Activity 2.2.4
Clues in the Chromosomes

Burst the cells, spread the chromosomes, count what lands. A wet lab. You drop cultured cells onto a slide, stain them, and count chromosomes in five separate spreads. This is the preparation every karyotype is built from.

DATE	PORTAL DAY	LESSON	TURN IN
Tuesday 2026-10-30	**Karyotype case analysis**	**Lesson 2.2 Decoding a Diagnosis**	**Lab report**

Where this sits. Single day. Your class calendar calls today Karyotype case analysis, and the PLTW activity is 2.2.4 Clues in the Chromosomes, which makes the chromosome spread. Building and reading a karyotype from a spread is tomorrow, in Activity 2.2.5. Search myPLTW for 2.2.4, not for karyotype.

01 Why today matters

Your next patient is five years old and has not grown the way she should, and you have ruled out the ordinary explanations one at a time until only her chromosomes are left.

Today you learn how anyone gets to look at chromosomes at all, by making the preparation yourself.

02 What you already know

- You know a chromosome is DNA wound around proteins, that body cells carry 46 in 23 pairs, and that the pairs are numbered 1 to 22 plus the sex chromosomes.
- You know from Activity 2.2.1 that chromosomes are most visible partway through division, when they are condensed. That is exactly the moment this lab freezes cells at.

WHAT THIS SHEET WILL NOT TELL YOU

- This sheet covers the preparation and the counting. It says nothing about what any patient's chromosomes show.

03 Vocabulary

TERM	WHAT IT MEANS, PLAINLY
Cytogenetics	The study of chromosomes: their number, their structure, and what changes to either do to a person.
Cytogeneticist	The laboratory professional who prepares cells so chromosomes can be seen and analyzed.
Cell culture	Growing cells outside a body in a controlled environment. These particular cells have been growing for a long time.
Culture medium	The sterile nutrient solution cells are grown in.
Metaphase arrest	Deliberately stopping cells at the point in division when chromosomes are most condensed and separated, using a chemical. It is the only stage at which they can be told apart.

Chromosome spread	Chromosomes released from a burst cell and spread flat on a slide so they can be counted and examined.
Giemsa stain	The dye that makes chromosomes visible and produces the light and dark bands used to identify each pair.
Banding pattern	The stripe pattern a stain produces along a chromosome. It is what lets a specialist say which chromosome this is, and where along it something has changed.
Karyotype	The organized profile: every chromosome pair arranged by size, largest to smallest, sex chromosomes last.
Chromosomal instability	The tendency of some cell lines to gain or lose whole chromosomes during division. It is why the cells you are using today will not show a tidy 46.
Endocrine system	The organs and glands that release hormones, controlling growth, metabolism, reproduction and sleep among other things.
Growth hormone	A hormone that drives growth and cell reproduction, and one of the two main drivers of height in childhood.
Growth chart percentile	Where a child's measurement sits relative to other children of the same age and sex. Below the first percentile means shorter than 99 out of 100.
Informed consent	Permission given by a person who understands what will be done with their sample and has genuinely agreed. The reason it is in this activity is worth reading.

Every term on this list is flagged for the illustrated glossary, scoped to this activity only. Terms are not shared forward or backward between activities, because a definition from a later activity can hand you an answer you were supposed to derive.

04 How to do the work

A five step preparation. Read every step before you start, because two of them are timed and one of them cannot be undone.

1. Confirm your dish floats in the water bath without letting water reach the slide. Fix this now, not with cells on the slide.
2. Lay your slide flat in the dish.
3. Mix the cell suspension gently by drawing it up and down the pipette slowly. Gently. Forcing it damages the cells you are about to look at.
4. With the same pipette, draw up the whole suspension and drop it onto the slide from about 15 centimeters above. The height is what bursts the cells and spreads the chromosomes apart. Too low and you get clumps; too high and you get splash.
5. Move the dish straight into the hot bath and put the cover back on at once. The bath has to stay both hot and humid, and it loses the humidity the moment the cover is off.
6. Incubate for 60 seconds on a timer, then take the dish out and let the slide dry for five minutes. Do not shortcut the drying.
7. Staining. With a transfer pipette, cover the area holding the spreads with the whole volume of Giemsa. Aim to cover the region without letting stain run off the edges.
8. Leave it five minutes at room temperature. Do not let the stain dry on the slide, and do not go and do something else.
9. Rinse by briefly dipping the slide in distilled water. Tap the edge gently on paper towel. If color still runs, change the water and dip again until the water stays clear.
10. Clean the bench as your teacher directs. Keep your stained slide.

11 Microscope. Find spreads at low power first, then move to 40x or 100x. Move around the slide; the first field you land on is rarely the best one.

