



Vitamin K2 ameliorates pregnancy- and lactation-associated osteopenia and postpartum depression

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Introduction

Skeletal and mental health during the perinatal period

Pregnancy- and lactation-associated osteopenia (PLO)

- Bone loss; possible fragility fractures
- Back pain may be missed, delaying diagnosis
- Increased miscarriage risk
- Treatment must account for pregnancy, lactation and future fertility

❑ PLO often co-occurs with symptoms of PPD

❑ Interventions should protect maternal skeletal and mental health while supporting offspring development

Postpartum depression (PPD)

- Impairs mental health and daily function
- Affects mother–infant interaction and family life
- Medication requires assessment of fetal and infant exposure



Introduction

- ❑ **Gut microbiota remodeling during pregnancy and lactation supports maternal and offspring health**
- ❑ **Dysregulated microbial and metabolic signals may disrupt both bone and brain homeostasis**

Research questions

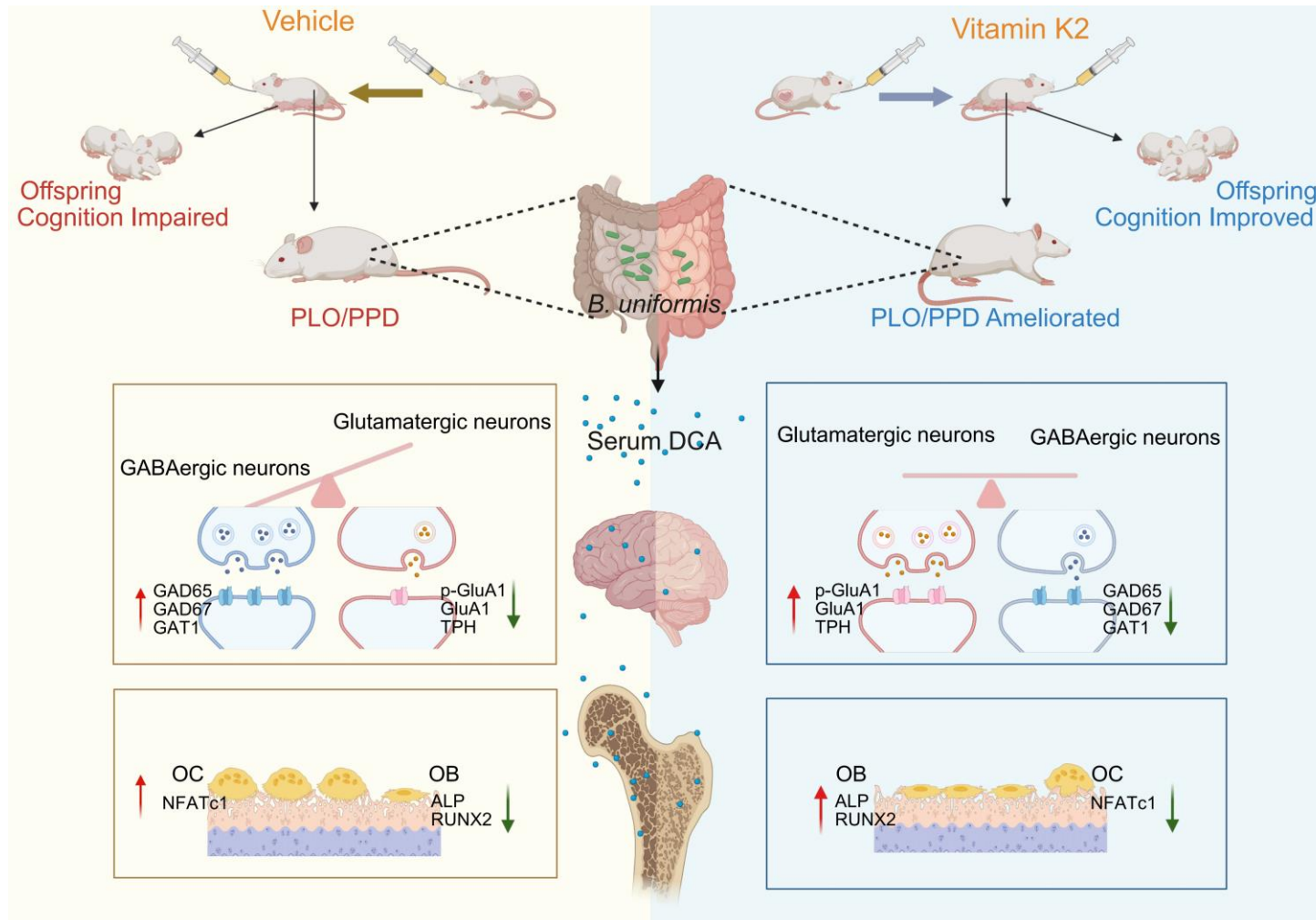
Do PLO and PPD share a gut microbiota-related mechanism?

