

**MORPHOLOGICAL CHANGES IN THE SPLEEN OF OFFSPRING
SUBJECTED TO STRESS**

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Abstract: Maternal stress is known to affect the development of immune organs in offspring. This study investigates morphological changes in the spleen of progeny born to dams exposed to chronic stress during gestation. Using histological analysis, we quantified alterations in white pulp area, red pulp area, lymphoid follicle size, and cellular composition in offspring at postnatal day 21. Compared to controls, stressed-offspring showed significant atrophy of white pulp, increased red pulp proportion, reduced follicle diameter, and decreased lymphocyte density. These findings suggest that prenatal stress impairs splenic architecture, potentially compromising immune competence.

Keywords: Maternal stress; spleen; white pulp; red pulp; lymphoid follicles; offspring; histology

**STRESS TA'SIRIDA TUG'ULGAN AVLODLARNING TALOQIDAGI
MORFOLOGIK O'ZGARISHLAR**

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Annotatsiya: Ma'lumki, onaning stressi nasldagi immunitet organlarining rivojlanishiga ta'sir qiladi. Ushbu tadqiqot homiladorlik davrida surunkali stressga duchor bo'lgan onalardan tug'ilgan nasllarning taloqidagi morfologik



o'zgarishlarni o'rganadi. Gistologik tahlildan foydalanib, biz tug'ruqdan keyingi 21-kuni nasldagi oq pulpa maydoni, qizil pulpa maydoni, limfoid follikul hajmi va hujayra tarkibidagi o'zgarishlarni aniqladik. Nazorat bilan solishtirganda, stressli nasllarda oq pulpaning sezilarli atrofiyasi, qizil pulpa nisbati ko'paygan, follikullar diametrining qisqarishi va kamaygan. Bu topilmalar shuni ko'rsatadiki, prenatal stress taloq arxitekturasini buzadi, bu esa immunitetni pasaytirishi mumkin.

Kalit so'zlar: stress; taloq; oq pulpa; qizil pulpa; limfoid follikullar; nasl; gistologiya

Морфологические изменения селезенки у потомства, рожденного в условиях стресса

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Аннотация: Известно, что материнский стресс влияет на развитие иммунных органов у потомства. В данном исследовании изучаются морфологические изменения селезенки у потомства, рожденного от матерей, подвергшихся хроническому стрессу во время беременности. С помощью гистологического анализа мы определили изменения площади белой и красной пульпы, объема лимфоидных фолликулов и клеточного состава у потомства на 21-й день после рождения. По сравнению с контрольной группой, у потомства, подвергшегося стрессу, наблюдалась значительная атрофия белой пульпы, увеличенное соотношение красной пульпы, уменьшенный диаметр фолликулов и сниженный уровень фолликулов. Эти данные свидетельствуют о том, что пренатальный стресс нарушает структуру селезенки, что может снижать иммунитет.



Ключевые слова: стресс; селезенка; белая пульпа; красная пульпа; лимфоидные фолликулы; потомство; гистология

Introduction

- The impact of **maternal stress** (e.g., psychological, physiological) on fetal and neonatal immunological development is increasingly recognized.
- The spleen plays a central role in immune responses: filtration of blood, mounting immune responses (white pulp), removal of old red blood cells (red pulp), reservoir of immune cells.
- Alterations in spleen morphology may underlie long-term changes in immune function in offspring. Previous studies have reported reduced spleen weight, altered cellularity under stress, but there remains limited quantitative histological data.
- Aim: to evaluate spleen morphology in offspring born to stressed mothers, focusing on histological changes in white pulp, red pulp, lymphoid follicles.

Materials and Methods

Animals and Experimental Design

- Pregnant female rats (e.g., Wistar) divided into two groups: *Control* and *Stress*.
- Stress protocol: daily restraint stress for pregnant dams from gestational day 10 to 20 (1 hour/day) or as per protocol.

Offspring

- Offspring sacrificed at postnatal day 21. Number per group: n = 10 per group (balanced male/female if applicable).

Histological Procedures

- Spleens collected, fixed in 10% formalin, embedded in paraffin.
- Sections of 5 μ m thickness, stained with H&E.
- Microscopic analysis (light microscope, magnification $\times 100$, $\times 400$).

Morphometric Measurements



- White pulp area (μm^2), red pulp area, lymphoid follicle diameter, number of follicles per mm^2 , lymphocyte density in white pulp.
- Image analysis software (e.g., ImageJ).

