TESTING MAGNETIC NANOPARTICLE TREATMENT IN OVARIAN CANCER CELLS

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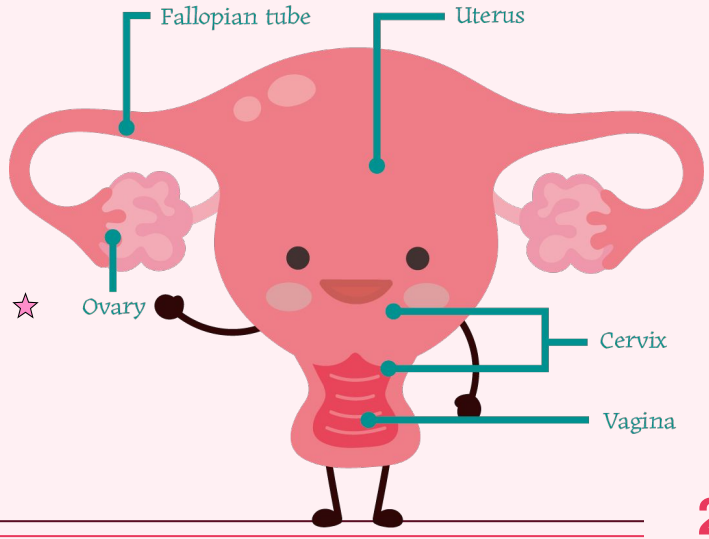
OVARIAN CANCER

What is it exactly?

- ★ Ovarian cancer is a disease in which malignant (cancer) cells form in the ***ovaries***. It's often diagnosed at later stages due to vague or absent early symptoms.
  - ***Fifth*** leading cause of cancer in women in the United States
  - Five year survival rate = **49%**
  - Approximately **13,000** deaths in 2024.
  - Research into new treatments and early methods is ongoing.



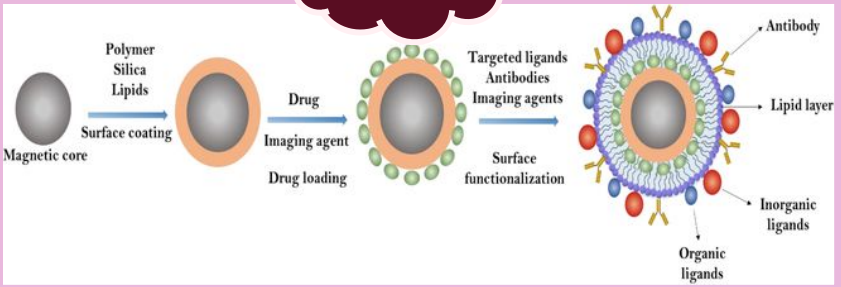
MNP AMF THERAPY

Magnetic
Nano
Particles under

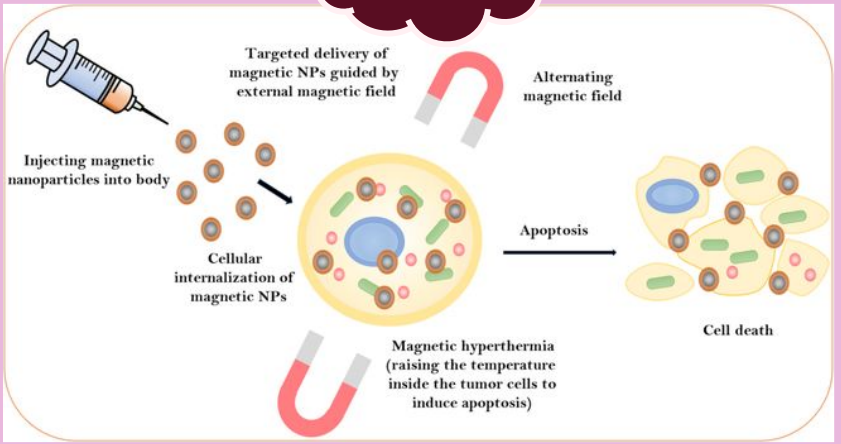
Alternating
Magnetic
Fields

- **Nanoparticles:** Composite materials with magnetic capabilities (ex. Iron, nickel)
- **Lipid/Polymer Coat:** prevents clumping, biocompatible, tumor triggered
- **Tumor Targeted:** gaps in blood vessels enhance permeability while having poor lymphatic drainage trap the NP (EPR Effect)
- **Cell Microenvironment:** important factor in therapy effectiveness, works best with solid tumors (glioblastoma, breast, prostate)

