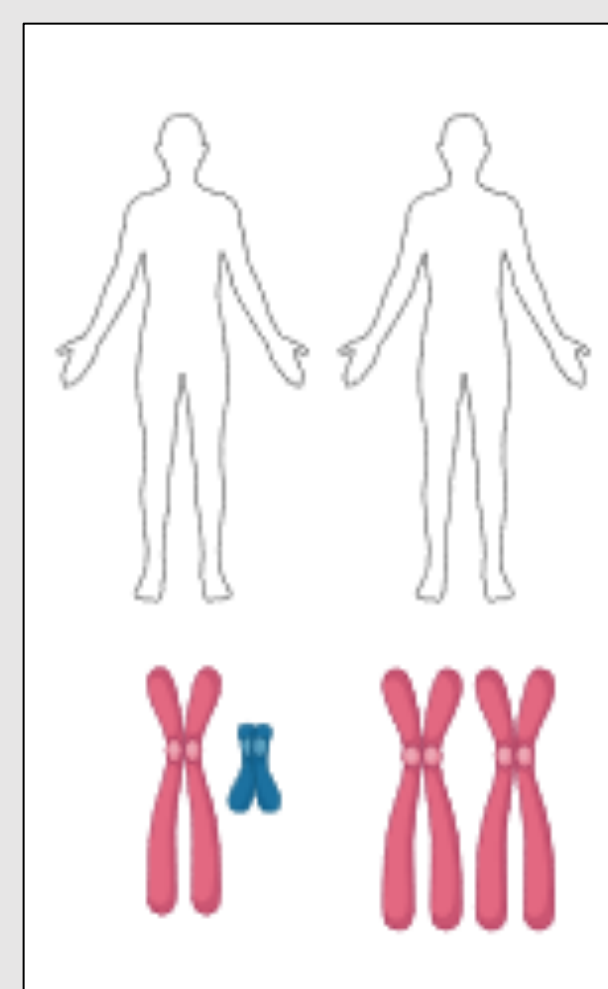
Each cycle of the segmentation clock occurs when a group of RNAs are made and then degraded allowing for the cycle to start again. One cycle generates one segment.

Species	Clock Cycle Time	Segment #
Human	4-6 hours	38
Mouse	2 hours	60
Snake	90min	>300

Inactivation of X-Chromosomes in Mammalian Females

The Question

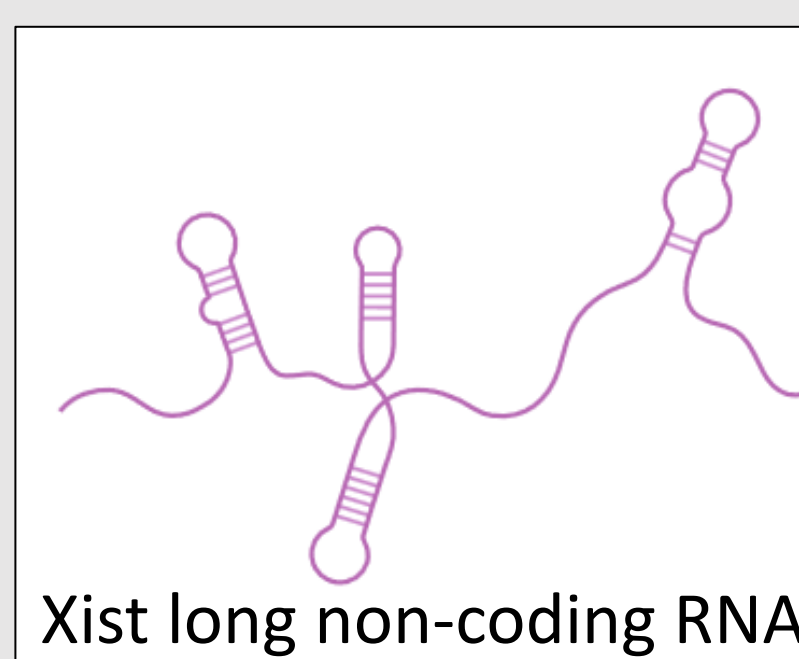
If mammalian females have twice as many X-chromosomes as mammalian males, why don't they have twice as much X-chromosome gene expression?



