Learn the fascinating science of protein degradation with our computer game

Have fun exploring protein degradation in our educational computer game and discover the science behind the ubiquitin-proteasome system that eliminates abnormal proteins in our cells. Learn also about targeted protein degradation, an innovative method of destroying pathogenic proteins using our own cellular degradation pathways.

Join us now to learn, play, and uncover the secrets of cellular life!

PLAY

Tu między tekst a Play potencjalnie filmik z gameplay w przyszosci

Protein degradation

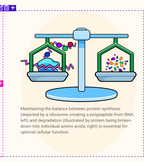
Discover the science behind the constant destruction of proteins in our cells and its implications for cell function and new therapies

The Art Of Keeping Balance

Proteins are constantly produced and degraded in our cells, so maintaining a balance between these processes, called cellular homeostasis, is important for our health. The main system responsible for protein degradation is the ubiquitin-proteasome system (UPS). It ensures that damaged proteins and unnecessary proteins are broken down at the right time.

When the UPS does not function properly, abnormal proteins can accumulate, causing various diseases. For example, disorders such as Alzheimer's disease and Parkinson's disease occur when the UPS does not work properly, leading to harmful aggregates in the brain. Moreover, UPS disorders can cause uncontrolled growth of cancer-causing proteins and the formation of tumors.

By studying protein degradation and its relationship to various diseases, we can develop new treatments. In fact, we have already made significant progress and are starting to use our own cellular degradation machinery to get rid of proteins associated with various diseases.



Maintaining the balance between protein synthesis (depicted by a ribosome creating a polypeptide from RNA, left) and degradation (illustrated by protein being broken down into individual amino acids, right) is essential for optimal cellular function.

The ubiquitin-proteasome system utilizes an enzymatic cascade to selectively mark proteins with ubiquitin, leading to their degradation by the proteasome and enabling precise regulation of protein levels for cellular homeostasis.

Ubiquitin-Proteasome System

Our game focuses on the ubiquitin-proteasome system (UPS), a major protein degradation pathway in the cell.

The UPS involves a cascade of enzymes, including E1 (ubiquitin-activating enzyme), E2 (ubiquitin-conjugating enzyme) and E3 (ubiquitin ligase), which work together to attach a small protein called ubiquitin to target proteins. This process, called ubiquitination, marks the proteins for recognition and subsequent degradation by the proteasome, a large molecular complex.

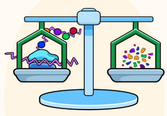
The proteasome acts as a cellular waste bin, breaking down ubiquitin-tagged proteins into smaller peptides that can be again used by the cell e.g. to produce new proteins.

Targeted Protein Degradation - The Future Of Medicine?

What if we could use our own ubiquitin-proteasome system and tune it to eliminate aberrant or toxic proteins that cause a disease? Well, this is not a science fiction anymore. Targeted protein degradation (TPD) approaches offer such innovative strategies to tackle "undruggable" proteins and expand the scope of therapeutic interventions by hijacking cellular degradation pathways to eliminate toxic elements.

Two prominent approaches in TPD involve using molecular glues and PROTACs (PROteolysis TArgeting Chimeras), both of which allow for ubiquitination of the target protein, leading to its subsequent degradation by the proteasome.

Molecular glues, exemplified by compounds like lenalidomide, have already demonstrated clinical success in diseases such as multiple myeloma. On the other hand, several PROTACs are currently undergoing clinical trials, showcasing their potential as a promising TPD approach. These methods offer exciting opportunities to degrade disease-causing proteins, including oncogenic proteins, and hold promise for a wide range of therapeutic applications.



Molecular glues and PROTACs are two distinct approaches in targeted protein degradation. Molecular glues act are small molecules that enhance interactions between the E3 ligase and the target protein, while PROTACs are bi-modal compounds composed of one part that recognizes a specific E3 ligase and another part that targets the desired protein. Both approaches result in the ubiquitination of the target protein, ultimately leading to its degradation.

Game characters

Meet the awesome characters from the game

E3 UBIQUITIN LIGASE

The main character of the game. Its goal, the same as for completing our game, is to recognize and bind proteins for degradation and mediate their ubiquitination and subsequent degradation.

E2 UBIQUITIN-CONJUGATING ENZYME

The best companion of the E3 ubiquitin ligase. Forms a complex with it and transfers ubiquitin to the target protein.

TARGET PROTEINS

Different target proteins, but one goal: tag them with ubiquitin and send for degradation.

UBIQUITIN

Although depicted as pink, is the gray eminence of the game. Its attachment to the target protein acts as a "destroy me" signal.

PROTEASOME

Large molecular complex that functions as a cellular waste bin. Recognizes and destroys ubiquitinated proteins.

DEUBIQUITINATING ENZYME

Major antagonist. Removes ubiquitin from proteins, preventing their degradation.

Also featuring...

PROTAC

Our protagonist, the E3 ubiquitin ligase, can only recognize a small subset of all proteins present in the cell. But that is not a problem. Thanks to the PROTAC (PROteolysis TArgeting Chimera) compound, our hero gains superpower and becomes capable of binding proteins it couldn't before. And guess what? This leads to their ubiquitination and subsequent degradation. So, keep calm and degrade on!

For educators

Our game was created with a primary focus on education, as we believe there's no better way to learn than through having fun.

To enrich the journey into the fascinating world of protein degradation, we have prepared a range of downloadable materials to enhance the learning experience and complement the knowledge gained from our game.

CLASS SCENARIO

Biology lesson scenario on protein degradation involving our game. For 12-14 y.o.

Download

CLASS SCENARIO

Biology lesson scenario on protein degradation involving our game. For 15+ y.o.

Download

ENCYCLOPEDIA

The Great Encyclopedia Of Protein Degradation from the game.

Download

QUIZES

Quizes about protein degradation based on the Encyclopedia.

Download

COMIC

Comic about E3 ligase ...

Download

BROCHURE

Educational brochure about protein degradation.

Download

POSTER

Poster about the DEGRADATOR GAME.

Download

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Add New Section

PUBLICATION

We have published an article in which we describe all the educational aspects of our game. Feel free to use it and cite:

Szulc N.A., Olchowik A., Jaszczak P. & Pokrzywa W. The DEGRADATOR Game. Journal of ... 2023. doi.org/xxx

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