Mutation Mat Activity: Instructions for the Teacher

Goal of the activity:
To show how random mutations that accumulate over time could, or could not, lead to cancer

Steps of the activity:
- The class should split into groups of 2-3, so that there are 10 groups.
- Cut out the "sunscreen tokens" (page #12) and give one to each group.
- Cut out the "gene tokens" (page #13) and put them all into a bag.
- Distribute a mutation mat (designed like a bingo board) to each group. Each board represents one skin cell in one person's body. Each board contains genes that are often mutated in cancer, in different arrangements.
- Draw one gene from the "hat" and announce it to the students. Instruct the students to place a **sunscreen token** on whichever gene is drawn, such that this one gene is **protected** from mutation, for the rest of the activity. (At this point, you may want to remind the students that sunlight is an example of something that can damage DNA, but sunscreen can help protect against UV rays. The mat in this activity represents a skin cell, so sunscreen will protect the skin cell from damage by UV rays.)
- Like bingo, continue to draw & announce 1 gene at a time. Each draw represents 5 years of time passing. The difference (from now on) is that all the genes will represent genes that get **mutated**. Instruct the students to write an "**X**" through each gene you select, that is present on their mat.
- Four "X's" in a row (vertically, horizontally, or diagonally) indicates that this group's skin cell got converted to a cancerous cell. (Sunscreen may help prevent a continuous stretch of four "X's" from forming, and in that case, the cell doesn't become cancerous.)
- Stop drawing gene names (in order to end the activity) once ~3 mats have converted to cancerous cells.

Questions for follow-up discussion:
- What proportion of the cells became cancerous, at the end of the activity?
- Were there certain genes that were mutated in every mat that got cancer?
- After each draw (i.e. every 5 years), how many cells became cancerous? Plot these numbers over time.
- How many mats would have become cancerous, but did not, because of the protective function of the sunscreen?