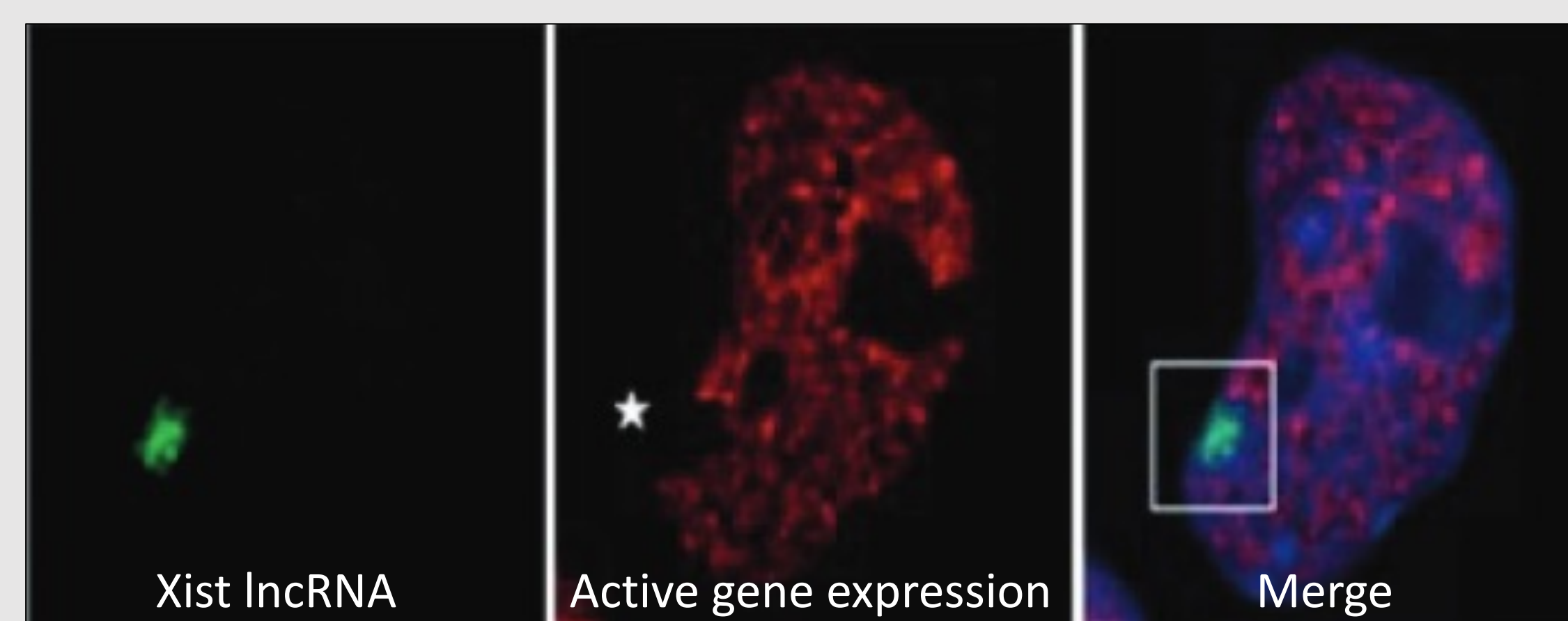
The cell's solution:

An RNA-based chromosome silencing system whose major player is a long noncoding (lnc) RNA called Xist

