Science

Insulin signaling in the long-lived reproductive caste of ants

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Fuqiang Lin

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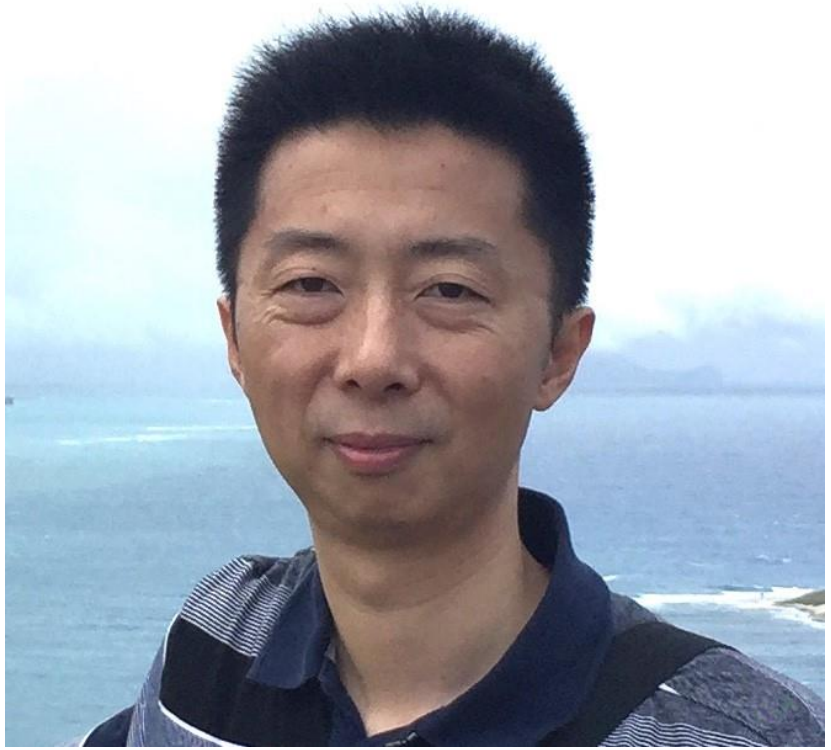
Authors

- Danny F. Reinberg
- 《Epigenetics》
- Research interests：Understanding the molecular mechanisms underlying key aspects of mammalian gene expression that foster distinct cell types; in particular, epigenetic regulation of chromatin dynamics.



- Hua Yan
- Assistant Professor at the University of Florida

Reproduction & longevity trade-off

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SPECIAL REVIEWS

The Endocrine Regulation of Aging by Insulin-like Signals

MARC TATAR, ANDRZEJ BARTKE, AND ADAM ANTEBI Authors Info & Affiliations

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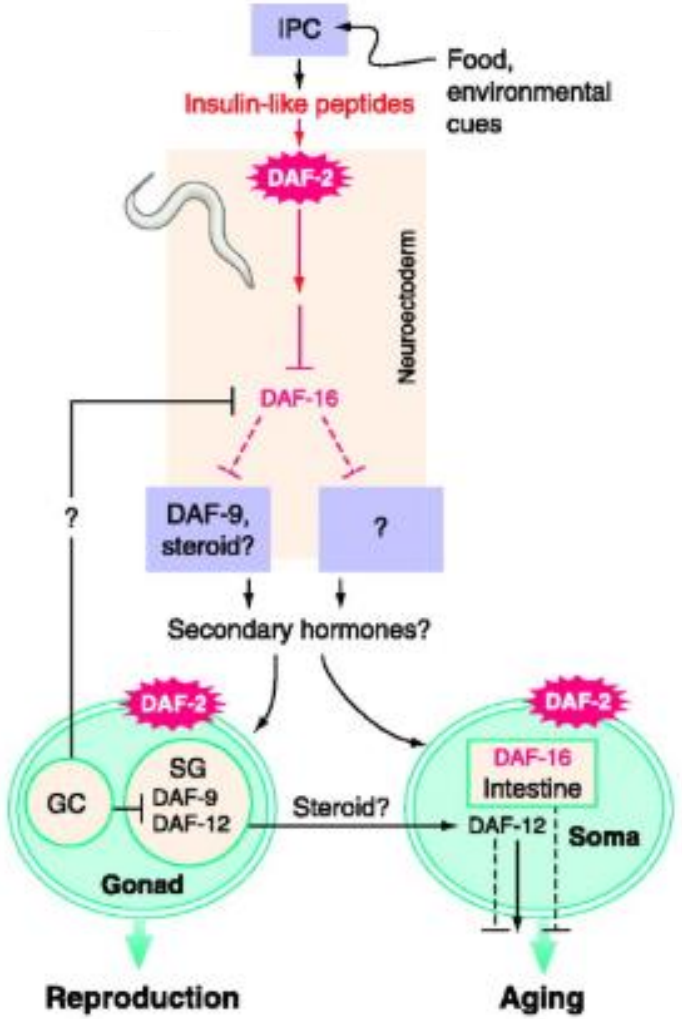

Reproduction & longevity trade-off

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Review Article | Published: 14 January 2021

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Valter D. Longo ✉, Maira Di Tano, Mark P. Mattson & Novella Guidi