MUTATION MAT #1

KRAS	GATA1	PIK3CA	NFkB2
RUNX1	FGFR1	NF1	CHEK2
P21	BCR-ABL	CTNNB1	RB1
MDM2	P53	EZH3	JAK1

MUTATION MAT #2

RUNX1	P53	EGFR	PAX8
MDM2	GATA1	NF1	NFkB2
ATM	HRAS	SMARCA4	JAK1
PIK3R1	BCR-ABL	PDGFRA	AKT1

MUTATION MAT #3

MYC	HRAS	PDGFRA	BRAF
PIK3R1	P53	EZH3	NFkB2
RUNX1	BCR-ABL	SMARCA4	ERBB2
P21	GATA1	CTNNB1	PAX8

MUTATION MAT #4

KRAS	MET	NF1	BRAF
RUNX1	DICER1	EZH3	JAK1
ATM	FGFR1	PDGFRA	CHEK2
PIK3R1	BCR-ABL	CDKN2A	PAX8

MUTATION MAT #5

KRAS	BCR-ABL	SMARCA4	BRAF
MDM2	GATA1	EZH3	RB1
ATM	HRAS	PIK3CA	ERBB2
RUNX1	DICER1	EGFR	NFkB2

MUTATION MAT #6

P21	BCR-ABL	NF1	BRAF
PIK3R1	P53	CDKN2A	AKT1
MDM2	MET	SMARCA4	ERBB2
ATM	MLL	PIK3CA	RB1

MUTATION MAT #7

P21	DICER1	PDGFRA	CHEK2
RUNX1	MET	EZH3	RB1
MYC	BCR-ABL	SMARCA4	PAX8
ATM	FGFR1	CTNNB1	BRAF

MUTATION MAT #8

P16	BCR-ABL	CDKN2A	AKT1
RUNX1	P53	EZH3	NFkB2
ATM	GATA1	EGFR	ERBB2
MDM2	HRAS	PDGFRA	PAX8

MUTATION MAT #9

MDM2	FGFR1	EGFR	CHEK2
KRAS	MET	NF1	BRAF
ATM	DICER1	PIK3CA	JAK1
MYC	BCR-ABL	EZH3	AKT1

MUTATION MAT #10

RUNX1	P53	PIK3CA	AKT1
MDM2	HRAS	EZH3	PAX8
MYC	DICER1	NF1	JAK1
P16	MET	EGFR	RB1

Sunscreen Tokens
(to distribute, one per group, to be used only in the first round)
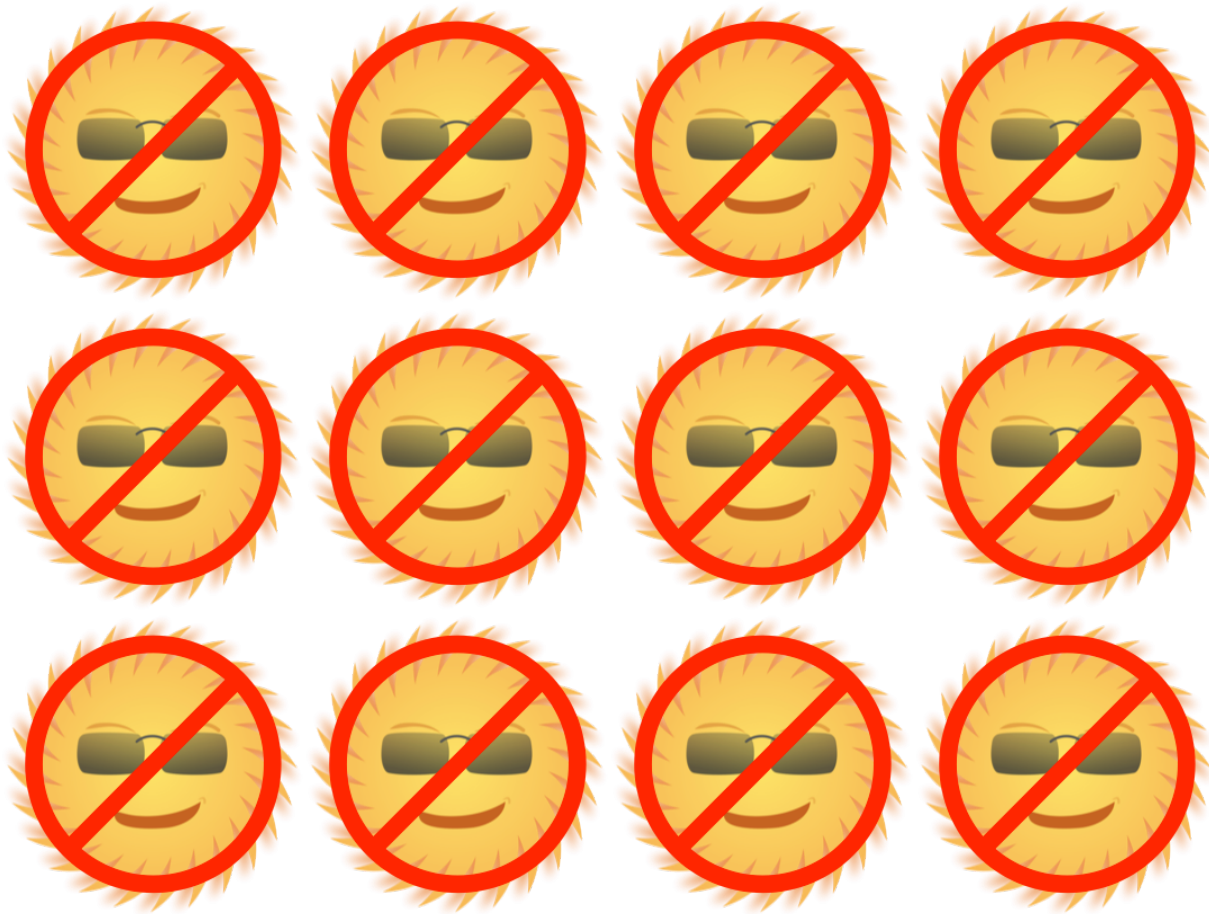
Gene Tokens
(for teacher to cut out, and draw, one per round)

RUNX1	P53	PIK3CA	AKT1
MDM2	HRAS	EZH3	PAX8
MYC	DICER1	NF1	JAK1
P16	MET	EGFR	RB1
ATM	MLL	CTNNB1	BRAF
KRAS	GATA1	PDGFRA	ERBB2
P21	BCR-ABL	SMARCA4	CHEK2
PIK3R1	FGFR1	CDKN2A	NFkB2