Can vitamin K2, a natural nutrient, improve both skeletal and brain phenotypes?



Highlights

Vitamin K2 regulates gut microbiota and bile acids to improve maternal bone and brain health

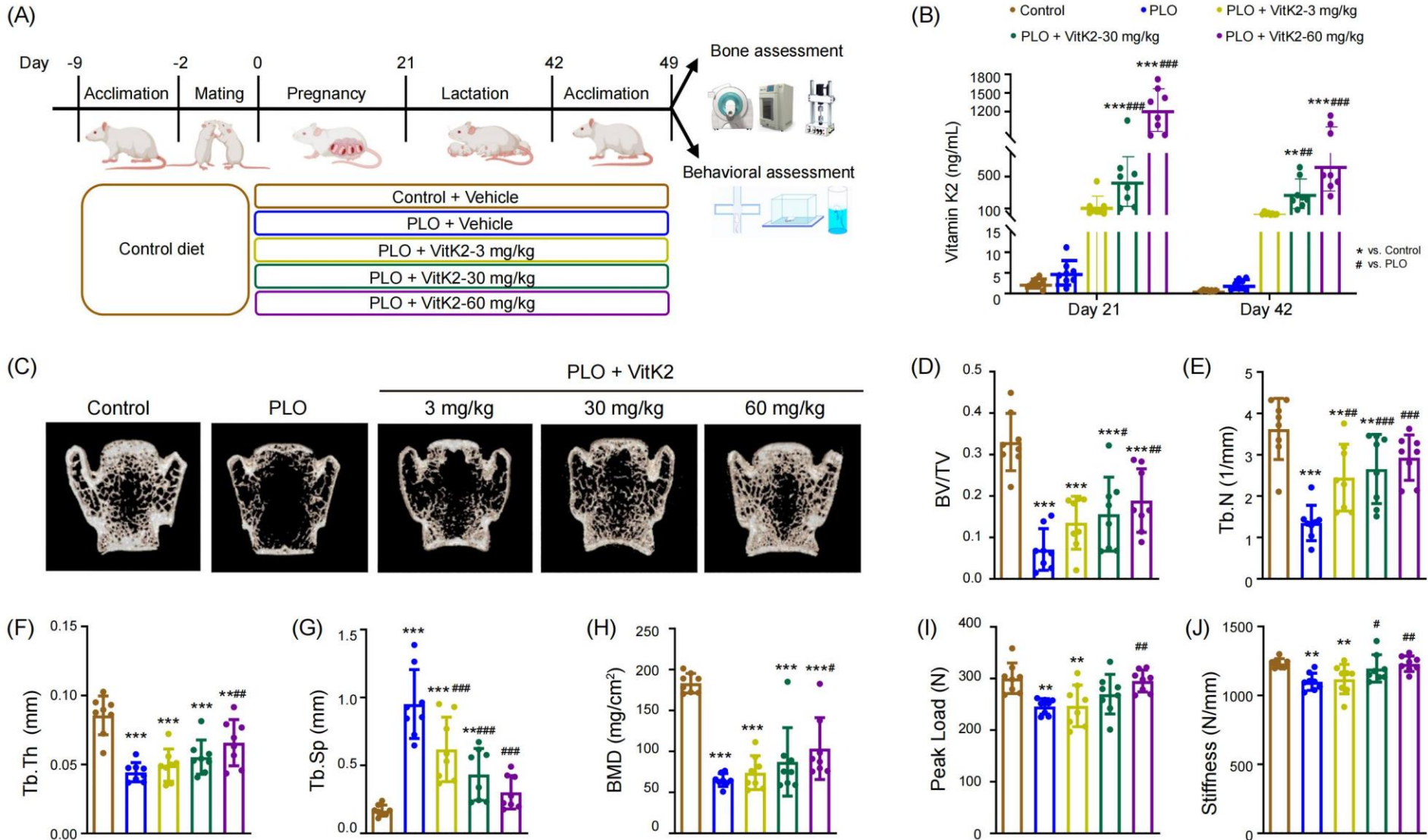


- PLO co-occurs with symptoms of PPD
- *B. uniformis* overgrowth and DCA accumulation
- Vitamin K2 improves maternal bone and brain phenotypes and reduces *B. uniformis* and DCA
- Maternal vitamin K2 benefits offspring cognition