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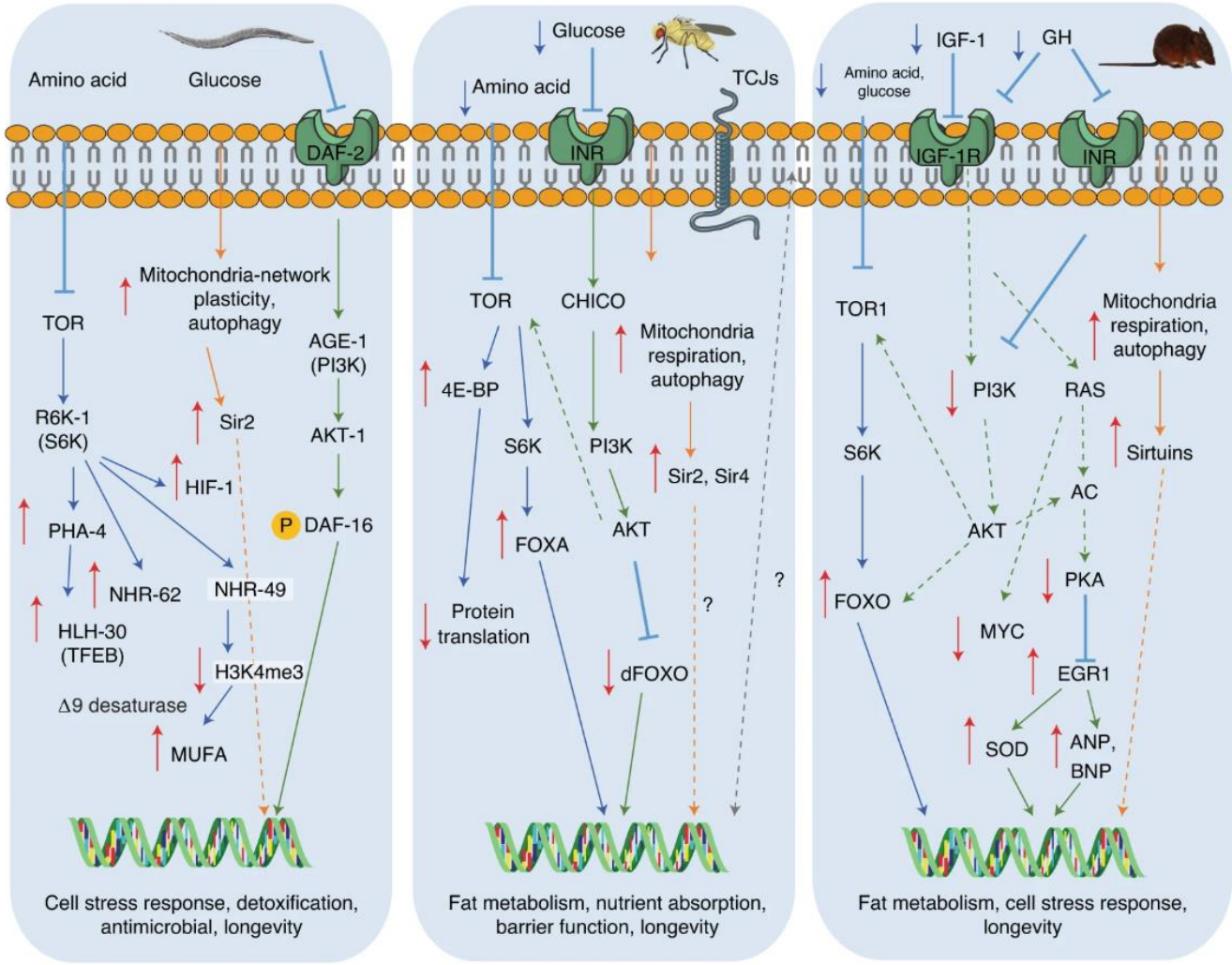


- Fasting(禁食), Insulin(胰岛素) & health, body management
- Decreased insulin level & extension of lifespan
- Decreased insulin level & negative impact on reproductive ability

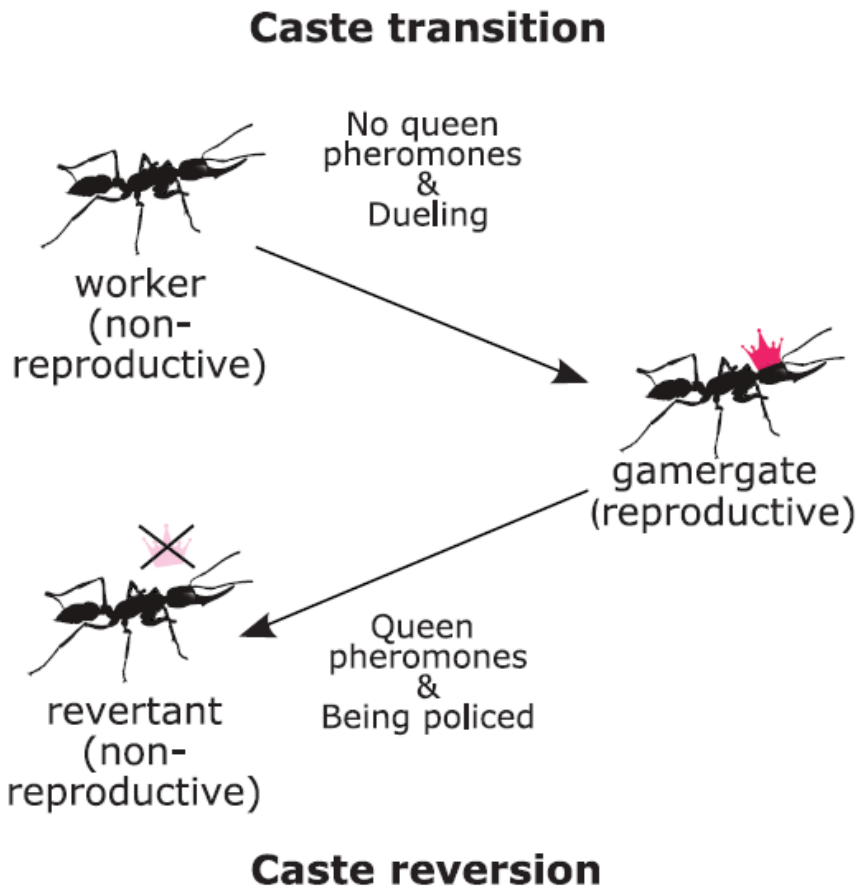
Reproduction & longevity trade-off

- Worker
  - 7 months
  - similar genomes

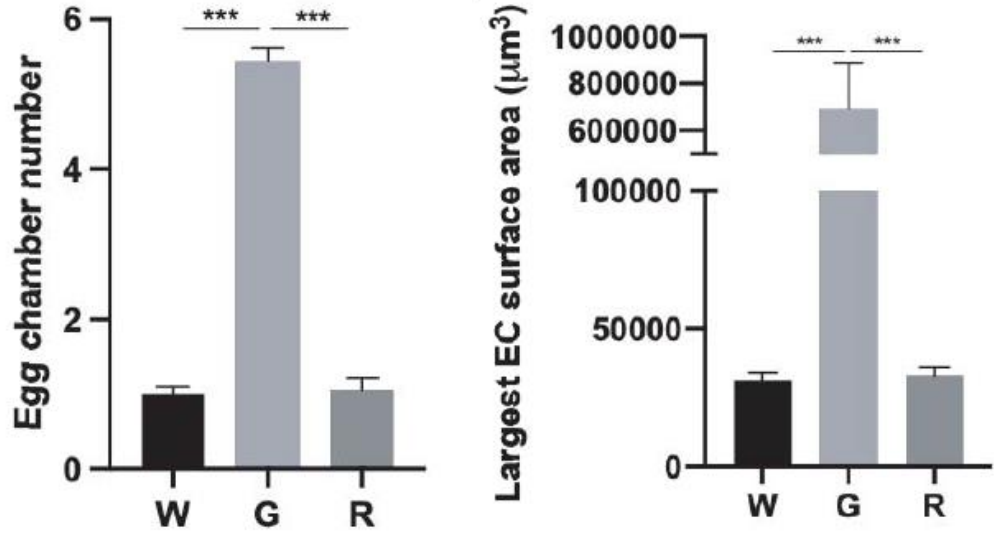
- Queen
  - 30 years
  - > 1,000,000 eggs
  - not follow the limitation of this trade-off
  - gain the ability of reproduction and longevity at the same time

How can ants break free from the constraints between longevity and reproductive ability?