MNP



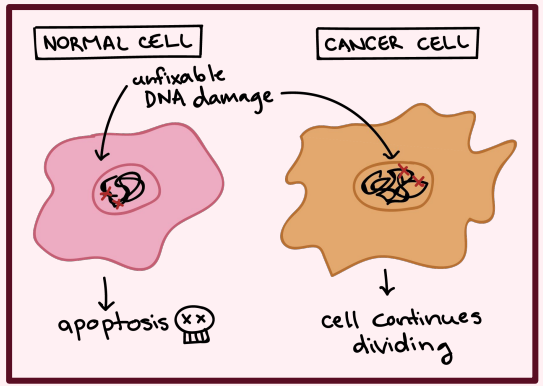
AMF

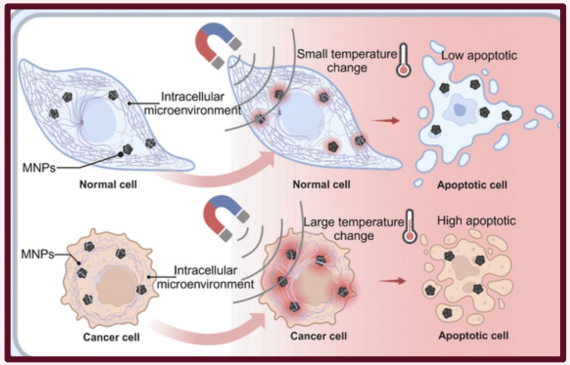


Here's the Breakdown:

Targeting Tumors with Heat

- ★ Inject magnetic nanoparticles into tumor
- ★ Apply alternating magnetic field from outside the body
- ★ Nanoparticles heat up due to the field
- ★ Heat damages or kills cancer cells → **APOPTOSIS (cell death)**





EXPERIMENTAL OUTLOOK

RNA sequence data retrieved on NCBI from a Peking University People's Hospital study (6/11/25) on Ovarian Cancer cells treated with MNP AMF, MNP and the control PBS

1 Hypothesis

Cells treated with ***magnetic nanoparticles (MNPs)*** combined with alternating magnetic field treatment (AMF) are expected to show the highest upregulation of genes involved in cytotoxicity, compared to **cells treated with MNPs alone (without heat)** and phosphate-buffered saline **(PBS) as the control**

2 Testing

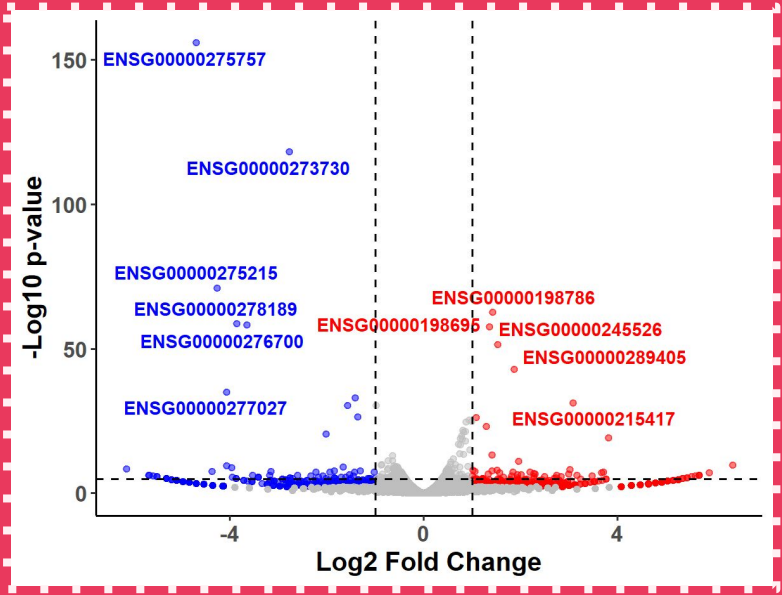
We will be looking at the **RNA sequencing data** from the three different groups (MNP, MNP AMT, PBS). The **level of expression** (upregulated or downregulated) for certain criteria of genes (apoptosis or proliferation) will suggest how **effective the treatment was.**

3 Importance

Understanding the principles of magnetic hyperthermia and its cellular bias is critical to maximize its ***anticancer therapeutic effect (chemotherapy)*** while minimizing its negative side effects on normal healthy cells.

RESULTS/ CONCLUSIONS

We performed differential gene expression analysis in R, and this volcano plot shows the most significant *differentially expressed genes* in our samples.



