TRINATION

Comparison of whole blood transcriptome responses of Atlantic salmon infected by three *Piscine orthoreovirus* (PRV) variants

Thomais Tsoulia, Arvind Y.M. Sundaram, Marit M. Amundsen, Espen Rimstad, Øystein Wessel
Jorunn Jørgensen & Maria K. Dahle

Forskningsrådet

RED FLAG

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PRV, a dsRNA virus, infects red blood cells (RBCs) of Atlantic salmon

BMC Part of Springer Nature | Veterinary Research

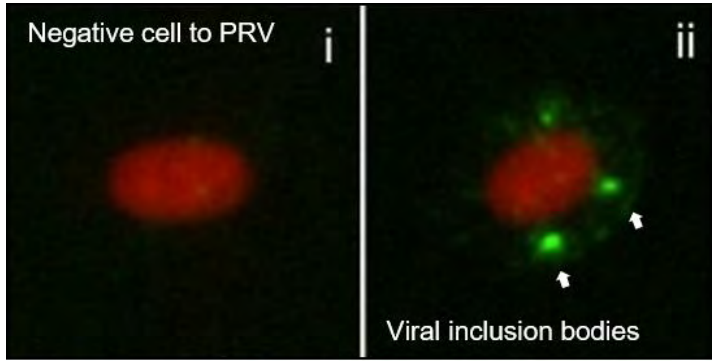
Piscine orthoreovirus (PRV) infects Atlantic salmon erythrocytes

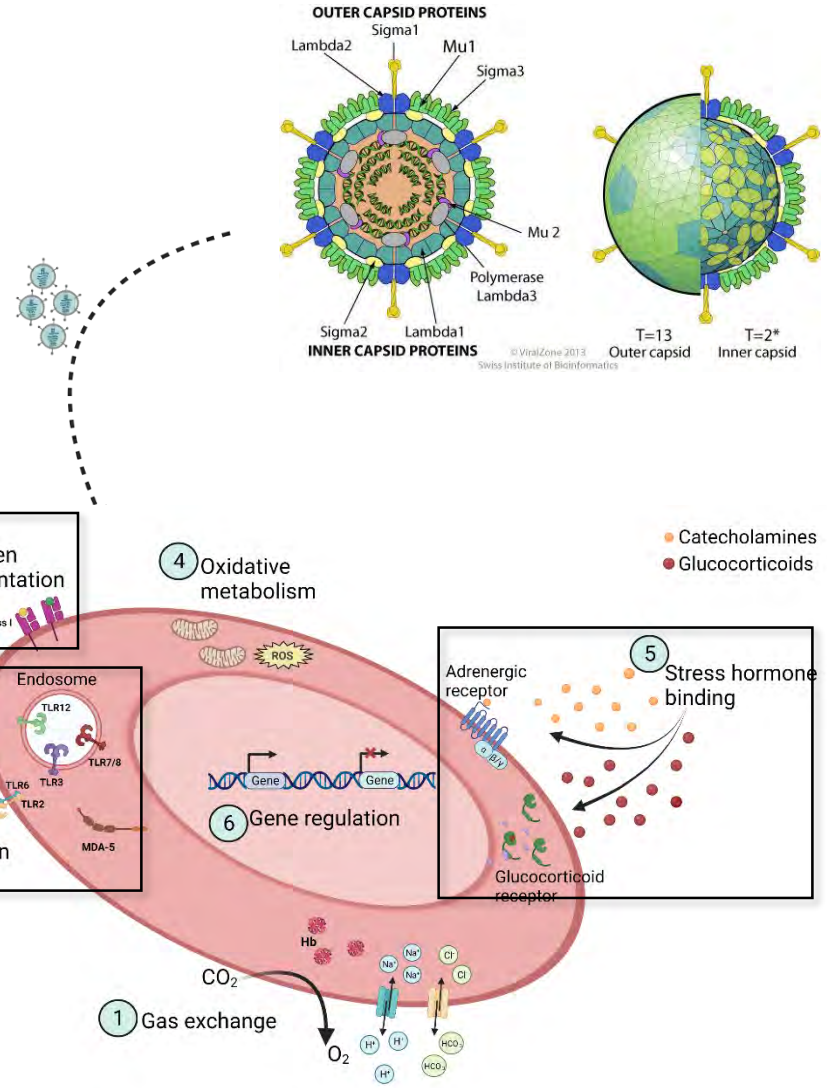
Øystein Wessel Finstad ✉, Maria Krudtaa Dahle, Tone Hæg Lindholm, Ingvild Berg Nyman, Marie Løvoll, Christian Wallace, Christel Moræus Olsen, Anne K Storset & Espen Rimstad