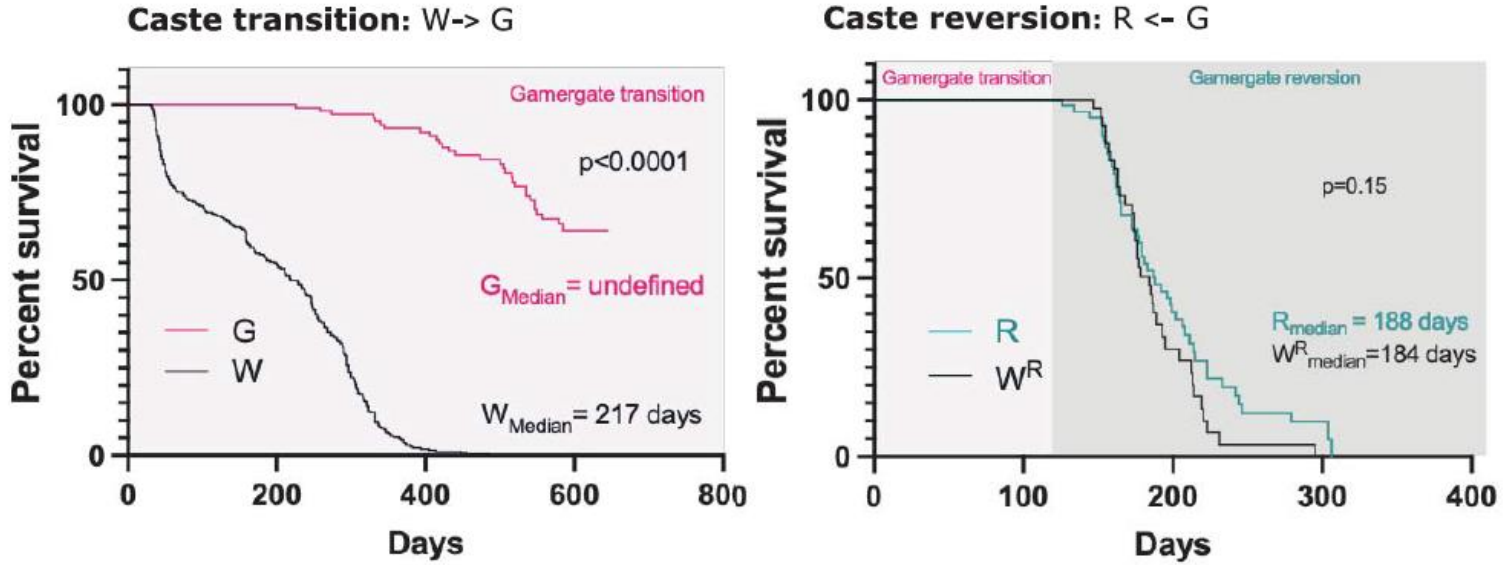
Extended longevity upon caste switching from worker to pseudo-queen