12 Count the chromosomes in five separate, clearly single-cell spreads. Record each count in a table. Then calculate the average of your five.

13 Choose your clearest spread. Draw a circle about four inches across in your notebook and draw the chromosomes inside it as they actually sit, in color.

14 Share your average and your raw counts with the class, and record the class spread of values. The variation between groups is data about the method as much as about the cells.

MATERIALS

- Chromosome preparation kit as supplied
- Microscope slides in a plastic dish that floats
- Cell suspension, already cultured and arrested
- Transfer pipettes
- Giemsa stain
- Beaker of distilled water
- Hot water bath with a cover
- Paper towels
- Microscope
- Gloves and any other PPE your teacher specifies

WHAT YOU SHOULD AND SHOULD NOT EXPECT TO COUNT

- These are cultured tumor cells that have been dividing in a laboratory for a very long time, and cell lines like this gain and lose whole chromosomes as they divide.
- So do not expect 46. Counts above 70 per cell are typical here and finding one is not an error in your technique.
- This matters for how you write your report: the number you are measuring is a property of this cell line, and it is not a finding about any person. Say that explicitly in your conclusion.
- A count that lands near 46 in this preparation is more likely two half-spreads or an incomplete cell than a healthy one. Look before you record it.

CONSENT, AND WHY IT IS IN A CHROMOSOME LAB

- The oldest human cell line still used in research came from a woman whose cells were taken and grown without her knowledge and without anyone asking her. Her family spent decades working to have that acknowledged and to get the rules changed.
- The rules did change. Federal protections for human research subjects were strengthened in 2018, and there is now a legal agreement recognizing her contribution.
- You are not using those cells today. You are using human cells, and the reason this history sits inside a technique activity is that the technique came before the consent, and the field is still catching up.

05 Safety

READ EVERY LINE BEFORE YOU START

- Put on the PPE your teacher directs before you handle anything. Gloves at minimum.
- Giemsa stain stains skin, clothing and bench tops, and it does not come off. Treat spills immediately and tell your teacher.
- The water bath is hot. Move the dish in and out with the cover, not with bare fingers, and keep the bath away from the bench edge.
- These are real cells from a real cell line. Handle them with the respect you would give any human sample. The consent history in this activity explains why that sentence is here.
- No food, no drink, nothing near your face at the bench. Wash your hands when you finish, whether or not you wore gloves.
- Slides are glass and get slippery when wet. Report a break rather than picking it up.
- Follow your teacher's disposal instructions for used stain, rinse water and pipettes. None of it goes in ordinary waste.

06 Where students get stuck

- Counting two cells as one spread. Cells that burst near each other overlap and look like one enormous spread. Move the slide and find spreads that are clearly separate before you count. This is the error that inflates a count most.
- Dropping from the wrong height. The 15 centimeter drop is not decoration. It supplies the energy that bursts the cell and separates the chromosomes. Drop from too close and everything lands in a clump you cannot count.
- Letting the cover off the water bath. The step needs heat and humidity together. Every second the cover is off, the humidity goes, and the spreads come out poor with no way to tell why afterwards.
- Letting the stain dry on the slide. Dried Giemsa leaves a residue over the whole preparation and you cannot rinse it back off. Five minutes wet, then rinse.
- Rinsing once and moving on. If the rinse water is still turning blue there is stain left. Fresh water, dip again. Residual stain looks like extra material on your spreads and it will make you count things that are not chromosomes.
- Recording only the average. Five counts and the average, all of them. The spread between your five is what tells a reader how confident to be in your average, and hiding it hides the honest part of the result.
- Calling a spread a karyotype. A spread is chromosomes lying wherever they landed. A karyotype is those chromosomes cut out, sorted by size, paired and numbered. Today produces the first. Tomorrow builds the second.

07 What you turn in

LAB REPORT

A full lab report. Purpose: what a chromosome spread is for and why the patient's case needs one. Materials. Method: the preparation in your own words, with the two timed steps and the drop height called out. Results: your table of five chromosome counts, the average, the class range, and your labeled color drawing of one spread. Discussion: what count you expected and why, what you got, and what explains the difference. State clearly that this count describes the cell line and is not a finding about a patient. Sources of error: name the specific step you think most affected your spread quality and say how you would change it.

08 Check yourself

- [ ] Why must cells be stopped partway through division before they can be dropped and stained? (Vocabulary, metaphase arrest)
- [ ] Your five counts are 68, 71, 74, 46 and 70. Which one do you look at again before averaging, and what are you looking for? (What you should and should not expect to count)
- [ ] You have a beautifully stained slide with 42 clear chromosomes visible in one spread. Can you conclude anything about a person's health from it? Explain. (What you should and should not expect to count)