Maria K. Dahle

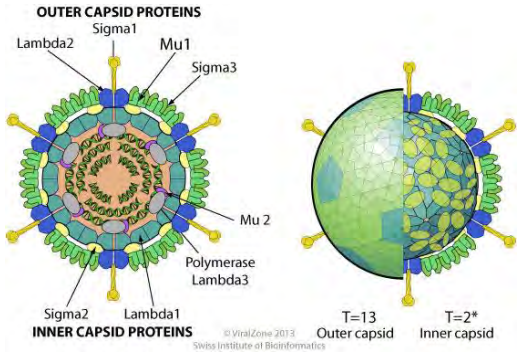
Øystein Wessel

Espen Rimstad

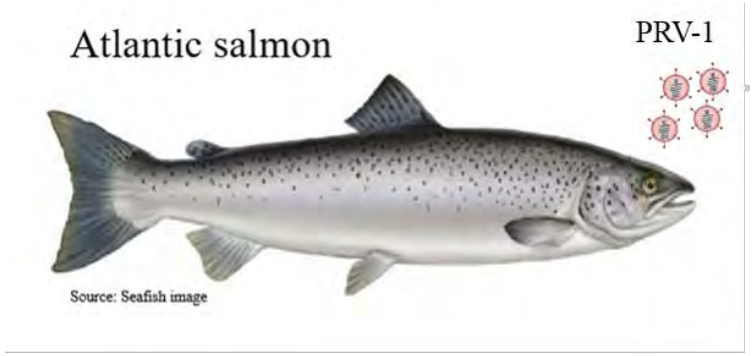




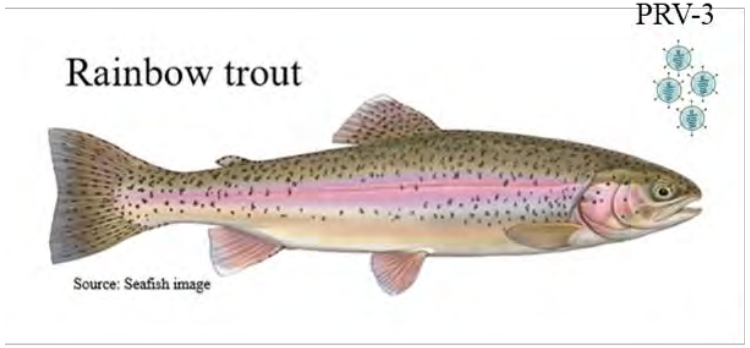
PRV can infect various salmonid species and cause different diseases



- 3 known subtypes:
  PRV-1, PRV-2 & PRV-3
- Genetic identity:
  PRV-1 & PRV-3 ~90%
  PRV-1 & PRV-2 ~80%
- No cases of PRV-2 infection in Norway



► Heart & skeletal muscle inflammation (HSMI)
► Few reports of anemia



► HSMI-like
► Anemia

► Erythrocytic inclusion body syndrome (EIBS)
► Anemia

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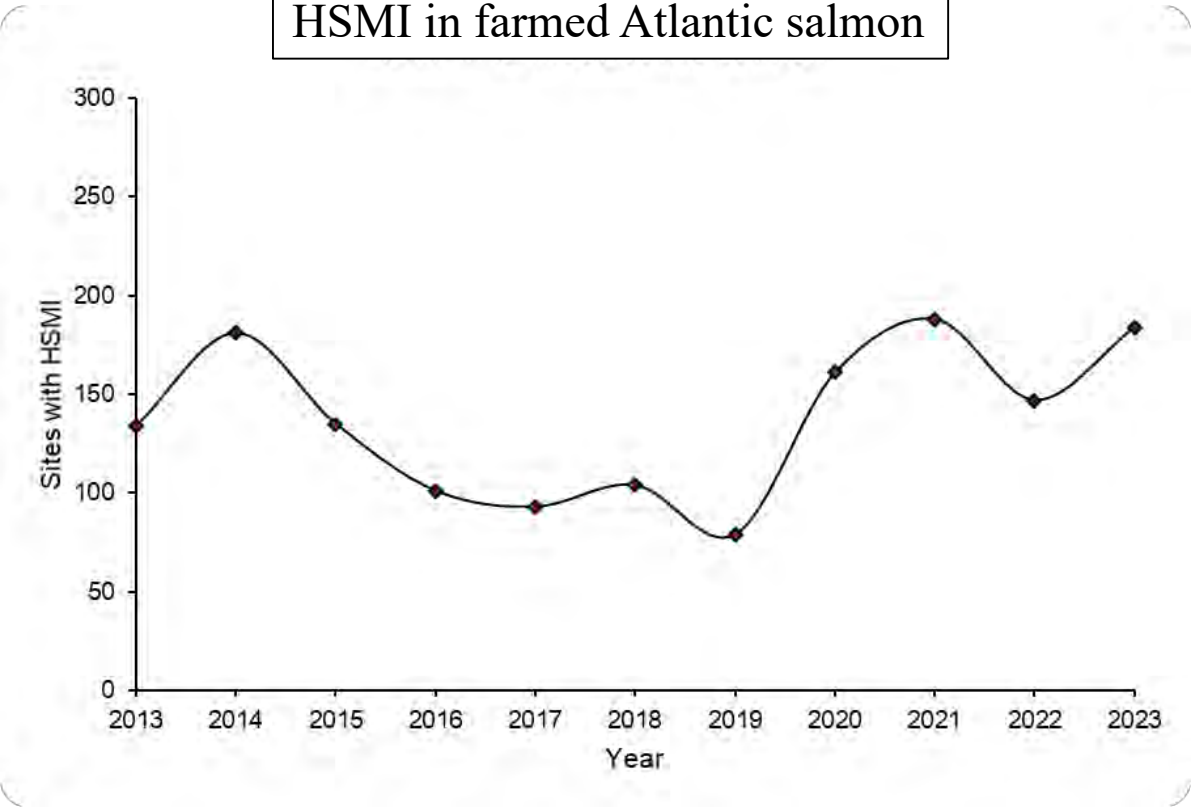
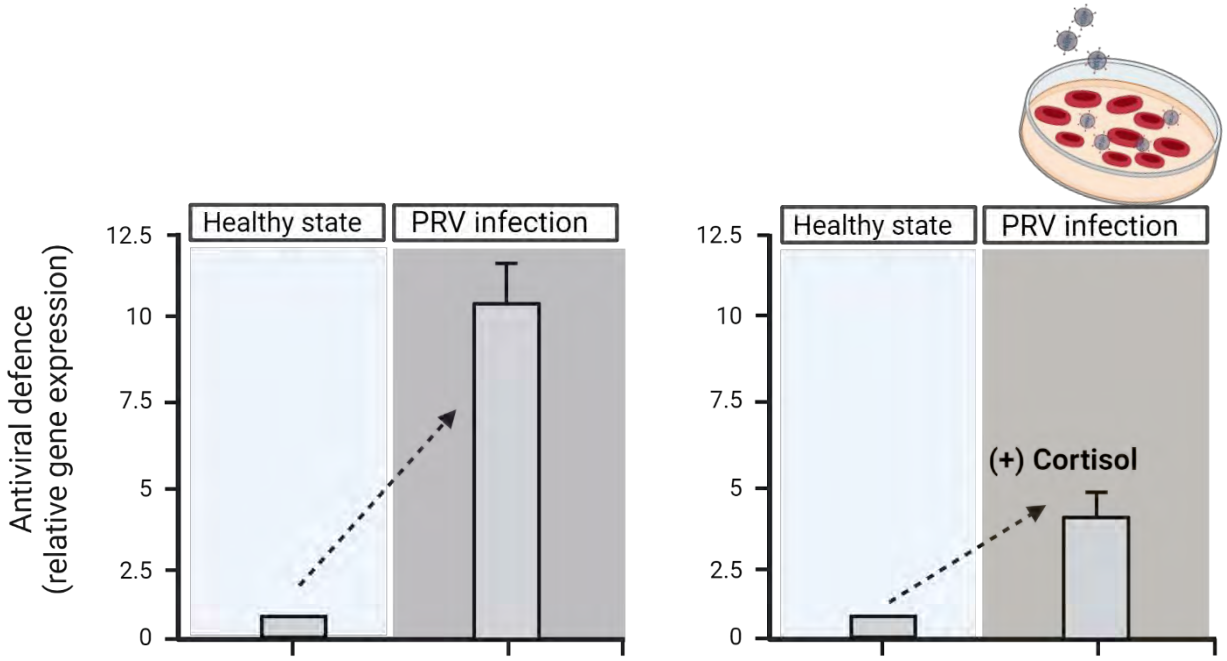
HSMI in Norwegian aquaculture

HSMI in farmed Atlantic salmon



Fiskehelserapporten 2023, Veterinærinstituttet

- HSMI outbreaks in the marine phase
- Up to 20% mortality rate
- PRV in asymptomatic fish population
- HSMI outbreaks are linked to stress by handling routines



Tsoulia et al., modified unpublished data

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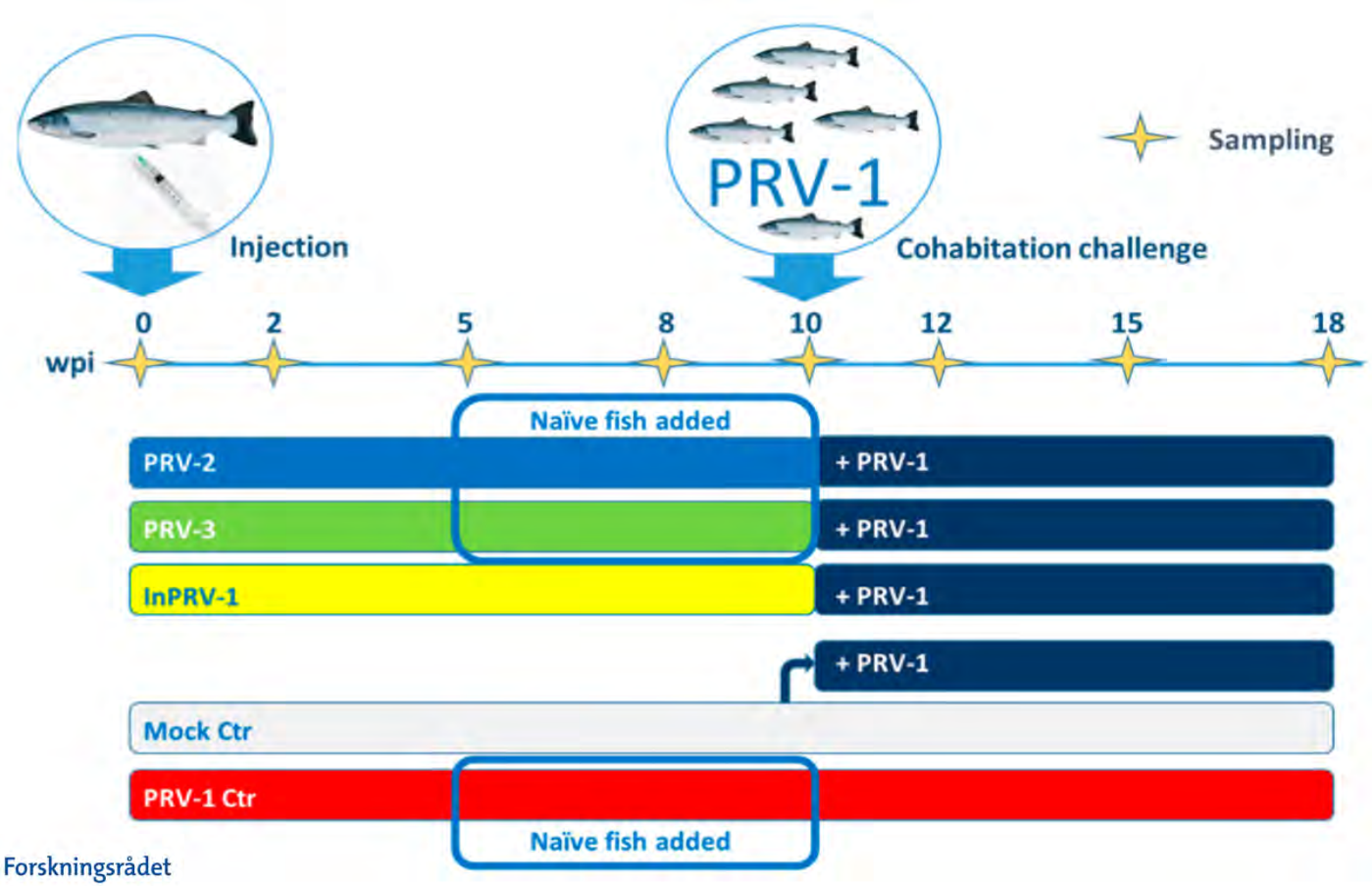
vaccines