- Reproduction

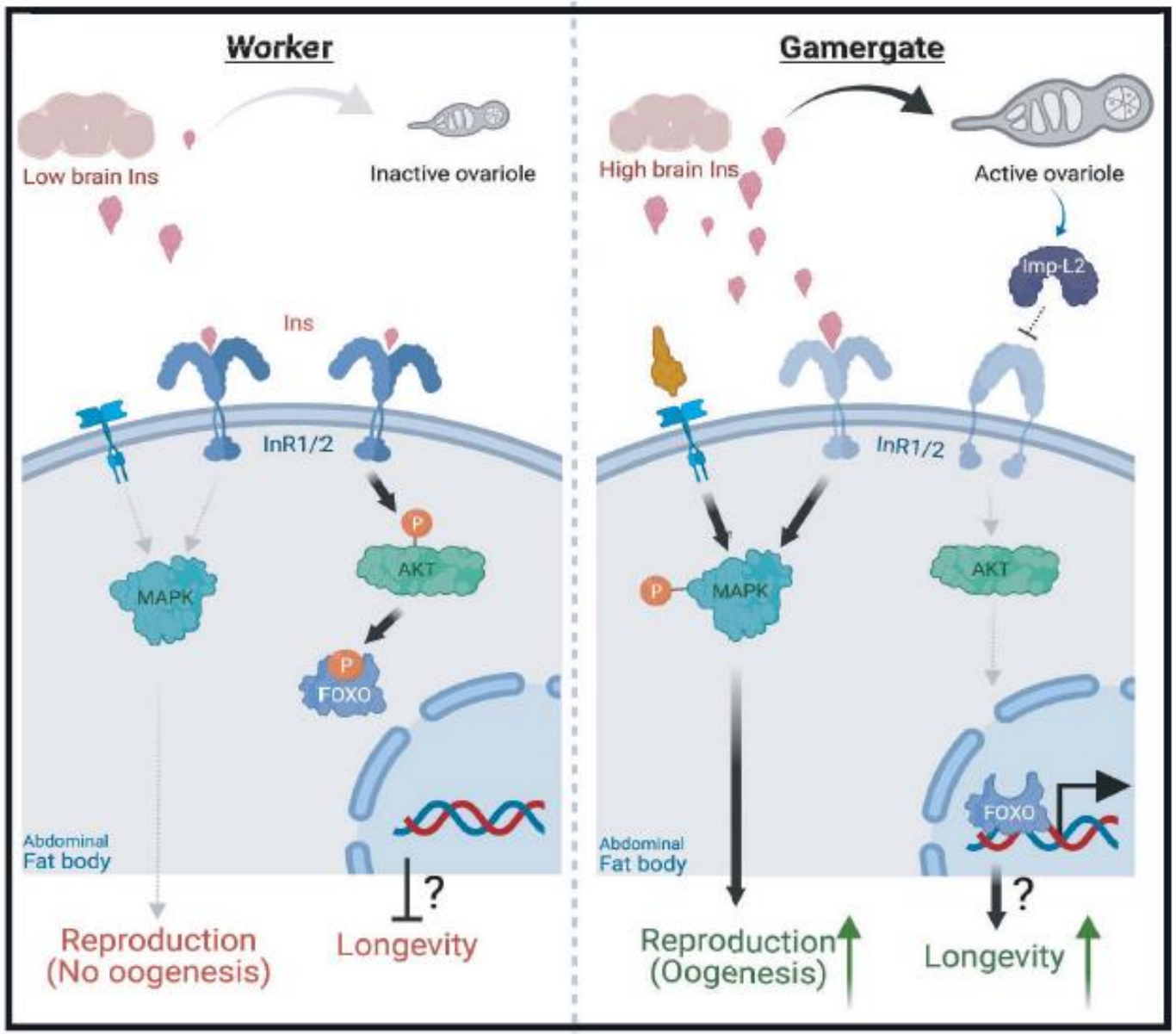


- lifespan

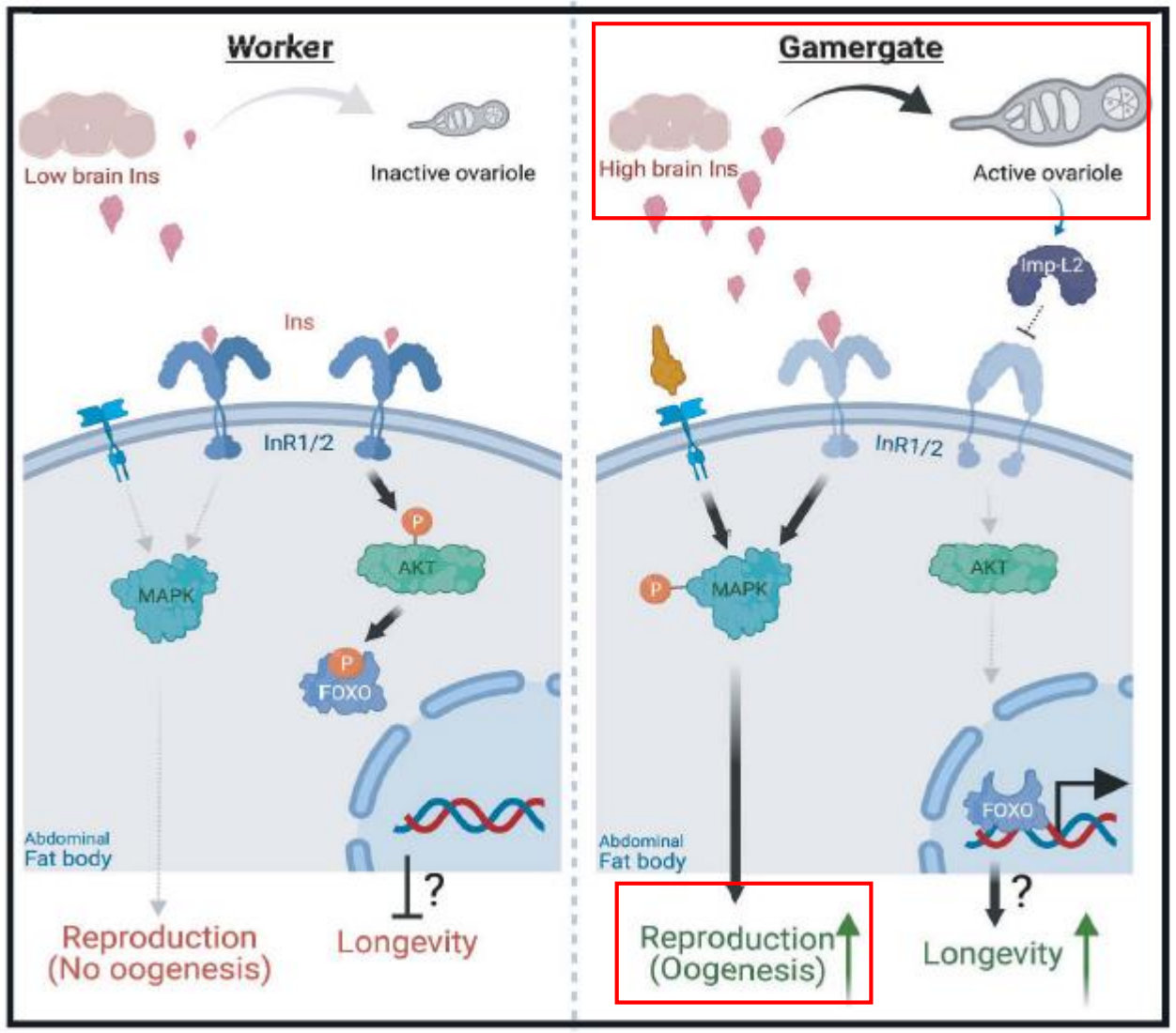


G: Gamergate (伪蚁后)
W: Worker
R: Revertant

Proposed models



Proposed models



- Insulin expression is increased in the brain of the reproductive caste
- Insulin promote the development of the ovary and the ability to lay eggs

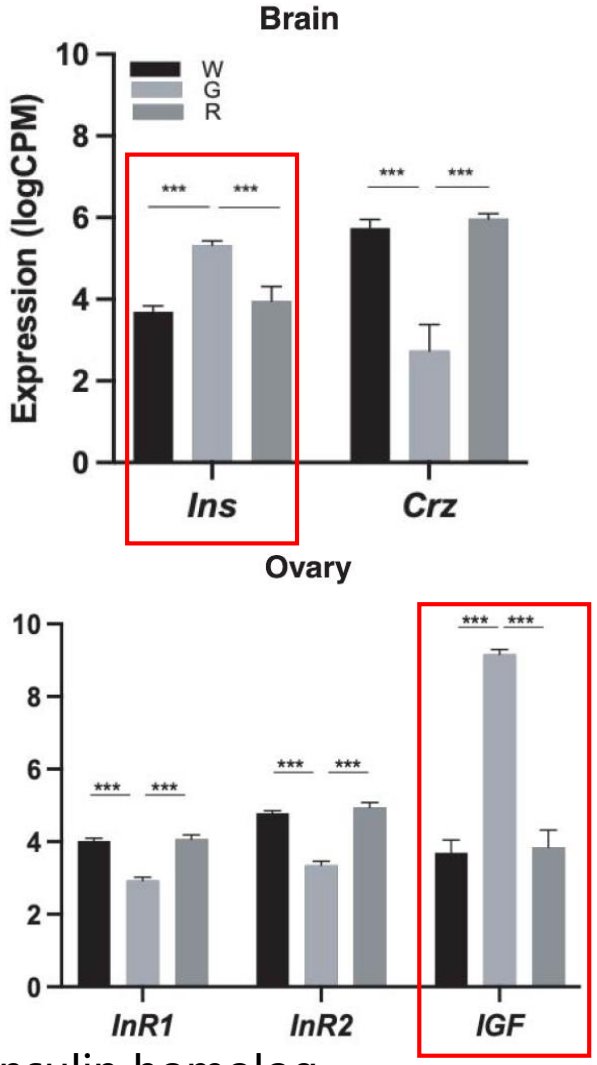