Results

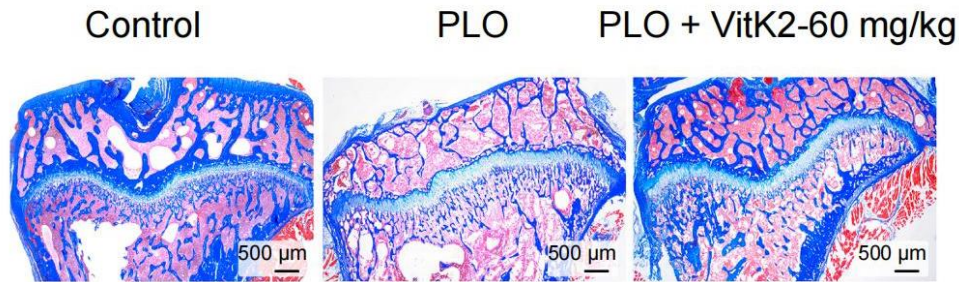
1 | Vitamin K2 alleviates bone microarchitecture, density and strength in PLO



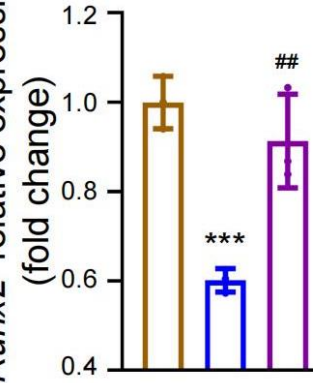
Results

2 | Vitamin K2 promotes bone formation and inhibits bone resorption in PLO

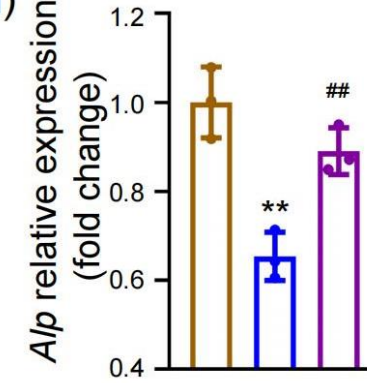
(K)



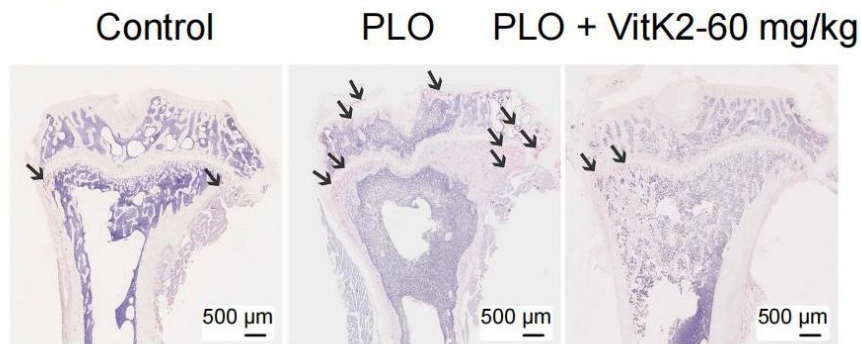
(L) *Runx2* relative expression (fold change)



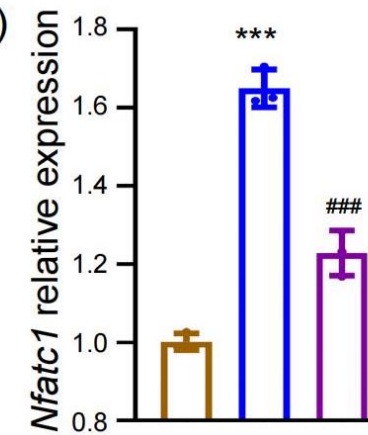
(M)



(N)



