

The Mitosis Dance

Overview

Pedagogical research provides evidence that including role play activities can effectively support student learning when teaching complex concepts such as those that take place inside a cell. Various teaching institutions have reported on the enhanced level of student engagement and understanding of mitosis (and meiosis) when a dance activity is used to explain the behaviour of the chromosomes and other cellular structures (centrioles, and nuclear and cell membranes) during nuclear division.

The following dance activity, using simple props, allows students to walk through the movement of chromosomes as they replicate, line up in identical pairs along the metaphase plate, and are pulled apart from their identical partner, as they move towards a centriole to form two new identical daughter cells.

Aim

The aim of this activity is for students to understand the movement of the chromosomes and the changes that go on within the nucleus of a cell during mitosis.

Equipment and Props

1. Representational items

Actual item	Structure represented in the cell
A room with 10 to 28 students*	<ul style="list-style-type: none"> • Most students represent single chromosomes. (Note that groups of 4 students are needed for each set of chromosomes. This dance will be described using 8 students, that is, 2 sets of chromosomes.) • 2 students represent the centrioles. • 2 students can be 'stage hands' to set up the nuclear and cell membranes, and/or be responsible for the music and/or filming the dance.
Four A4 sheets of pink paper, two with a capital 'A' and two with a lower case 'a'. The students will wear the sheets of paper on their fronts.	<ul style="list-style-type: none"> • All the pink sheets of paper represent a single autosomal chromosome number. • The upper and lower case letters represent 2 different alleles for a gene on that chromosome. • One of the sheets of paper with the 'A' allele represents a chromosome from mum, and one of the sheets with the 'a' allele represents a chromosome from dad (total=2), with a doubling up (total=4) to show replication before mitosis begins. Note: The two chromosomes with allele A are identical sister chromatids

Four A4 sheets of blue paper – two with a capital 'B' and two with a lower case 'b'. The students will wear the sheets of paper on their fronts.	<ul style="list-style-type: none"> The blue paper represents a second autosomal chromosome. Again, there is one copy from mum ('B') and one copy from dad ('b'), and their replicated pairs.
2 white A4 sheets of paper	<ul style="list-style-type: none"> Centrioles
Blue wool (~10m) x 2	<ul style="list-style-type: none"> The cell membrane
Red wool (~10m) x2	<ul style="list-style-type: none"> The nuclear membrane

*See 'Casting' in the Teacher Notes below re adapting activity to suit varying student numbers

2. Other, non-representational items:

- Song related to life and or living. E.g. *Happy* by Pharrell Williams, *Staying alive* by the Bee Gees (or N'Trance version), or *Get a Life* by Soul to Soul
- Music player (CD player or computer with speakers and relevant music file)
- Black Texas(to write the letters 'A' or 'a' on the paper)
- Scissors(to cut the wool)
- Sticky tape (to stick A4 sheets to the front of students' chest/stomach area, and to stick wool on the floor)

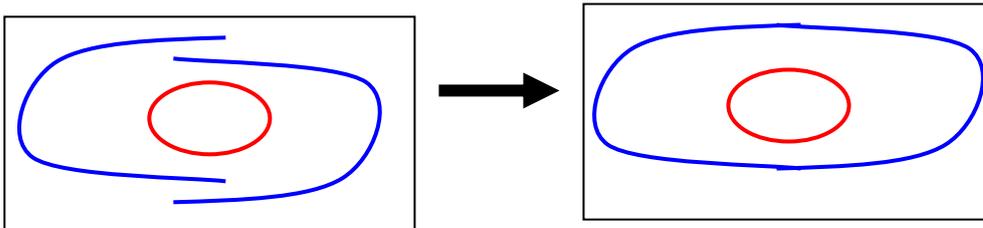
Student roles:

Student(s)	Role
All students	Move desks and chairs safely to the edge of the room
2 students who will wear a pink sheet of paper with 'A' on it	Prepare their sheet of paper by writing the appropriate letter and sticking the paper on their front so it is clearly visible. During the dance each group of 4 students will represent the movement of the 4 versions of a single chromosome by following the choreographic movements allocated to them.
2 students who will wear a pink sheet of paper with 'a' on it	
2 students who will wear a blue sheet of paper with 'B' on it	
2 students who will wear a blue sheet of paper with 'b' on it	
Students who will be the centrioles	Prepare their sheet of paper by writing 'centriole' on it and sticking it on their front so it is clearly visible. During the dance the students will represent the centrioles by following the choreographic movements allocated to them.
Students who will be responsible for the cell and nuclear membranes	Make a big circle around the edge of the room by sticking each of the 2 pieces of the blue