- Insulin can activate AKT and MAPK, but AKT is down-regulated
- FOXO localizes in the nucleus, resulting in prolonged life

- The IIS inhibitors Imp-L2 and ALS are up-regulated in the ovary
- Imp-L2 specifically blocks AKT in the fat body

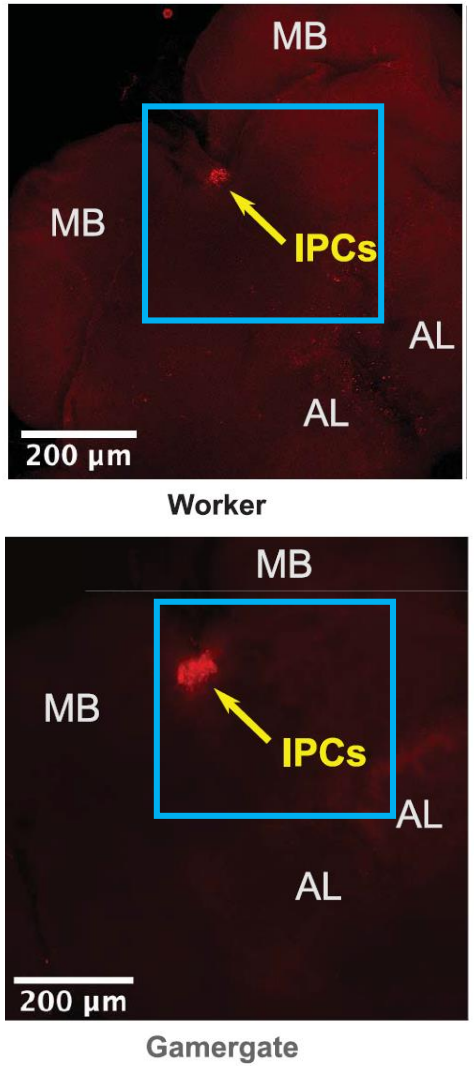
✓ An effective solution to the discrepancy between increased insulin and reproduction and prolonged life