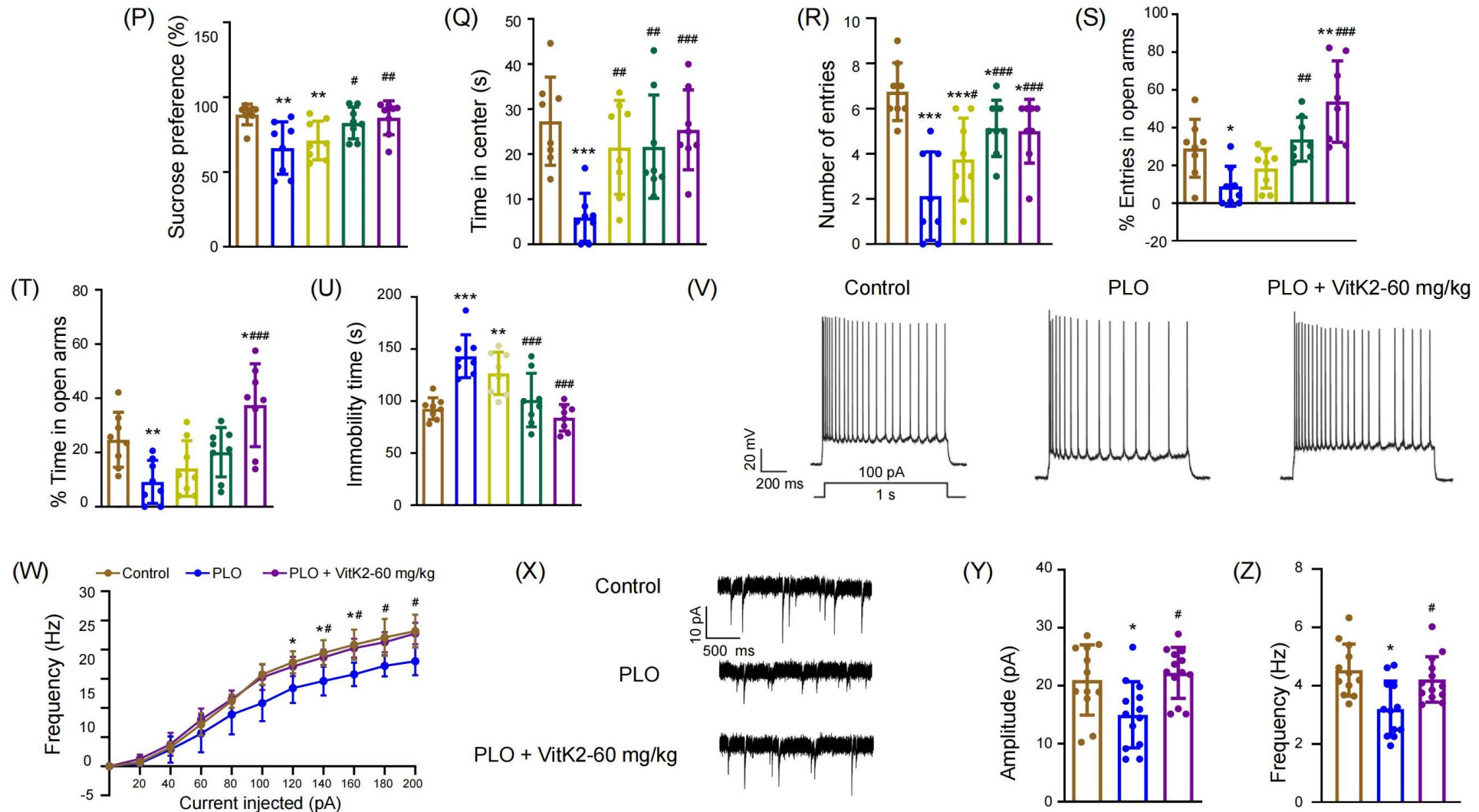
(O)





