ARTIFICIAL OVARIES

Slide Guide and Presentation Notes

Instructions: Use this slide guide to be better prepared for and help move through the PowerPoint presentation as well as provide the students with a greater source of information.

- *Define, explain* and *show* indicate something needs to be better explained, or may be useful for the students understanding of the content given
- *Ask* indicates a question that should prompt student participation/responses, with an answer example given
- *Common questions* give a look into what students often have a difficulty understanding and potential answers you can give
- *Citations* indicate any sources used within this slide guide, or images/videos used within the PowerPoint itself, actual sources used for the information on the slides can be found at the end of the presentation

Slide 1: *Title*

Slide 4: *Learning Goals*

Slide 5: *What are the Ovaries?*

Slide 6: *Overview of the Ovaries: What?*

Explain:

Diagram is of the different stages involved in oogenesis (which will be important for *their virtual histology lab* assignment). Begins in bottom left with early primary follicle and continues counterclockwise.

Optional to explain the following:

Stages:

1. ***Early Primary Follicle***: develops as the granulosa cells become enlarged
2. ***Late Primary Follicle***: zona pellucida appears
3. ***Secondary Follicle***: contains fluid filled versicles that will develop among granulosa cells, as well as an inner and outer theca (outer theca is capsule around the follicle)
4. ***Mature Follicle:*** forms when the fluid-filled vesicle consolidates into one antrum

5. ***Ovulation***: oocyte is released from the follicle along with surrounding granulosa cells (corona radiata)
6. ***Developing Corpus Luteum***: granulosa cells divide rapidly to form the corpus luteum
7. ***Corpus Albicans***: degenerated corpus luteum

Image Citations:

Garcia, Alexandra. "Oogenesis Labeled." Ovary, Wikipedia, 2020, https://en.wikipedia.org/wiki/File:Oogenesis_Labeled.svg

Slide 7: *Overview of the Ovaries: Where?*

Image Citations:

Winslow, T. "Reproductive System, Female, Anatomy." Salpingo-Ovarian & Peritoneal, National Cancer Institute, 8 June, 2018, https://training.seer.cancer.gov/ovarian/intro/

Slide 8: *Overview of the Ovaries: Ovarian Tissue Anatomy*

Image Citations:

Thompson, L. (2020, April 9). The Ovaries. Retrieved January 29, 2021, from https://teachmeanatomy.info/pelvis/female-reproductive-tract/ovaries/

Slide 9: *The Menstrual Cycle*

Explain:

The menstrual cycle occurs around every month from the time of puberty to menopause. During each menstrual cycle, an egg develops and is released from the ovaries. The lining of the uterus builds up, and should pregnancy *not* occur, the uterine lining sheds during the menstrual period. Each menstrual cycle, and even more specifically, each phase, may differ in time depending upon the individual.

Image Citations:

Wakim, S. and Grewal, M."Ovarian Cycle." 22.7 Menstrual Cycle, LibreTexts. 2020, https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_(Wakim_and _Grewal)/22%3A_Reproductive_System/22.07%3A_Menstrual_Cycle

Slide 10: *1. Menstrual Phase*

Explain:

This drop in estrogen often causes headaches or nausea, while the hormones and contractions to help shed and pass the uterine lining can cause cramps/discomfort.

Image Citations:

Wakim, S. and Grewal, M."Ovarian Cycle." 22.7 Menstrual Cycle, LibreTexts. 2020, https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_(Wakim_and _Grewal)/22%3A_Reproductive_System/22.07%3A_Menstrual_Cycle

Slide 11: *2. Follicular Phase*

Explain:

This phase begins on the first day of one's period with the length of this phase really differing upon the person. Estrogen levels increase to thicken the uterine lining and create a healthy environment for a potential embryo to grow.

Image Citations:

Almazon, M. (2019, December 06). Supercharge your cycle: Expert reveals how planning your life around your PERIOD can make your more successful at work and boost personal relationships. Retrieved January 29, 2021, from https://www.dailymail.co.uk/femail/article-7760747/Expert-reveals-plan-life-period-make-day-month.html

Slide 12: *3. Ovulation*

Explain:

The continuous rise of estrogen signals to the pituitary gland to release the luteinizing hormone.