Insulin expression is increased in the brain of the reproductive caste

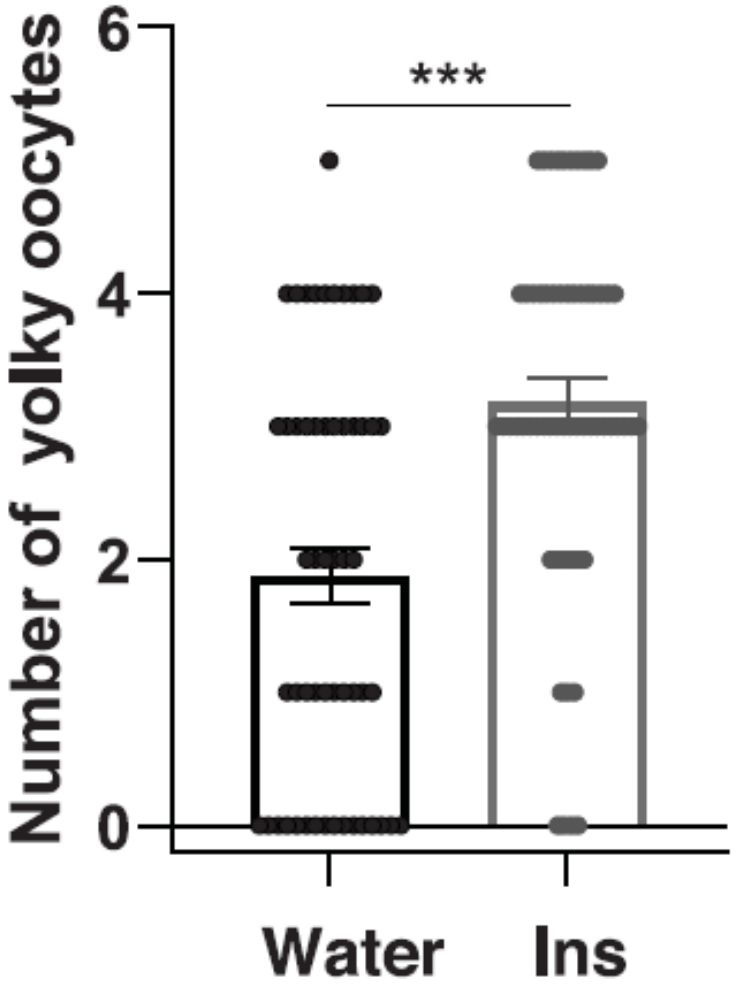
- Increased Insulin expression



- Localization of Ins mRNA



- Insulin promotes reproductive ability

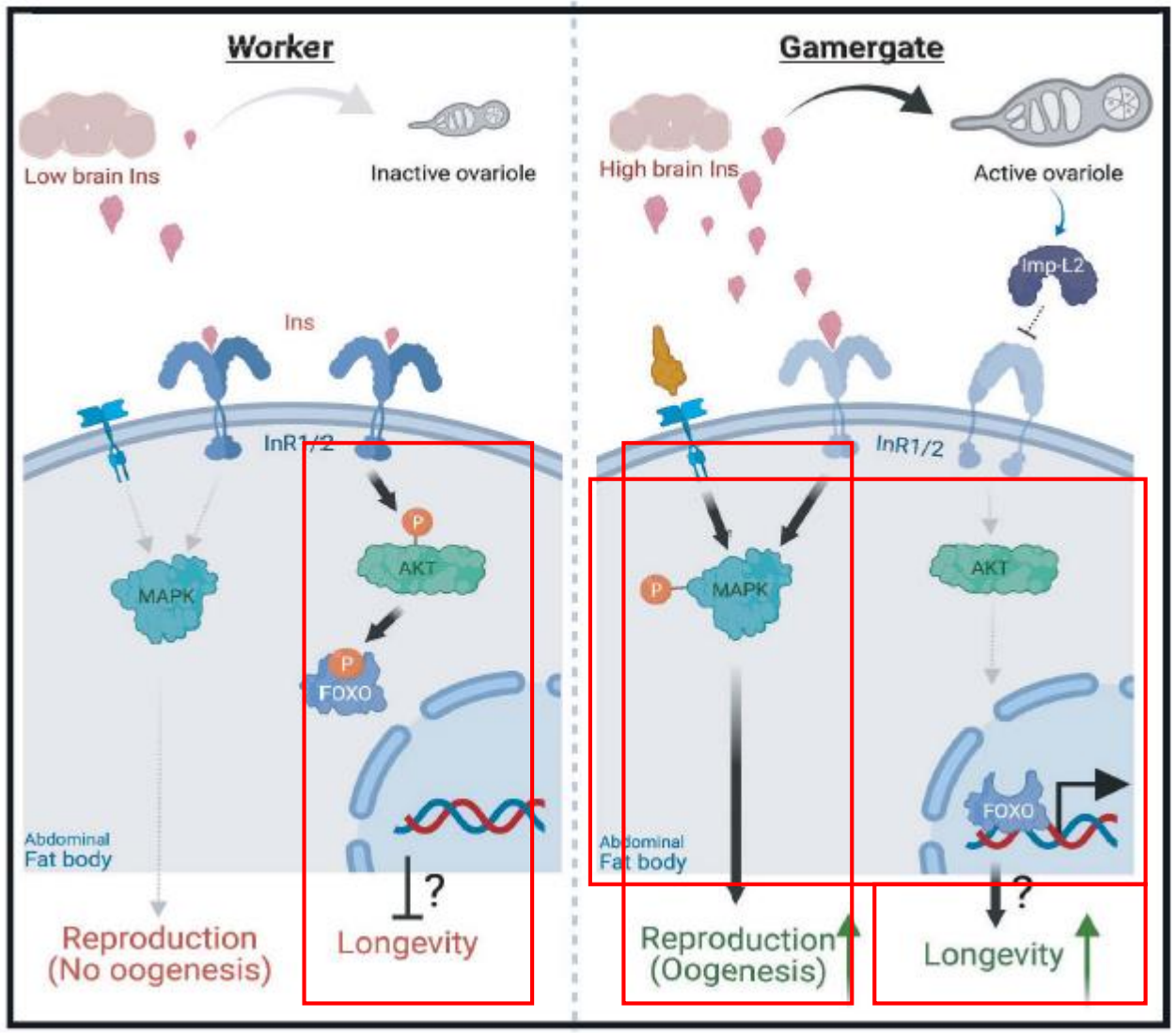


- the number of yolk oocytes in the eggs increased by 2.3 times

Ins: insulin homolog
IGF: insulin-like growth factor

IPCs: insulin-producing cells

Proposed models



- Insulin expression is increased in the brain of the reproductive caste
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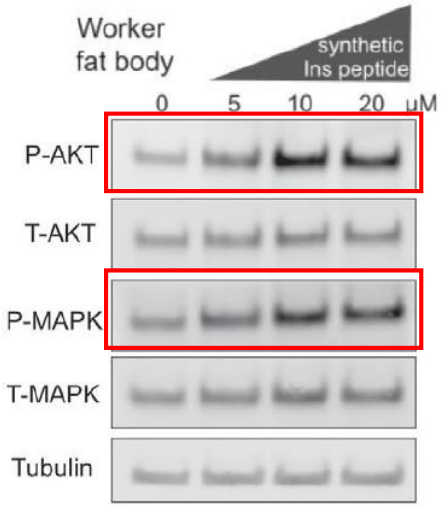
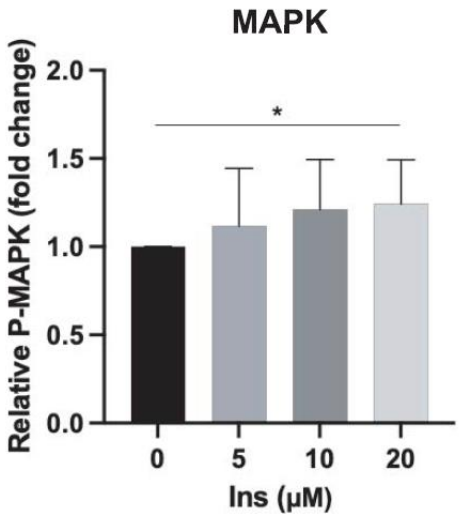
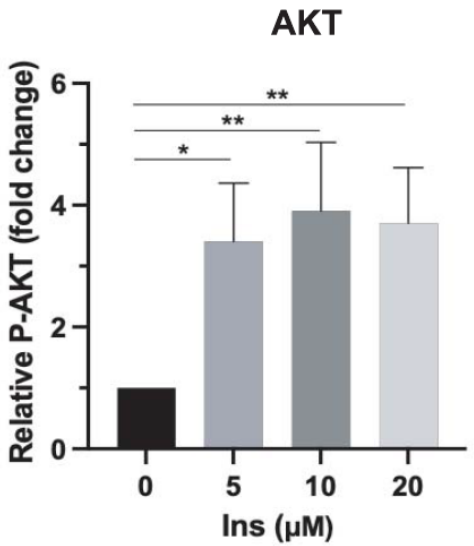
Insulin can activate AKT and MAPK, but AKT is down-regulated

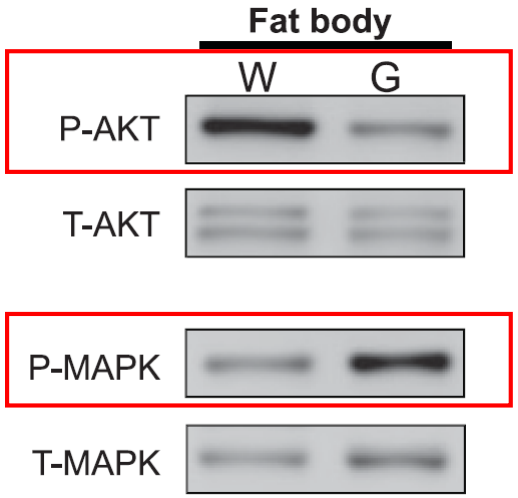
- Insulin can activate AKT and MAPK
- AKT is down-regulated
- The subcellular localization of FOXO