	<p>wool (~10 meters) to the floor (see Diagram 1 below). This represents the nuclear membrane.</p> <ul style="list-style-type: none"> • Make an inner circle in the middle of the room, by taping 1 piece of red wool to the floor (see Diagram 1 below). The size of the red (nuclear membrane) circle will depend on the number of student chromosomes there are.
--	--

Note: The cell membrane is made out of two pieces of wool, while the nuclear membrane is made out of one piece.

Diagram 1 – position of the cell membrane (outer oval/circle comprised of 2 pieces of blue wool), and nuclear membrane (inner circle comprised of a single red piece of wool)



Choreography

Opening scene:

- The following student chromosomes crouch down inside the red circle:
 - Pink A
 - Pink a
 - Blue B
 - Blue b
- The remaining identical pairs of chromosomes wait outside the cell membrane until it is time for them to enter the dance (when the crouching chromosomes replicate).
- One centriole stands at the 'top' of the cell, inside the cell membrane but outside the nucleus.
- The other centriole stands outside the cell membrane, waiting until it is time for the centriole inside the cell to duplicate.

Music starts and dance takes place according to the following beats:

Counts	What chromosomes do	What centrioles do	What 'stage hands' do
8	Chromosomes inside the nuclear membrane move their arms around to show movement is beginning to take place.		
8	Chromosomes inside the nuclear membrane call their partner (exact copy) over to their side. (The pink A moves to the pink A and so on.) They hold hands with their exact copy.		
8	Pink and blue chromosomes stand up and form a circle, continuing to hold hands with their exact copy.	Centriole duplicate (second student) joins in and stands next to the centriole that started inside the cell.	
8	Circle clockwise, dancing	Centrioles start to move in an arc inside the cell membrane to opposite poles, so one is on the right and the other is on the left facing the front of the room	Remove the nuclear membrane
8	Circle anticlockwise, dancing		
8	Identical chromosome pairs (still holding hands) walk out of the circle and line up in a straight line (representing the metaphase plate) facing the front of the classroom.	Centrioles arrive at opposite side of the room (poles).	
8	Identical chromosome pairs (still holding hands) look to their closest centriole.	Centrioles try to attract the chromosome closest to them with beckoning movements.	
8	Identical chromosome pairs (still holding hands) look to their sister chromatid.		
	Identical chromosome pairs look to their closest centriole – still holding hands		

	but starting to move towards the centriole.		
8	Identical chromosome pairs release hands and move to the closest centriole, forming their own circle like the original chromosomes.		
8	Circle anticlockwise, dancing.		Make new nuclear membranes on the floor around the dancing chromosomes, representing the two newly formed nuclei.
8	Circle clockwise, dancing.		
8	Crouch down and start waving their arms about.		Take the loose ends of the blue wool in each hand and walk to the centre of the cell (representing cleavage) so that each end of the wool joins with itself (rather than the other piece of wool) around the red nuclear membrane.
8	Stay crouched, moving arms less.		Form a new cell membrane with the blue wool around each new daughter cell and stick it to the floor.
8	Remain still; dance has finished with the same number and type of chromosomes it began with. An identical copy of the cell has been made.		

Teacher notes:

- **Year level**

Stage 5 – Year 9 or 10 Genetics

Stage 6 – Year 11 Biology or Year 12 Biology as revision (comparing with and understanding meiosis).

- **Casting (fitting a different number of students to the roles)**

Teachers doing this dance will have different numbers of students to work with. This is less of a problem than it might initially appear.