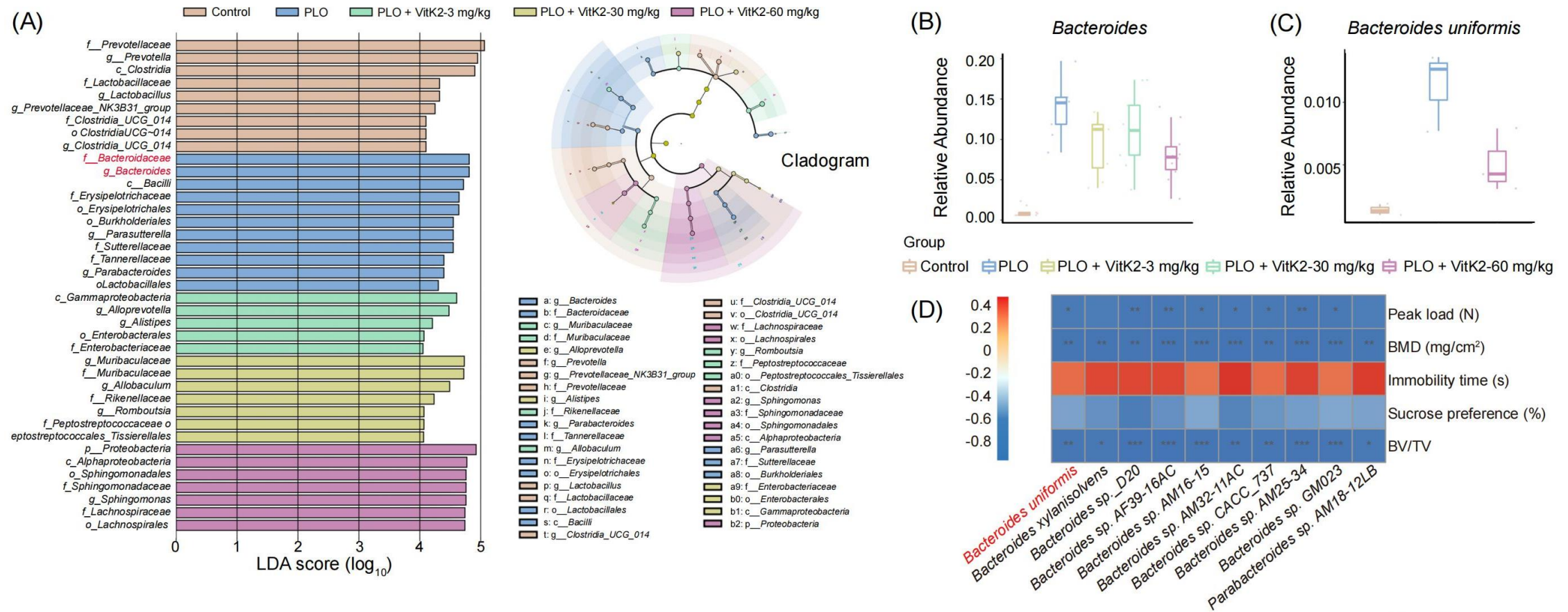
Results

3 | Vitamin K2 alleviates postpartum depressive behavior



Results

4 | Vitamin K2 corrects gut dysbiosis and reduces *B. uniformis* abundance

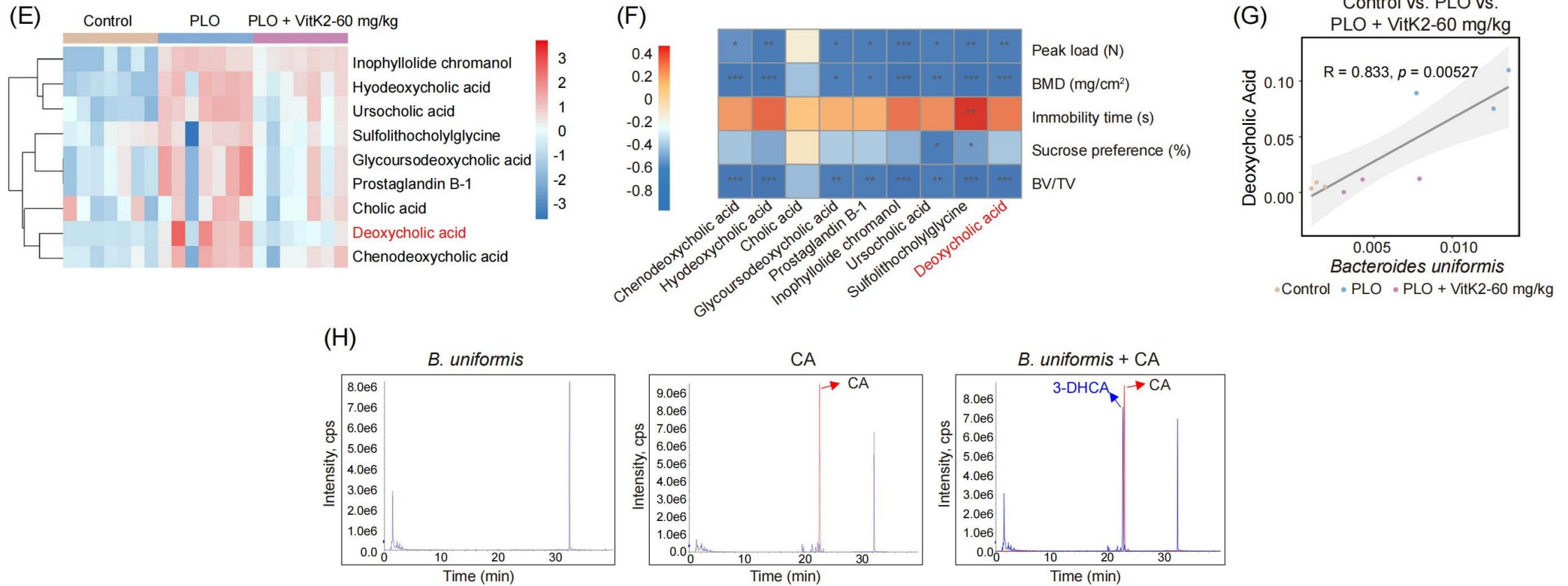


Bacteroides uniformis (*B. uniformis*) is the focus of subsequent metabolic analyses



Results

5 | Vitamin K2 corrects dysregulated gut microbiota and bile acid metabolism

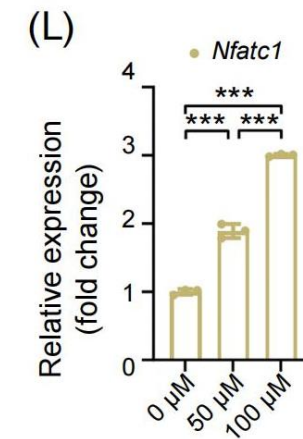
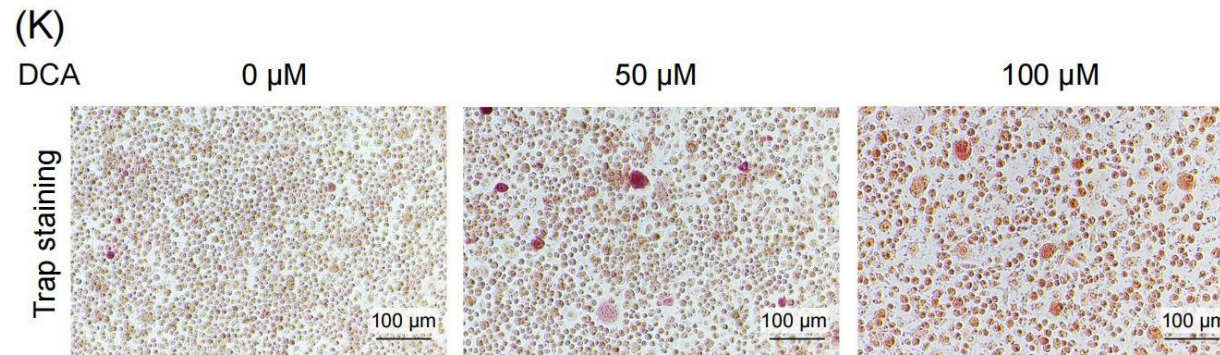
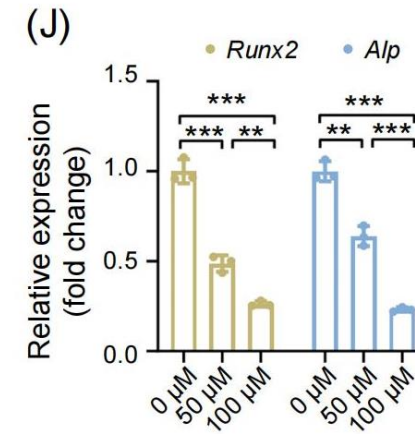
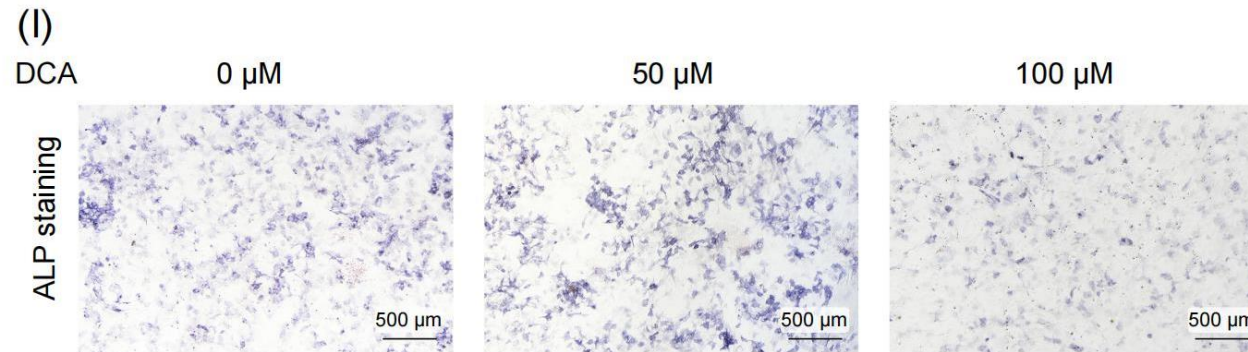


Vitamin K2 suppresses *B. uniformis* overgrowth and deoxycholic acid (DCA) accumulation



Results

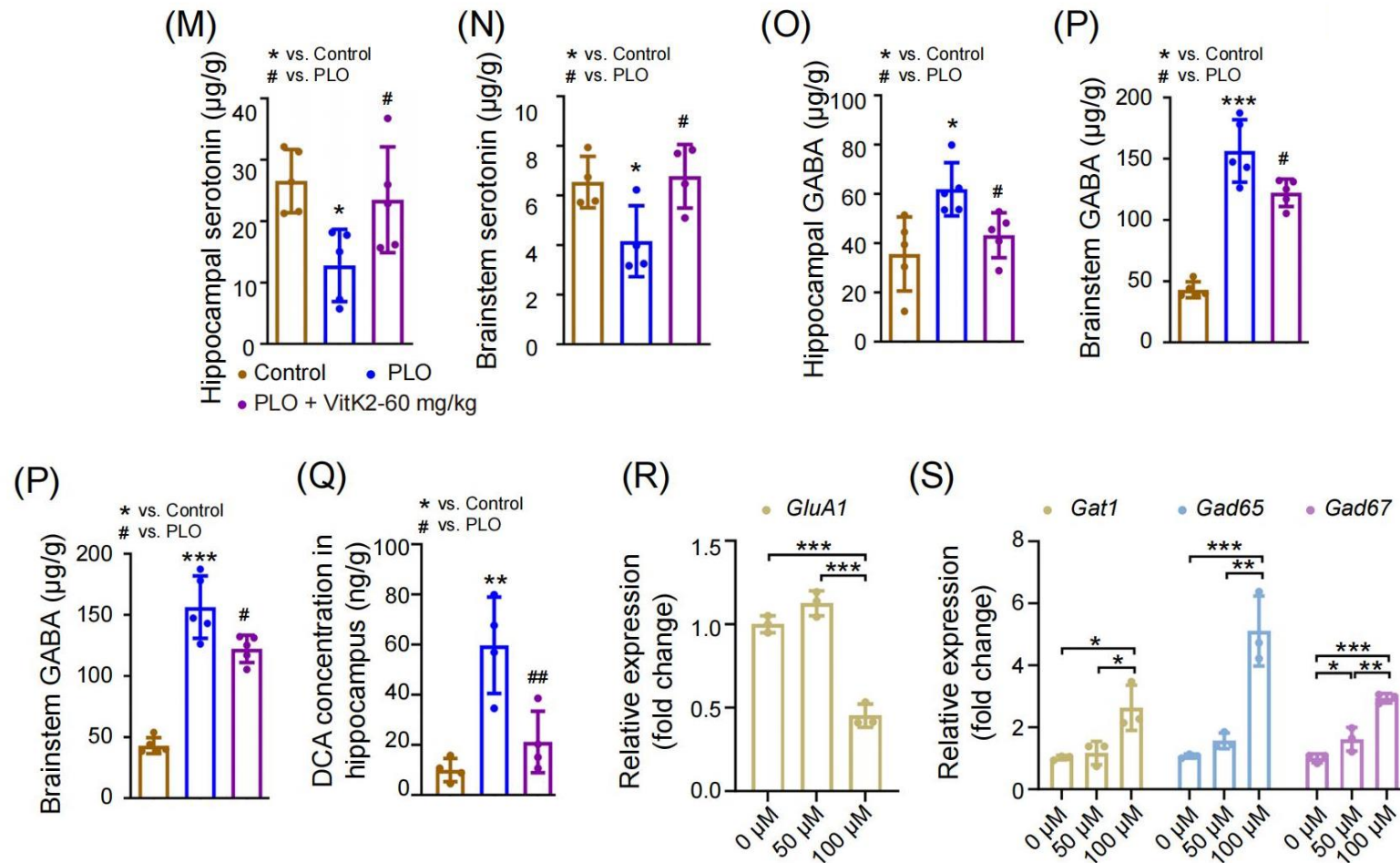
6 | DCA inhibits osteoblast differentiation and promotes osteoclast differentiation





Results

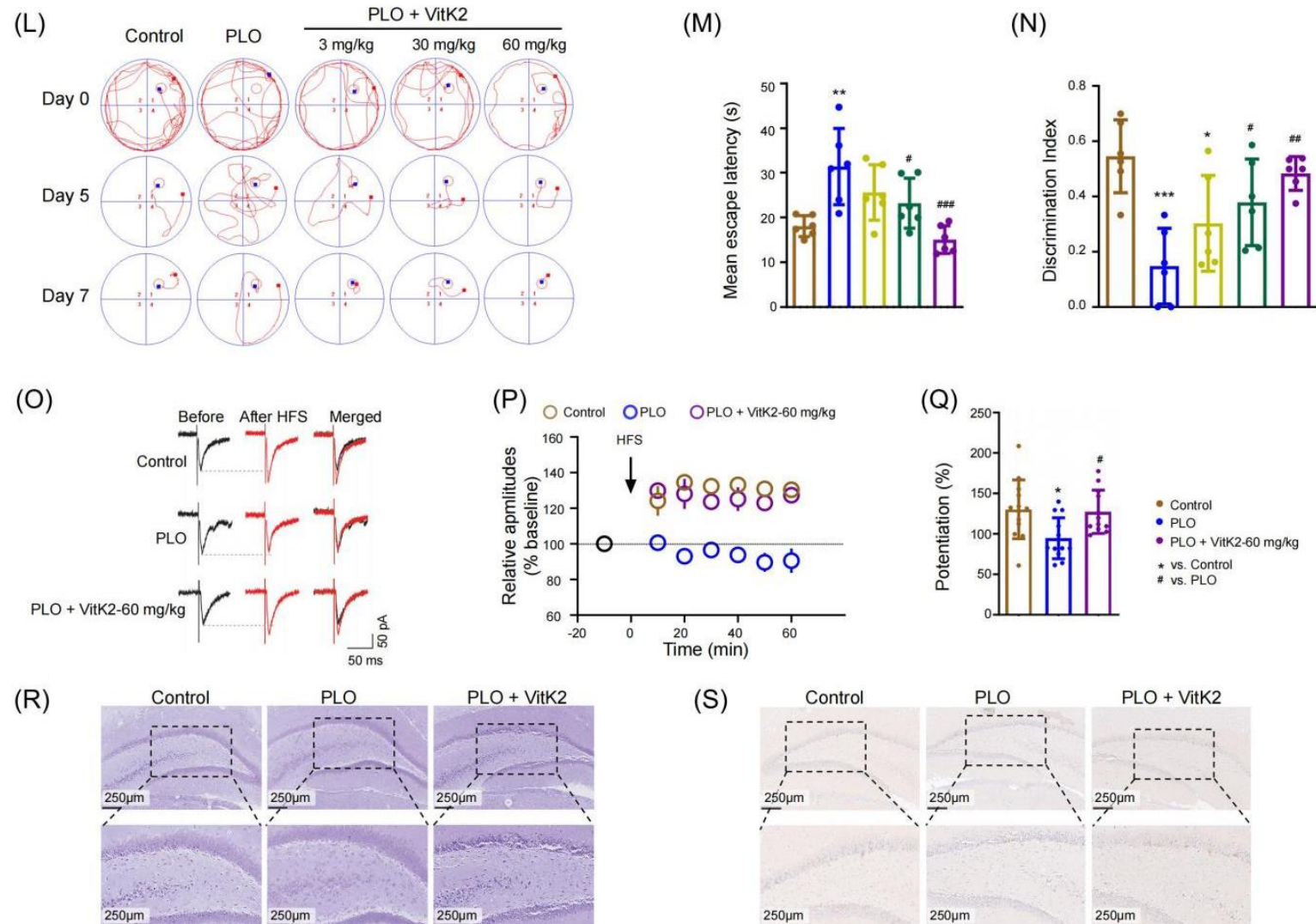
7 | Vitamin K2 corrects the neurotransmitter imbalance associated with DCA in PLO





Results

8 | Maternal Vitamin K2 supplementation rescues offspring cognitive impairment





Summary

Nutritional intervention for maternal skeletal and mental health

- ❑ Shared mechanism: Gut dysbiosis and DCA accumulation link maternal bone and brain phenotypes
- ❑ Intervention effects: Vitamin K2 improves bone remodeling and depressive behavior, with cognitive benefits for offspring
- ❑ Translational relevance: These findings support further investigation of nutritional interventions for women during the perinatal period

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