Xist RNA silences one of the X-chromosomes in females

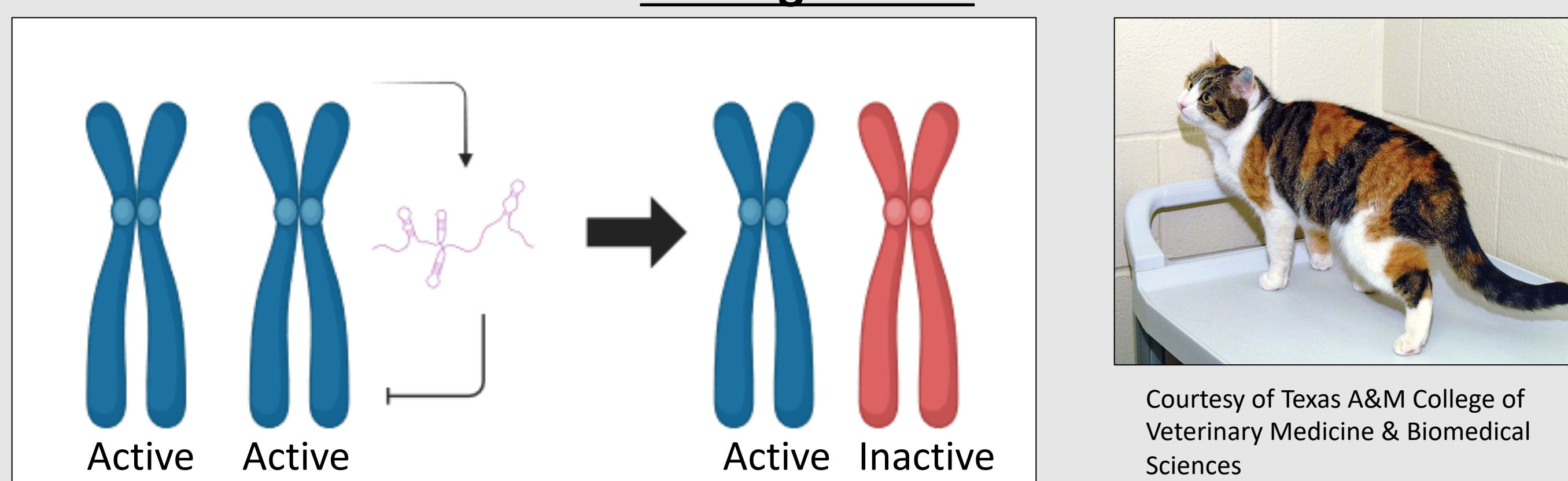


Xist lncRNA is produced by only one of the X-chromosomes. Xist coats that chromosome and starts the silencing process.



Galupa and Heard (2018) *Annual Reviews in Genetics*

The Big Picture



Courtesy of Texas A&M College of Veterinary Medicine & Biomedical Sciences

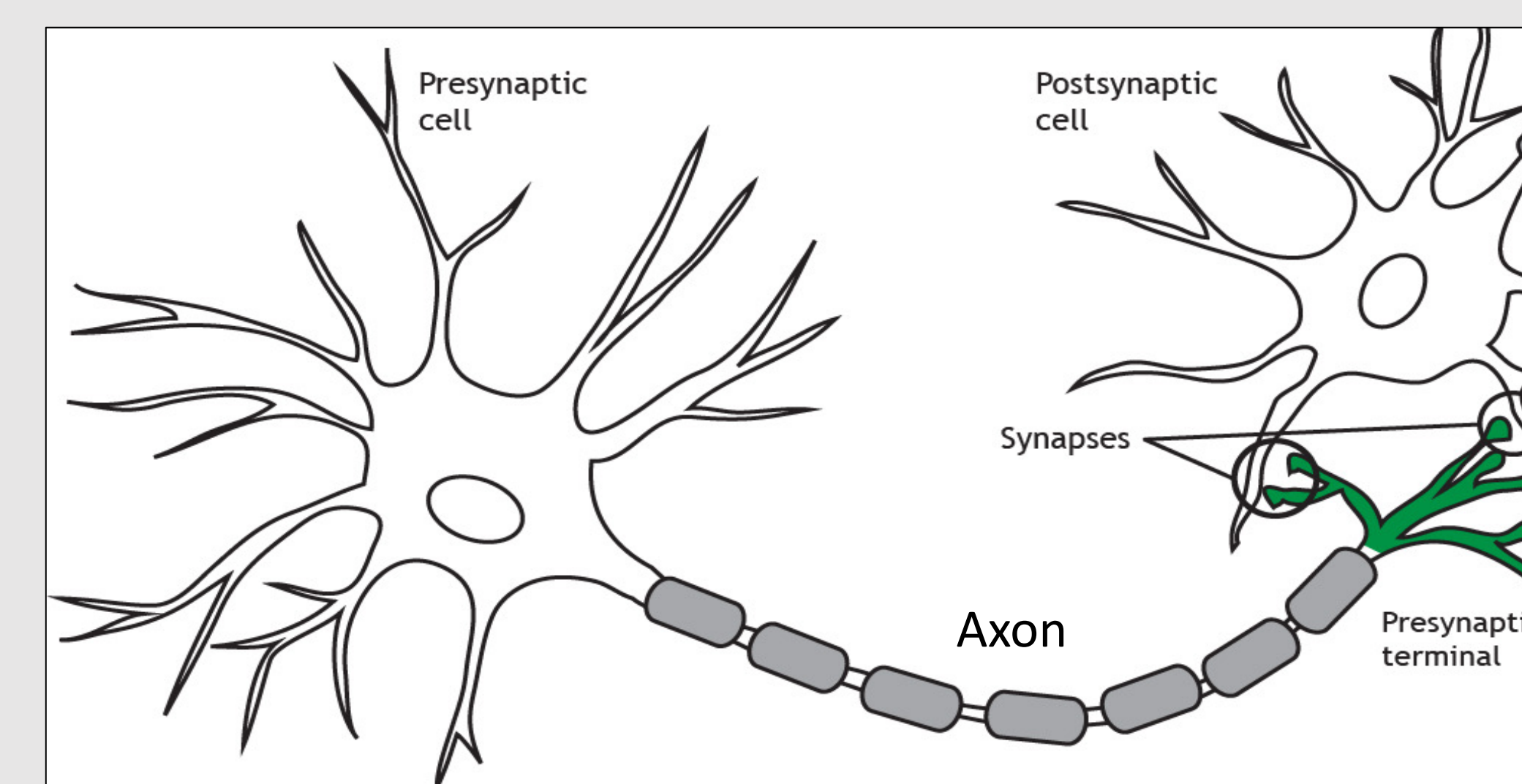
This means female mammals are "mosaics" and if their two X-chromosomes encode different traits some cells express one trait and some the other. That's how calico cats happen!

