**Familial Partial Lipodystrophy, Dunnigan Variety**

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**Part 3: Why does Jill have no fat? Can it be fixed?**

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| ***Box 3: Storyline***  The structural explorations of FPL2 demonstrate how the Tryptophan can bind differently to neighboring amino acid side chains, ultimately changing the protein's conformation.  The article, [**Structure of the lamin A/C R482W mutant responsible for dominant familial partial lipodystrophy (FPLD)**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2705630/), helps explain the structural impact Tryptophan has on the protein and its interaction with DNA, leading to premature death of adipocyte cells. |

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| **Background Information: Regulation of Enzymatic Activity**  *Allosteric regulation* - the regulation of an enzyme by binding an effector molecule at a site different from the active site of the enzyme.  *Effector molecule* - a small molecule that regulates biological activity by selectively binding to a protein. Effector molecules can have an impact on enzyme activity (increase or decrease), cell signaling or gene expression. |

Read [Structure of the lamin A/C R482W mutant responsible for dominant familial partial lipodystrophy (FPLD)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2705630/) to help answer the following questions, as well as using the structures you generated in part 2. For question 1, read sections 3.3 and 3.4 in the discussion.

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Question 1. What type of enzymatic activity is represented by an arginine to tryptophan mutation in the Lamin A/C protein? Why does this mutation cause the enzymatic activity? (hint: think about enzymatic activity as stated in the background information box or in sections 3.3 and 3.4 of the reading).

Answer:

Question 2. Compare the superimposed diagram of the mutated lamin A/C and the wild type lamin A/C.

1. Go to the Mol\* homepage at <https://molstar.org/> and Open Mol\* Viewer.
2. Navigating to the left hand menu, open both structures by typing in the PDB Ids as “1IFR, 3GEF”.
3. Manipulate the image to focus on the mutated residue. Upload a file with the image you create.
   1. Hide the water molecules by clicking the eye icon in the left menu.
   2. Enter toggle mode by clicking the cursor in the right toolbar. Select residues R482 (1IFR) and W482 (3GEF) from the sequence window. Alternate between the two structures with the dropdown option in the top toolbar.
   3. Change the representation: Select “Component” in the right menu → Select “Add” → for Representation, choose Ball & Stick.
   4. With the two residues still selected, change the color: Select the Paintbrush from the upper toolbar→ Choose a contrasting color→ Click “Apply Theme”.
   5. With the residues still selected, navigate to Superposition in the right menu.
   6. Select “By Chain” and click “Superimpose”.
   7. Label the two residues: In toggle mode, select a residue → select “Measurement” → “Add” → “Label”
4. Label the structures in the image you produce to differentiate between 1IFR and 3GEF.

Answer:

Question 3. The distance of the Arg482 to the Glycerol small molecule on the wild type Lamin A/C (1IFR) is 10.71Å. Find the distance between the Try482 to the CSD (3-Sulfinoalanine) small molecule on the mutated Lamin A/C (3GEF). Compare the two distances. What do your results suggest? Upload an image of the mutated distance from PDB.

1. In the 3D view tab of the RCSB page, manipulate the protein with Mol\*
   1. On the RCSB structure summary page of 3GEF, click on the 3D view “Structure”.
   2. In toggle selection mode, select “Residue” for selection type in the upper toolbar. Highlight the mutated amino acid (W482). It may be easier to find the residue in the sequence box above the structure and select its one letter code.
   3. Label the residue and small molecule by clicking on “Measurements” - “Add” - “Label”.
   4. Click on both the residue and the small molecule → click “Measurements” → “Add” → “Distance”.

Answer:

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| ***Box 4: Storyline***  Now that you understand that Jill’s disease is caused by the R482W mutation and how the enzymatic activity of the amino acid changes the conformation of the protein, we will read how the LMNA gene and Lamin A/C protein interacts with adipocyte cells. We will then investigate possible therapies and drugs that could be used to prevent FPL2 since there is no known cure. Each patient diagnosed with FPL2 is treated on an individual basis based on the symptoms they express. |

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| **Background information: R482W Effect on Adipocyte Cells**  According to Oldenburg *et al.* (2017), in the article, [**A lipodystrophy-causing lamin A mutant alters conformation and epigenetic regulation of the anti-adipogenic MIR335 locus | Journal of Cell Biology**](https://rupress.org/jcb/article/216/9/2731/54868/A-lipodystrophy-causing-lamin-A-mutant-alters), the FPL2 Lamin A/C R482W mutation is associated with adipogenic impairment. Although the mechanism for which this mutation affects the adipocyte cells is unclear, they note the mutation inhibits adipogenic gene expression which further deregulates the anti-adipogenic MIR335 microRNA gene in human adipocyte progenitor cells. The R482W mutation prevents the LMNA gene from binding to the MIR335 gene, which leads to inactive adipocyte cells and decreased fat storage.  [This information was only presented to show the connection between LMNA gene and Lamin A/C protein to adipocyte cells. Nothing will be investigated with this given information.] |

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| **Background Information: Drugs/Therapies**  *Sterol Response Element Binding Protein 1 (SREBP1)-targeting molecules:* Activity of SREBP1, a transcription factor that regulates hundreds of genes involved in lipid metabolism and adipocyte differentiation, is elevated with the R482W mutation. New therapeutic drugs target this protein to inhibit its activity.  *Metreleptin* - Prescription medication used alongside a diet plan to treat leptin deficiency in people with congenital or acquired generalized lipodystrophy.   * Leptin - A hormone mainly constituted by adipose cells and enterocytes located in the small intestine. Fat storage in adipocytes is diminished because leptin helps regulate energy balance by inhibiting hunger. * Lipodystrophy - A disorder of adipose tissue characterized by a selective loss of body fat.   Read: [p.R482W substitution in A-type lamins deregulates SREBP1 activity in Dunnigan-type familial partial lipodystrophy](https://academic.oup.com/hmg/article/24/7/2096/598363) (introduction only) for more information on SREBP1, [Metreleptin](https://go.drugbank.com/drugs/DB09046) for more information on Metreleptin, and [Leptin | Hormone Health Network](https://www.hormone.org/your-health-and-hormones/glands-and-hormones-a-to-z/hormones/leptin) for additional information regarding Leptin. |

Question 4. Could SREBP1 be useful in treating Jill? Why or why not?

Answer:

Question 5: Could Metreleptin be useful in treating Jill? Why or why not?

Answer:

Question 6. Summarize the main parts of this case study regarding FPL2 and Jill. Furthermore, predict why you think Jill and the Olympian could appear completely different, but have the same mutation? (hint: reread [The DIY Scientist, the Olympian, and the Mutated Gene](https://www.propublica.org/article/muscular-dystrophy-patient-olympic-medalist-same-genetic-mutation) to understand the apparent discrepancies between Jill and Priscilla).

Answer: