THE LYON HYPOTHESIS IN THE CONTEXT OF TURNER SYNDROME

1. **Lyon Hypothesis (X-Inactivation)**:
    - Proposed by English geneticist **Mary Lyon**, the Lyon hypothesis explains how female mammals achieve dosage compensation for X-linked genes.
    - In females, who have two X chromosomes, one X chromosome is randomly inactivated in each cell during early embryonic development.
    - The inactive X chromosome becomes a condensed structure called a **Barr body**.
    - This process ensures that females do not produce twice as many X chromosome gene products as males (who have only one X chromosome).
2. **Turner Syndrome and X-Inactivation**:

    2.1. **Normal Woman (XX)**:

    2.1.1. One X chromosome is randomly inactivated in each cell.

    2.1.2. The choice of which X chromosome is inactivated varies across cells.

    2.1.3. Approximately half of the cells have the paternal X chromosome inactivated, and the other half have the maternal X chromosome inactivated.

    2.2. **Woman with Turner Syndrome (XO)**:

    2.2.1. Turner syndrome results from the absence of one X chromosome (45,X karyotype).

    2.2.2. In these individuals, there is no second X chromosome to undergo inactivation.

    2.2.3. Therefore, all genes on the single X chromosome remain active.

    2.2.4. This lack of dosage compensation can lead to characteristic features of Turner syndrome, such as short stature, ovarian dysfunction, and other health issues.

In summary, the Lyon hypothesis ensures proper gene dosage in females by randomly inactivating one X chromosome.
In Turner syndrome, the absence of one X chromosome disrupts this process (see 2.1 and 2.2):
- No X inactivation: the only X stays active. Is it of maternal or paternal origin?

- All genes are active. No such thing as half inactivated X chromosomes are paternal and half are maternal.

SOURCES:

1. https://link.springer.com/article/10.1007/s00439-011-1013-x. 2011.
2. Takagi N, Sasaki M, 1975. "Preferential inactivation of the paternally derived X chromosome in the extra embryonic membranes of the mouse". Nature. **256** (5519): 640–
2. Bibcode:1975Natur.256..640T. doi:10.1038/256640a0. PMID 1152998.
3. Okamoto I, Otte AP, Allis CD, Reinberg D, Heard E (January 2004). "Epigenetic dynamics of imprinted X inactivation during early mouse development". Science. **303** (5658): 644–
9. Bibcode:2004Sci...303..644O. doi:10.1126/science.1092727
4. Deng Q, Ramsköld D, Reinius B, Sandberg R (January 2014). "Single-cell RNA-seq reveals dynamic, random monoallelic gene expression in mammalian cells". Science. **343** (6167): 193–6.
5. Xue Z, Huang K, Cai C, Cai L, Jiang CY, Feng Y, Liu Z, Zeng Q, Cheng L, Sun YE, Liu JY, Horvath S, Fan G (August 2013). "Genetic programs in human and mouse early embryos revealed by single-cell RNA sequencing". Nature. **500** (7464): 593–7.
6. Vértesy Á, Arindrarto W, Roost MS, Reinius B, Torrens-Juaneda V, Bialecka M, et al. (May 2018). "Parental haplotype-specific single-cell transcriptomics reveal incomplete epigenetic reprogramming in human female germ cells". Nature Communications. **9** (1): 1873.
7. Puck JM, Willard HF (January 1998). "X inactivation in females with X-linked disease". The New England Journal of Medicine. **338** (5): 325–8.
8. Lyon MF (January 1972). "X-chromosome inactivation and developmental patterns in mammals". Biological Reviews of the Cambridge Philosophical Society. **47** (1): 1–35.
9. Chow JC, Yen Z, Ziesche SM, Brown CJ (2005). "Silencing of the mammalian X chromosome". Annual Review of Genomics and Human Genetics. **6**: 69–92.
10. https://link.springer.com/article/10.1007/s12041-015-0575-0. 2015.