This is an example of how mammals solve the sex chromosome dosage issue. Non-mammalian animals have different solutions!

mRNA Transport in Synapse Formation and Maintenance

The Question:

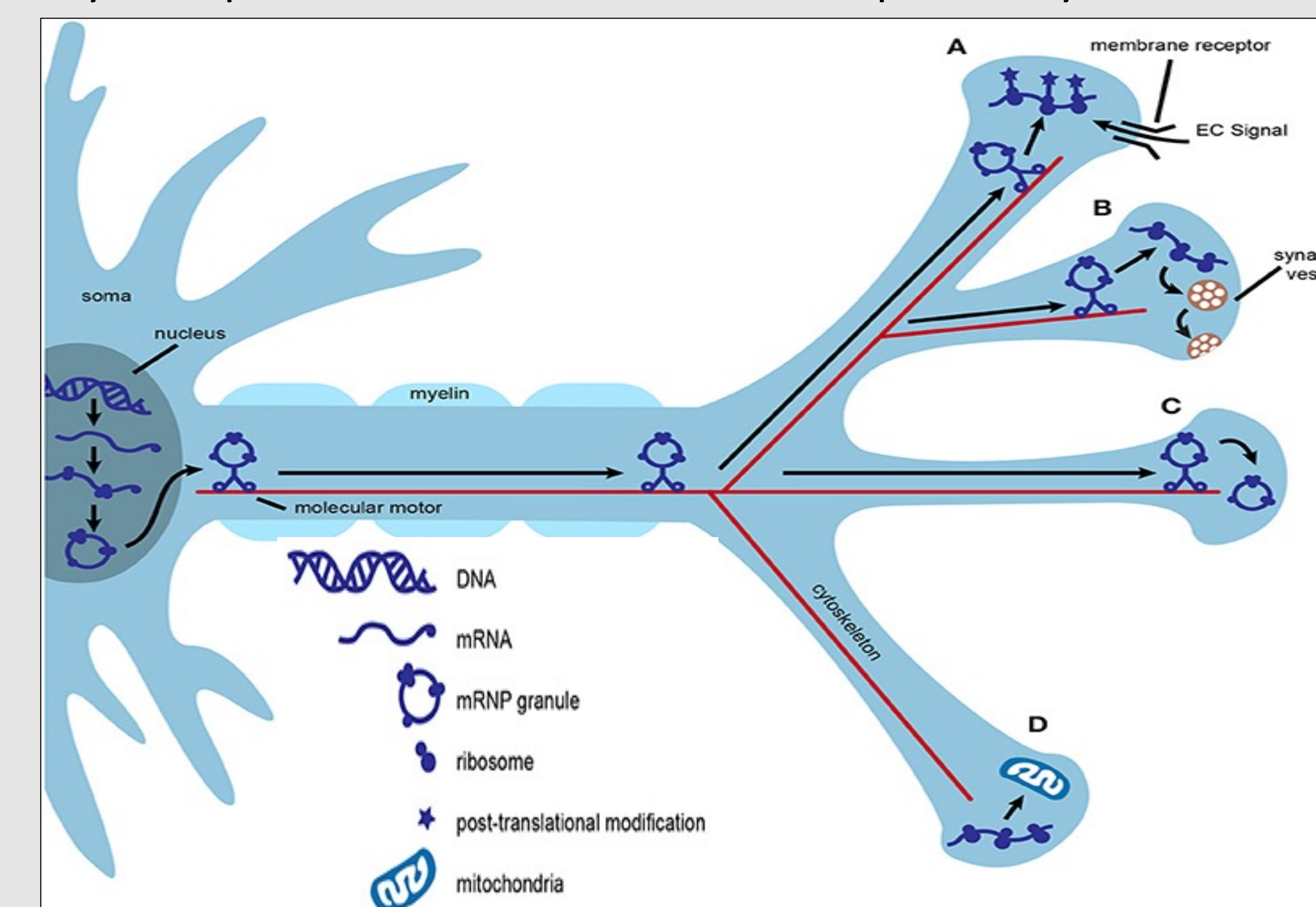
Connections between neurons are called synapses. For a synapse to form, many different proteins must function at the tip of the axon. This can be meters away from the nucleus, where mRNAs are made, which are needed to make protein. How do mRNAs get to the tip of the axon?