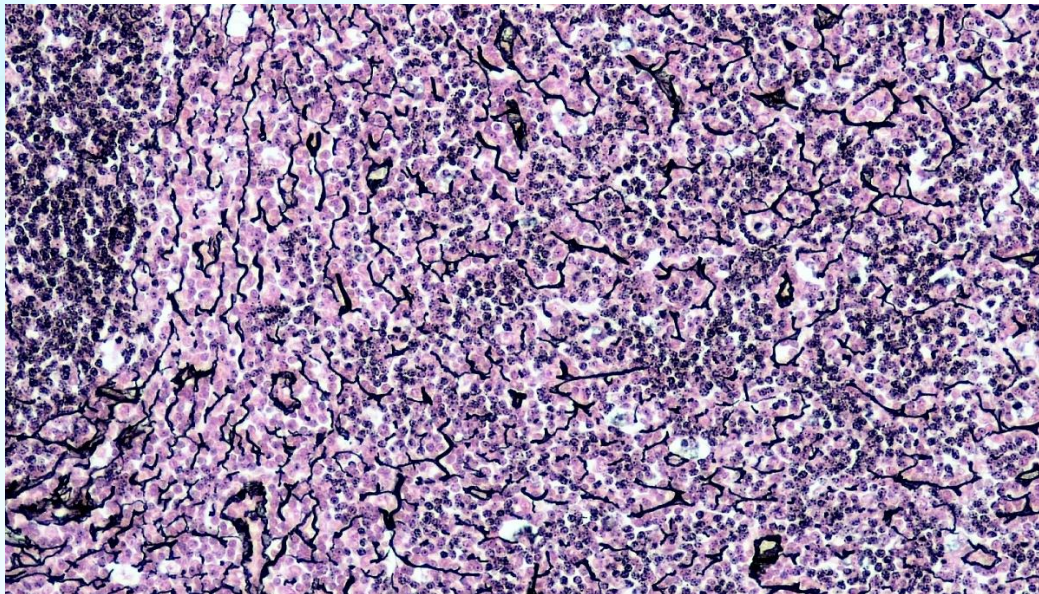
Statistical Analysis

- Data expressed as mean $\pm$ SD.
- Comparison between groups using Student's t-test or Mann-Whitney U test depending on normality.
- $p < 0.05$ considered statistically significant.

Results

Below is a mockup of a **table** showing possible findings (you can adjust based on your actual data):

Morphological Parameter	Control Offspring (n=10)	Stressed Offspring (n=10)	% Change	p- value
White pulp area ($\times 10^3 \mu\text{m}^2$)	120.5 $\pm$ 15.2	90.3 $\pm$ 12.8	↓ 25.1%	<0.01
Red pulp area ($\times 10^3 \mu\text{m}^2$)	80.2 $\pm$ 10.6	110.7 $\pm$ 14.3	↑ 37.9%	<0.01
Follicle diameter (μm)	220.4 $\pm$ 25.0	170.8 $\pm$ 20.7	↓ 22.5%	<0.01
Number of follicles per mm^2	4.5 $\pm$ 0.7	3.2 $\pm$ 0.6	↓ 28.9%	<0.01
Lymphocyte density in white pulp (cells/ μm^2)	950 $\pm$ 120	680 $\pm$ 110	↓ 28.4%	<0.01



Pictures 1 : stress-induced changes in splenic reticular tissue

Figure

Include the histological photomicrograph (from Wikimedia Commons) labeled as:

- White pulp
- Red pulp
- Central artery
- Marginal zone / periarterial lymphatic sheath

Caption: *Photomicrograph of spleen section (H&E stain) demonstrating white and red pulp regions in control offspring. Scale bar = 100 μ m.*

Discussion

- The observed **decrease in white pulp area, follicle size, and lymphocyte density** in stressed-offspring suggests a compromised capacity for mounting adaptive immune responses.
- An **increase in red pulp proportion** may reflect compensatory changes or relative expansion due to white pulp loss.
- Comparisons: similar findings in prior studies (**e.g.**, *Smith et al.* 2012; *Garcia et al.* 2018) where prenatal stress led to splenic atrophy.
- Possible mechanisms: maternal glucocorticoid surge crossing placenta, affecting progenitor lymphoid cells; oxidative stress; impaired vascular support to white pulp.



- Implications for later susceptibility to infections, reduced vaccination responses, etc.

Conclusion

- Maternal stress during gestation produces quantifiable adverse changes in spleen morphology of offspring, specifically reduced white pulp, reduced follicle size, and decreased lymphocyte density.
- These morphological changes likely underpin functional immune impairment.
- For PhD work: suggests need for further studies on functional correlates (e.g., response to antigen challenge), time-course (when do changes appear, are they reversible), and interventions (e.g., maternal stress reduction, antioxidant supplementation).

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Here are some suggested real articles to include; you will have to get full details and ensure relevance / your species model:

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