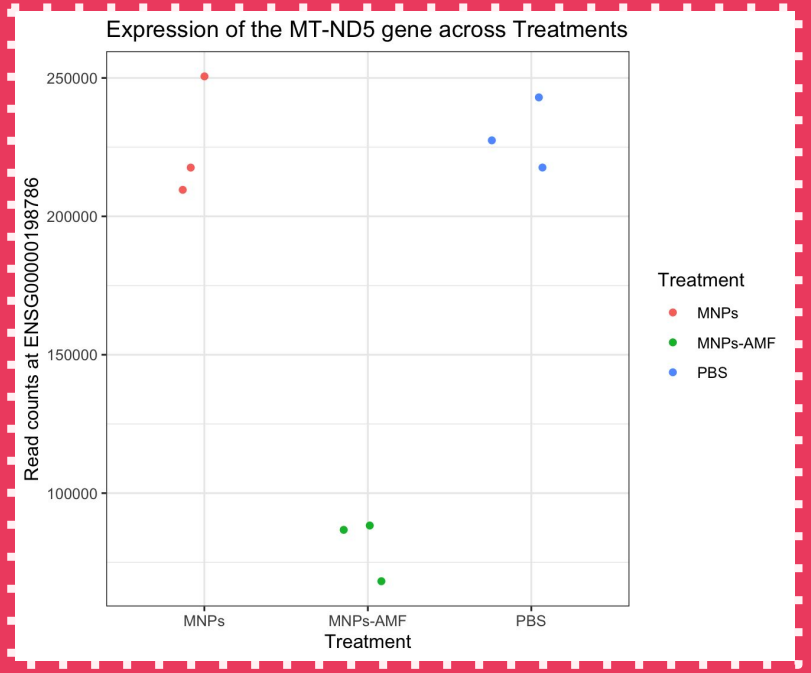
Number of Upregulated genes: 491
Number of Downregulated genes: 427

RESULTS/ CONCLUSIONS

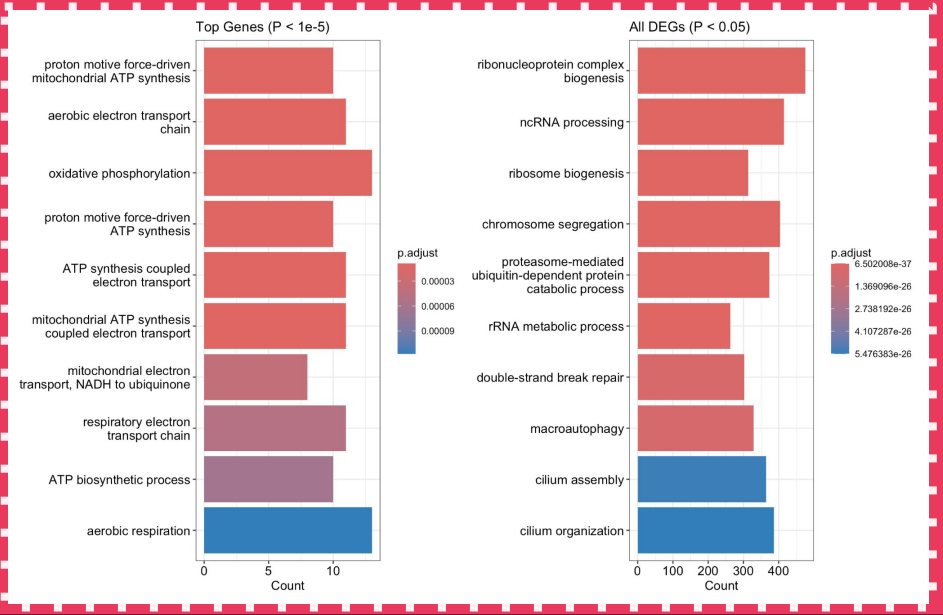
- ★ **The most significant downregulated gene is the 5.8S rRNA gene.** Gene expression is low in control (PBS) and MNPs-only treatments, but **significantly upregulated** in MNPs-AMF-treated samples.
- ★ This shows the combined treatment of MNPs-AMF may be inducing **ribosomal stress** in cancer cells.

RESULTS/ CONCLUSIONS

- ★ **MT-ND5**, a key mitochondrial gene for ATP production, was the most downregulated in MNPs-AMF-treated cells.
- ★ Its suppression indicates **impaired mitochondrial respiration** and energy loss.
- ★ This may trigger **oxidative stress** and contribute to **cancer cell death**.



GENE ONTOLOGY (GO)



- ★ We performed GO analysis to see which gene functions are overrepresented in our analyses.
- ★ Functions related to mitochondrial respiration (oxidative phosphorylation/ATP synthesis) were involved.
- ★ Ribosome biogenesis and protein degradation pathways are activated.
- ★ This shows that energy collapse plus stress- response drives cancer- cell cytotoxicity.

CONCLUSION

Together, our findings support the hypothesis that the MNPs-AMF combination disrupts essential pathways that contribute to cytotoxicity and potentially leading to cancer cell death.

Future direction will be to investigate the expression of ribosomal and mitochondrial genes in each sample.

REFERENCES

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3. NCBI Sequence Read Archive (SRA). Study Accession **SRP591351** deposited to NCBI SRA. Available via NCBI Traces database, accession SRP591351.

THANK YOU!

- Potential Energy