Image Citations:

Almazon, M. (2019, December 06). Supercharge your cycle: Expert reveals how planning your life around your PERIOD can make your more successful at work and boost personal relationships. Retrieved January 29, 2021, from https://www.dailymail.co.uk/femail/article-7760747/Expert-reveals-plan-life-period-make-day-month.html

Slide 13: *4. Luteal Phase*

Image Citations:

Almazon, M. (2019, December 06). Supercharge your cycle: Expert reveals how planning your life around your PERIOD can make your more successful at work and boost personal relationships. Retrieved January 29, 2021, from https://www.dailymail.co.uk/femail/article-7760747/Expert-reveals-plan-life-period-make-day-month.html

Slide 14: *Let's talk about hormones,*

Explain:

Graph indicates the change in hormone levels during the menstrual cycle. Red area is the menstrual phase/period, and center line is the ovulation phase.

Ask:

"What appear to be some of the relationships between the phases and hormone levels, and why might these be?"

Potential Answer(s):

Estrogen, FSH and luteinizing hormone levels begin to increase right before ovulation. This could be due to the fact that FSH is needed to produce mature follicles that will release an egg during ovulation. This release occurs in response to the release of LH. Both of these hormone releases are signaled by the peak release of estrogen.

Progesterone levels increase and peak during the luteal phase, with a small increase seen from estrogen. This is due to this phase seeing the production of the corpus luteum, which produces a large amount of progesterone and some estrogen in order to keep the uterine lining thick and ready for a fertilized egg to be implanted. Should fertilization not occur, both of these levels will sink again, leading to the beginning of the individual's period.

Image Citations:

Ray, L., DNP. (2018, December 11). The menstrual cycle: More than just your period. Retrieved January 29, 2021, from https://helloclue.com/articles/cycle-a-z/the-menstrual-cycle-more-than-just-the-period

Slide 15: *Important Fact*

Explain:

The number of eggs a woman has decreases over time, with the quality of the eggs also decreasing with age.

Ask:

"What might this trend explain?"

Potential Answer(s):

The decrease in number and quality of eggs a woman has may explain why it becomes increasingly more difficult to become pregnant beyond a certain age.

Image Citations:

SheCares Editorial Team. (2019, September 10). Fertility and Age (1170734478 877946263 L. F MD, Ed.). Retrieved January 29, 2021, from https://www.shecares.com/pregnancy/fertility/fertility-and-age

Slide 16: *What is female fertility?*

Ask:

"*What might be some factors that could affect female fertility?"*

Potential Answers:

Age, smoking, alcohol, diseases/disorders, etc.

Image Citations:

L. (2017, August 11). IVF: The Pregnancy Tests: Pregnancy Tests During the IVF Process. Retrieved February 01, 2021, from https://www.lifeloveandsugar.com/ivf-the-pregnancy-tests/

Slide 17: *Ovarian Infertility: Polycystic Ovary Syndrome (PCOS)*

Explain:

Each cyst is a follicle that contains an immature egg. These eggs in turn never mature enough to trigger ovulation. This in turn disrupts the normal hormone levels and in turn the menstrual cycle, leading to greater levels of estrogens and missed/skipped periods.

Image Citations:

Chorro-Mari, V. (2020, March 24). Case-based learning: Management of polycystic ovary syndrome. Retrieved February 01, 2021, from https://www.pharmaceutical-journal.com/cpd-and-learning/learning-article/case-based-learning-management-of-polycystic-ovary-syndrome/20207804.article?firstPass=false

Slide 18: *Ovarian Infertility: Cancer Treatments*

Image Citations:

Stock image found at https://www.dreamstime.com/royalty-free-stock-image-chemotherapy-drugs-biohazard-cy totoxic-image25604946

Slide 19: *Ovarian Infertility: Scarred Ovaries*

Image Citations:

“CardiacSurgeryOperatingRoom.”Surgery, Wikipedia,2014, https://upload.wikimedia.org/wikipedia/commons/2/2e/Cardiac_surgery_operating_room.jpg

Slide 20: *What is Tissue Engineering, and how can we use it?*

Ask:

What the students know about tissue engineering before this point.

Show:

If you have time, show this YouTube video which gives a quick 2-minute introduction to tissue engineering.

Link: https://www.youtube.com/watch?v=7Q3S6q97FiU

Creator: NBIB/NIH (Creative Commons License)

Slide 21: *Tissue Engineering*

Explain:

The image depicts the three main techniques used to aid the field of tissue engineering.