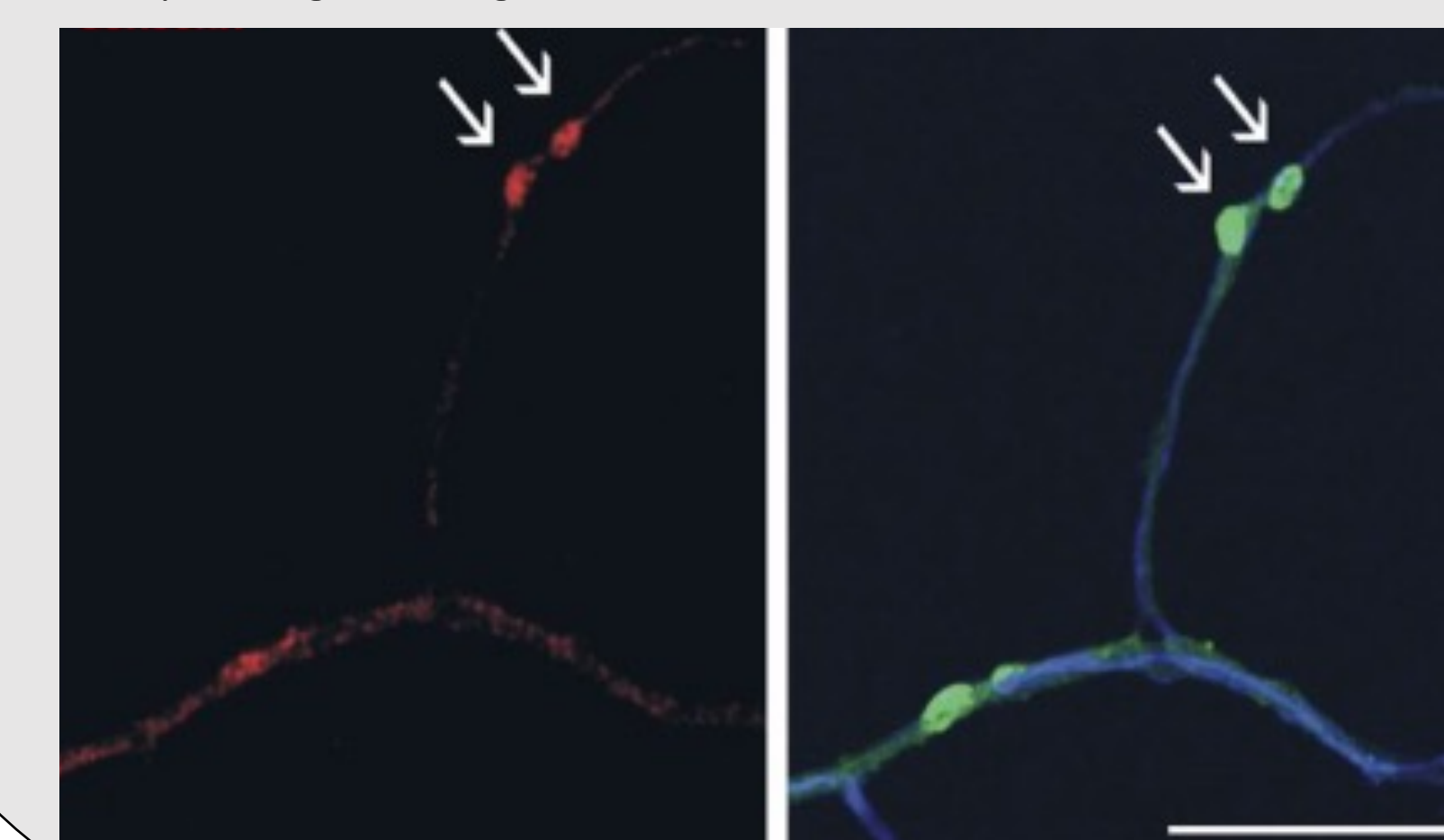
Henley, *Foundations of Neuroscience*, 2021

The neuron's solution:

mRNAs are packaged with proteins into mRNP granules which are then actively transported to the axon terminal for protein synthesis.



Spaulding and Burgess, *Front. Neurosci.* 2017



Lyles et al., *Neuron*, 2006

Red: mRNA for Neurotransmitter

Green: Synapse Marker

Blue: Cell Membrane