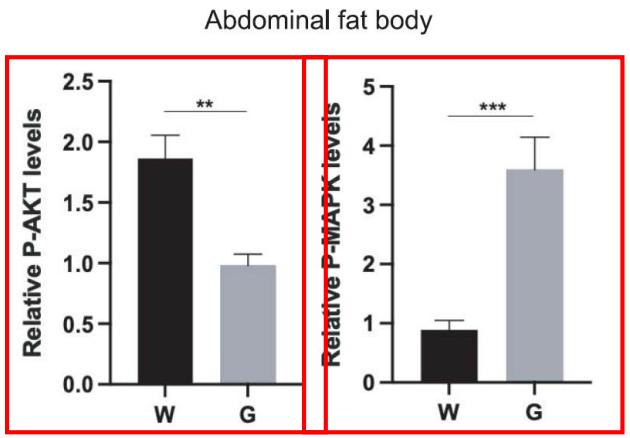


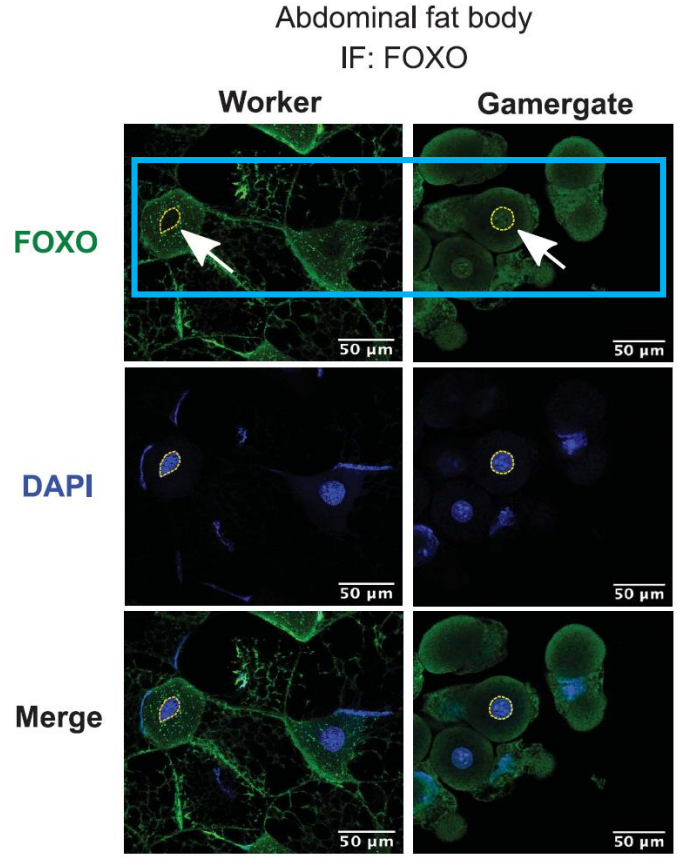
P-: phosphorylated(磷酸化)
T-: total





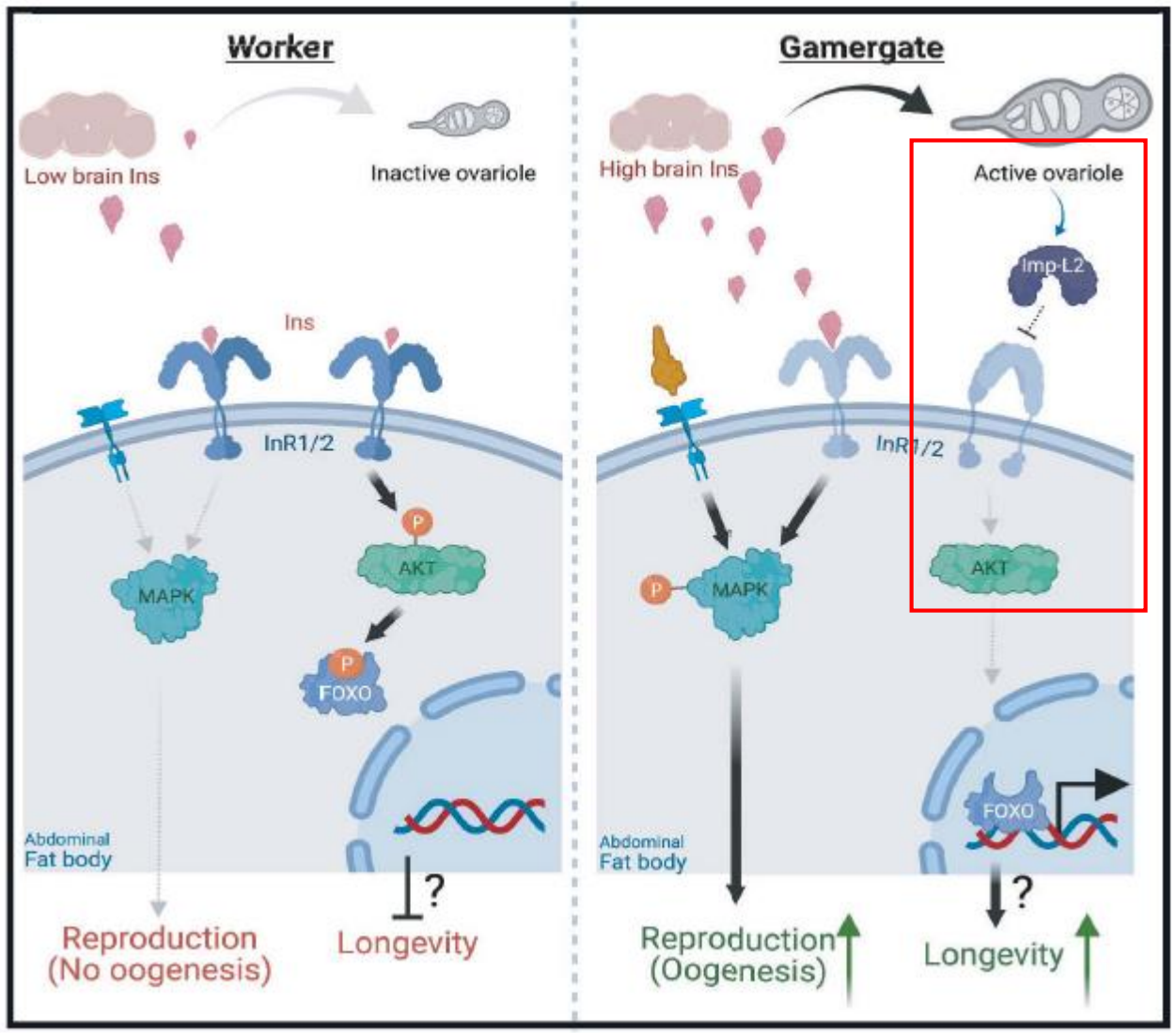






FOXO： forkhead box O transcription factor, related to apoptosis, autophagy, and cell cycle arrest

Proposed models



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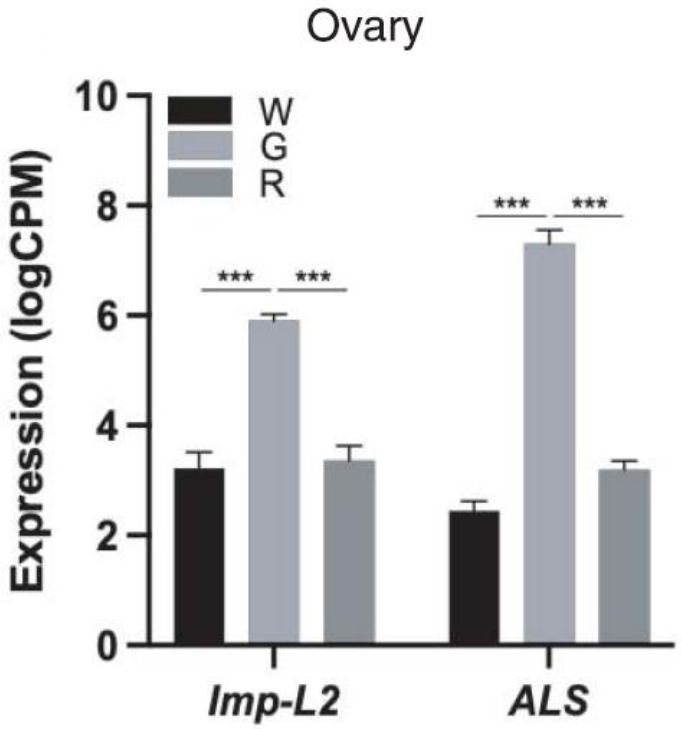
- The IIS inhibitors Imp-L2 and ALS are up-regulated in the ovary
- Imp-L2 specifically blocks AKT in the fat body, help to achieve different activation

✓ An effective solution to the discrepancy between increased insulin and reproduction and prolonged life