1. Tissue architecture
    - Can include 3D printed organs and decellularized organs (the latter involves taking existing organ structures and removing all cellular components so that only the ECM matrix model is left)
2. Biomaterials
    - Can include scaffolds and any material engineered to act as a biological framework that promotes cell growth and tissue regeneration
3. Engineered cells
    - Can include stem cells, reprogrammed cells, lab grown cells

Image Citations:

Tissue engineering. (n.d.). Retrieved February 01, 2021, from https://en.wikipedia.org/wiki/Tissue_engineering

Slide 22: *Artificial Ovaries and Tissue Engineering*

Explain:

Organ transplantations is a final solution for those with non-functioning or under-functioning organs. However, there are numerous issues with this approach:

- Long waiting lists (some in need may never receive an organ transplant)
- Greater demand than supply (not enough organ donors, which further contributed to the point above)
- Transplant rejection

Medical devices such as implants, are a "bridge-to-transplant" solution. This means that they are not always meant to last the rest of the patient's life but give them more time till they can obtain an organ transplant. However, this also comes with issues, such as:

- Tissue rejection (body attacks the foreign object due to numerous reasons)
- Infection
- Poor long-term durability

Tissue engineering aims to offer another solution, which can be specifically applied to the creation of artificial ovaries.

Slide 23: *Scaffolding*

Image Citations:

Tissue Engineered Scaffold for a Multiple Tissue Junction. (n.d.). Retrieved February 02, 2021, from https://biotextiles2018.wordpress.com/team-9/

Slide 24: *Scaffolding Cont.*

Explain:

3D Printing

Pros

- Allows for the rapid production of complex 3D objects from a computer model with varying levels of internal and external structures (fast)
- Ability to include material and structural specifications during production (precise)
- Easy reproducibility

Cons

- There are limits to the precision and intricacies that can be printed (especially as the size of the product becomes smaller)
- Ethical concerns
- Expensive and timely depending on the method of 3D bioprinting used
- Complications in keeping the cells alive once printed

Decellularization

Pros

- Allows for precise replication of the unique structures that make up the organ in question
- Relatively low immune response/rejection
- Organic and thus has a relatively good biodegradability capability
- Can be made to contain bioactive substances

Cons

- Recellularization of the scaffold has proven to be quite difficult
- Protocols have not been established and field relatively young
- Complications in keeping the scaffold alive once printed
- Difficulty ensuring efficient vascularization/cell matrices and networks

Ask:

"Why might decellularization methods have lower immune responses?"

Potential Answers:

By getting rid of the foreign cellular material, and therefore foreign antigens, the body is less likely to attack the scaffold.

Pros and Cons Citations:

1. Bishop, Elliot S., et al. "3-D bioprinting technologies in tissue engineering and regenerative medicine: Current and future trends." *Genes & diseases* 4.4 (2017): 185-195.
2. Garreta, Elena, et al. "Tissue engineering by decellularization and 3D bioprinting." *Materials Today* 20.4 (2017): 166-178.
3. Liao, Jie, et al. "Applications of decellularized materials in tissue engineering: advantages, drawbacks and current improvements, and future perspectives." *Journal of Materials Chemistry B* (2020).

Slide 25: *Types of Scaffolds*

Explain:

Scaffolds can be made of many different materials. Often, they are laden with drugs in addition to the cells. These drugs often promote cell adhesion, proliferation and growth.

Image Citations:

Jana, S., Tefft, B., Spoon, D., & Simari, R. (2014). Scaffolds for tissue engineering of cardiac valves (article) Author. Acta Biomaterialia, 10(7), 2877-2893. doi:https://doi.org/10.1016/j.actbio.2014.03.014

Slide 26: *Scaffolding Considerations*

Before clicking on the slide to continue,

Ask:

"What might be important to consider when making a scaffold?"