Here is a way to allocate roles to students:

1. Ask students to partner with someone they don't mind holding hands with, and to stand next to that person.
2. Ask one pair to step aside. This pair will be the centrioles.
3. Divide the rest of the group into smaller groups of 4. Each group of 4 will represent a homologous set of chromosomes, (e.g. chromosome 1, chromosome 2, etc) with one copy from mum and one from dad, and then a duplicate of these (to show replication before mitosis begins). In other words, each set of 4 will be a different chromosome number and its replicated pair.
4. If there are left-over students:
 - a. 3 left over students - two can manage the nuclear and cell membranes, and one can look after the music and or filming
 - b. 2 left over students – one can manage the nuclear membrane and the other can manage the music
 - c. 1 left over student – he/she can manage all the above roles, or just the membranes and the teacher manages the music
 - d. 0 left over students – the centriole characters can also set up the membranes.

Examples:

14 students in a class	<ul style="list-style-type: none"> • 4 students are chromosome 1 ('A' and 'a' and their replicates) • 4 students are chromosome 2 ('A' and 'a' and their replicates) • 4 students are chromosome 3 ('A' and 'a' and their replicates) • 2 student are the centrioles and also act as stage hands that move the membranes
22 students in a class	<ul style="list-style-type: none"> • 4 students are chromosome 1 ('A' and 'a' and their replicates) • 4 students are chromosome 2 ('A' and 'a' and their replicates) • 4 students are chromosome 3 ('A' and 'a' and their replicates)

	<p>replicates)</p> <ul style="list-style-type: none"> • 4 students are chromosome 4 ('A' and 'a' and their replicates) • 2 student are the centrioles • 1 student lays out and moves the cell membrane • 1 student lays out and moves the nuclear membrane • 1 student films the dance • 1 student queues the music
--	---

- **Teaching sequence**

The mitosis dance can be taught either:

- before the use of any technical biological terminology
- along-side the theory
- as revision at the end of teaching the theory, to support student understanding.

It is recommended that students try the dance before learning the theory of mitosis. This way, they can focus more on the movements themselves, rather than comparing them to anything theoretical. When they then come to learn the theory, they will find it easier to relate the dance to mitosis at the cellular level, for example, by saying: "that was the part Amy played."

- **Variations**

- If students are using the mitosis dance as revision, they can be broken into groups of about 5 or 6 and asked to choreograph their own dances.
- In a co-educational school, boys can represent the fathers' chromosomes and the females can be used to represent the mothers' chromosomes.
- Students can be shown the dance and asked to:
 - a. 'label' it i.e. label the sheets of paper with the word Chromosomes, label the centrioles and the membranes, and the stages of mitosis
 - b. 'annotate' it, with written explanations as the dance unfolds
 - c. narrate it, by doing the dance without music, but with a fun or serious commentary that explains what is happening in relation to actual mitosis.

- **Extension**

- Meiosis can be taught as a dance in relation to the mitosis dance. When they line up at metaphase plate in meiosis 1 they can take random sides showing how variation is introduced. Crossing over can also be shown by swapping gloves or other props.
- Critique the strengths and limitations of the mitosis dance as a model for teaching the actual process of mitosis.
- Compare to other dances, looking for similarities and differences. Students can write criteria for a variety of dances or teaching methods to do with mitosis and apply that criteria to make judgements about them.

- **Troubleshooting**

- If some students are particularly reluctant to participate, they can be given supporting roles, such as moving the membranes or filming the dance.
- If students do not want to hold hands, they can both hold the end of a baton or similar item to represent the centromere.

Example Links

Video of a large number of students doing a well rehearsed mitosis dance outdoors (5.17 minutes) - <https://www.youtube.com/watch?v=ZEwddr9ho-4>

Another well-rehearsed version (4.41) ; <https://www.youtube.com/watch?v=ZF-VAfTgY4s>

References

1. Darrell L Ray (2008) *Demonstrating Independent Assortment of Chromosomes, Square Dance Style*. The American Biology Teacher. 70(7):394-394.
2. Joseph P Chinnici, Joyce W Yue, Kieron M Torres (2004) *Students as "Human Chromosomes" in Role-Playing Mitosis & Meiosis*. The American Biology Teacher 66(1):35-39.
3. Kreiser, Brian; Hairston, Rosalina (2007) *Dance of the Chromosomes: A Kinetic Learning Approach to Mitosis and Meiosis*. Bioscene: Journal of College Biology Teaching, v33 n1 p6-10