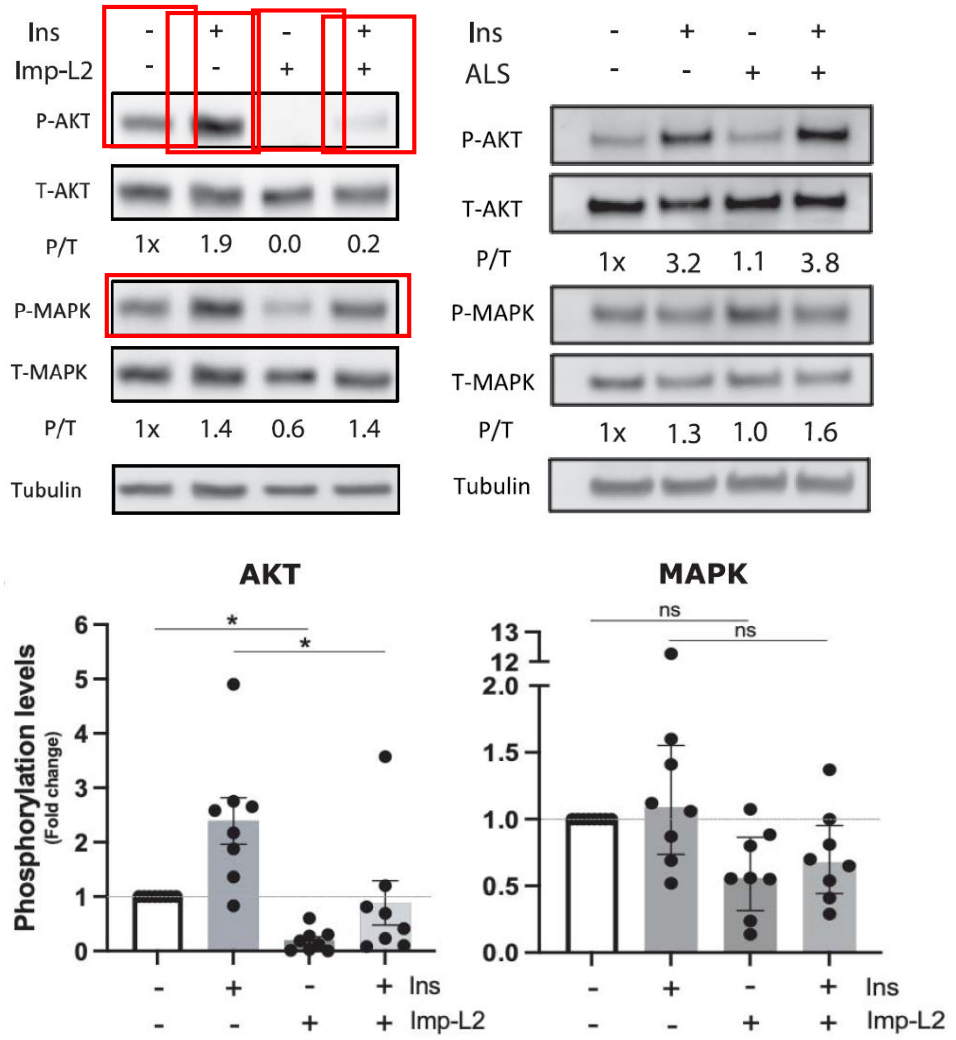
The IIS inhibitors Imp-L2 and ALS are up-regulated in the ovary

- The IIS inhibitors are up-regulate



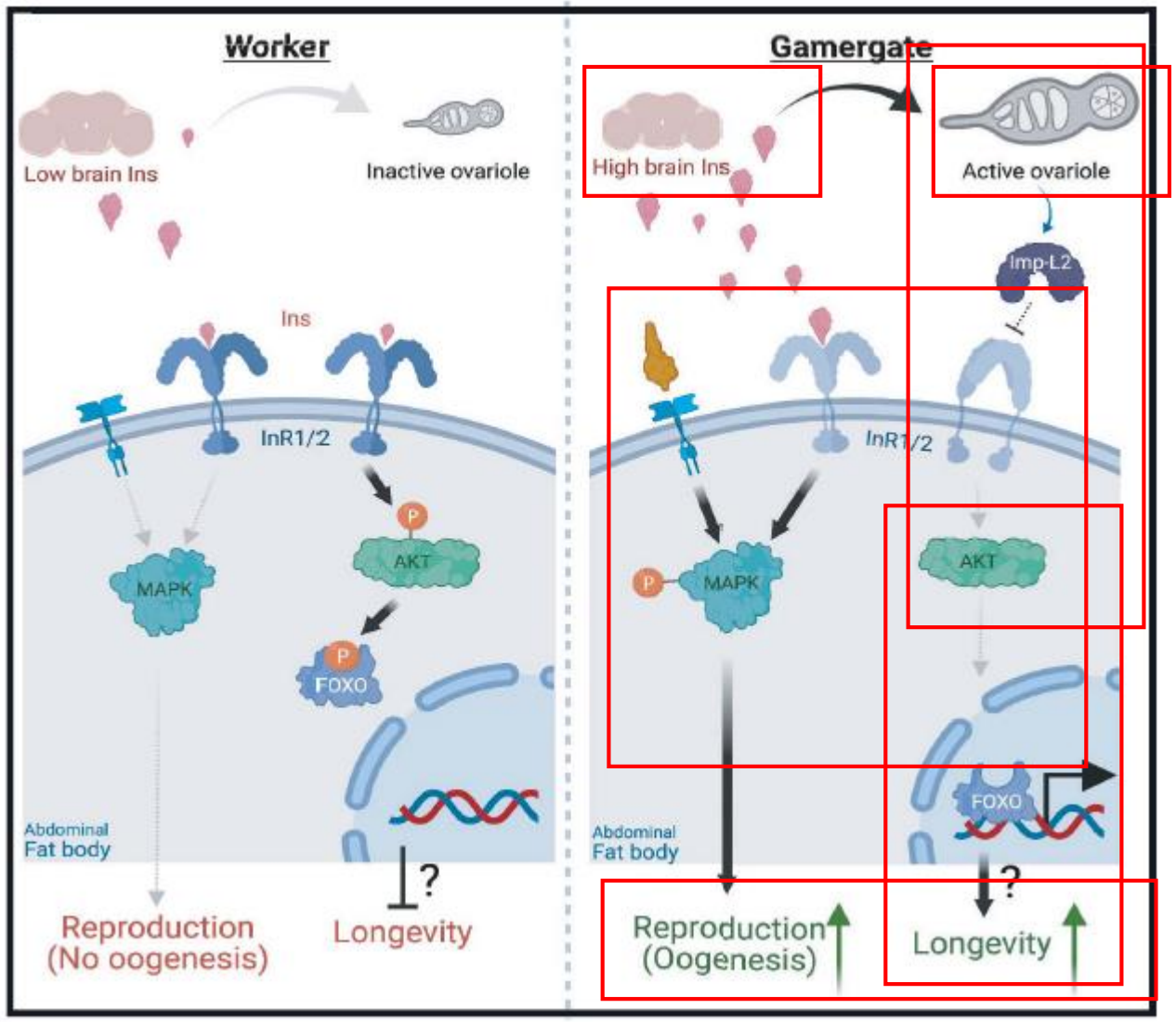
Imp-L2: Imaginal morphogenesis protein-Late 2
ALS: Acidlabile Subunit

- Imp-L2 specifically blocks AKT in the fat body



- Ovaries produce Imp-L2,
- Reduces the activity of AKT, leading to the extension of lifespan
- MAPK activity is less affected, not influence the reproductive ability
- ✓ Ants effectively resolve the conflict between the acquisition of reproductive ability and the extension of lifespan by differentially inhibiting AKT phosphorylation downstream of the Ins pathway.

Summary



- Insulin expression is increased in the brain of the reproductive caste
- Insulin activates the ovaries, leading to the production of eggs
- Insulin can activate AKT and MAPK, but AKT is inhibited
- Imp-L2 specifically blocks AKT in the fat body
- FOXO localizes in the nucleus，resulting in prolonged life

✓ Ants efficiently break free from the reproduction-longevity trade-off through such a strategy, enabling reproductive individuals to simultaneously achieve a longer lifespan.

Highlights and disadvantages

➢Highlights:

- Reveal selectivity in the response of AKT and MAPK to insulin.
- Ants restrict IIS hyperactivity throughout their very long reproductive life through selective inhibition of AKT by Imp-L2, thus retarding aging and achieving longevity in the reproductive caste.

➢Disadvantages:

- There was almost no discussion about the queen, including the results of insulin injection, the responses of AKT and MAPK pathways to insulin and Imp-L2

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Thanks for your listening!