After listening to responses, click on slide to reveal answers (as seen below)

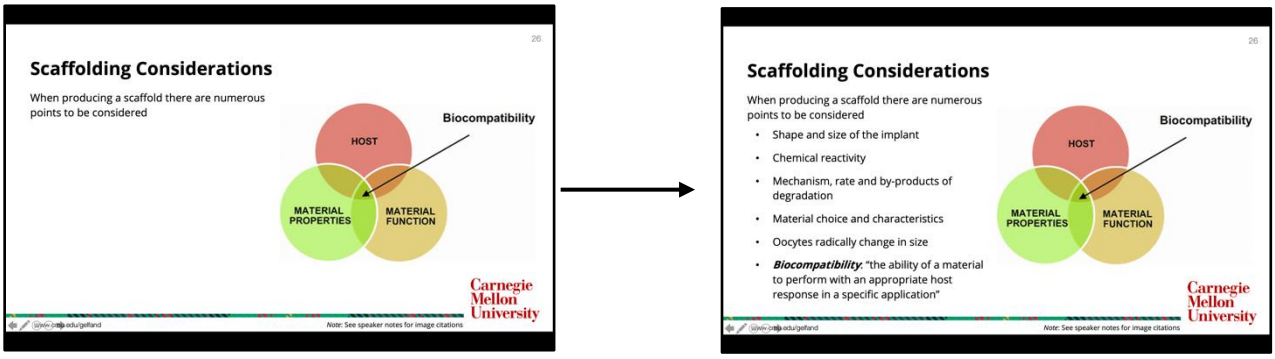

Image Citations:

Siswomihardjo, Widowati. (2016). Biocompatibility Issues of Biomaterials. 10.1007/978-3-319-14845-8_3.

Slide 27: *Isolation of Oocytes and Seeding*

Image Citations:

Image made by editor.

Slide 28: *Growth*

Ask:

"What type of conditions may need to be controlled in a bioreactor?"

Potential Answers:

Temperature, pH, pressure

Image Citations:

Rauh, J. et al. "Bioreactor systems for bone tissue engineering." *Tissue engineering. Part B, Reviews* 17 4 (2011): 263-80 .

Slide 29: *In real life…*

Ask:

"What may be some issues with this seemingly successful mouse study?"

Potential Answers:

The tissue of the mouse may not accurately represent or react how a human's tissues would respond.

There are ethical and moral concerns regarding testing on animals, as well as using and engineering ovarian cells.

Image Citations:

Franco, M. (2017, March 21). Tail or tunnel? Mouse-handling methods could influence experiments. Retrieved February 06, 2021, from https://newatlas.com/mouse-transport-influences-study-results/48512/

Slide 30: *Problems*

Image Citations:

Anderson, S., Ph.D. (2014, April 25). 9 exciting advances in tissue engineering. Retrieved February 06, 2021, from http://sjabioscience.com/9-exciting-advances-in-tissue-engineering/

Slide 31: *Possible Recipients*

Before clicking on the slide to continue,

Ask:

"Who might benefit from tissue engineered ovaries?"

After listening to responses, click on slide to reveal answers (as seen below)

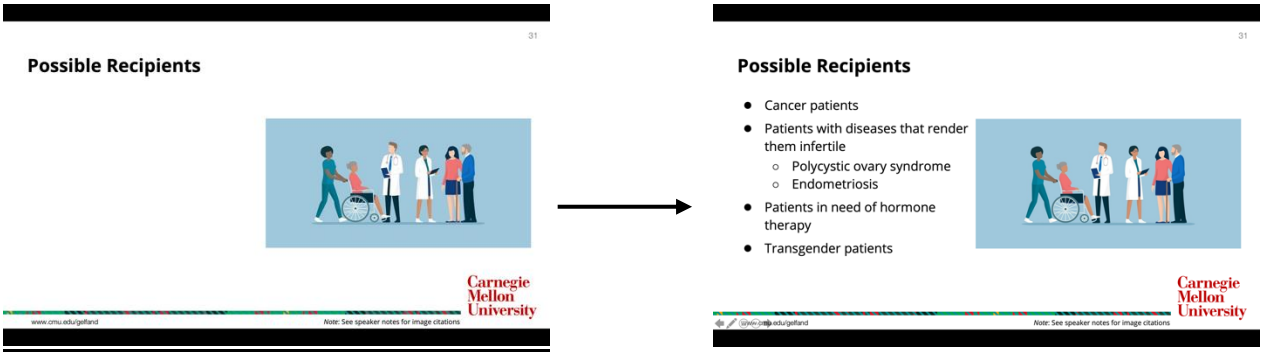

Image Citations:

Spinner, J. (2020, February 27). BBK: Patients, trial participants share a voice. Retrieved February 06, 2021, from https://www.outsourcing-pharma.com/Article/2020/02/27/Survey-on-patients-and-trial-participants-voices