Piscine Orthoreovirus (PRV)-3, but Not PRV-2, Cross-Protects against PRV-1 and Heart and Skeletal Muscle Inflammation in Atlantic Salmon

Malik MS, Teige LH, Braaen S, Olsen AB, Nordberg M, Amundsen MM, Dhamotharan K, Svenning S, Edholm ES, Takano T, Jørgensen JB, Wessel Ø, Rimstad E and Dahle MK. 2021 Mar 6;9(3):230.

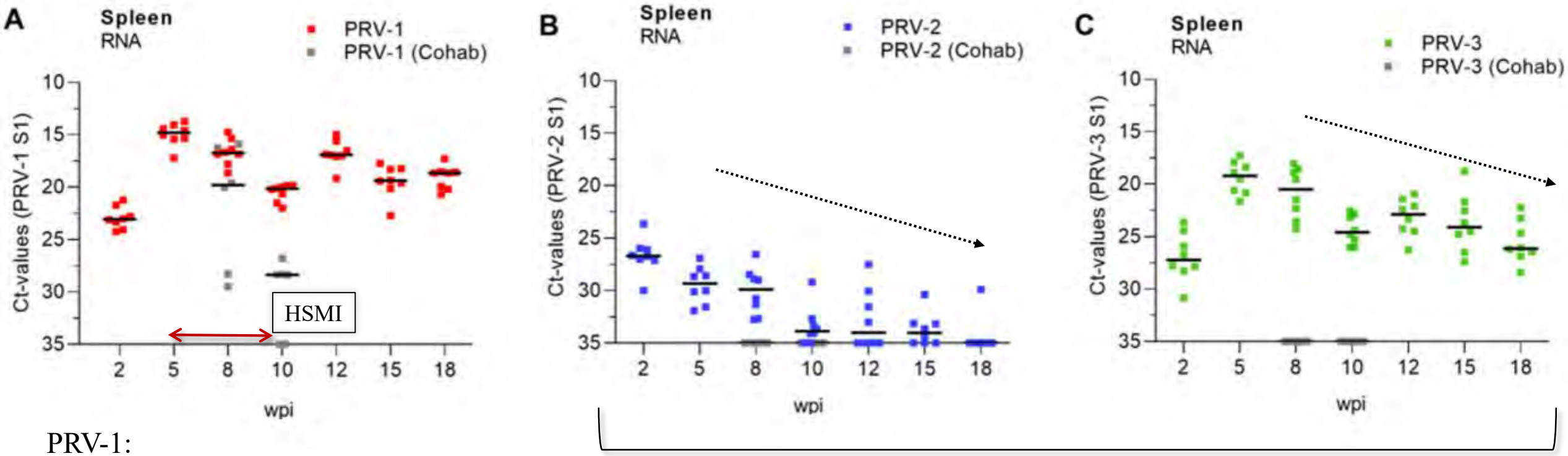


Lena Teige
Salman M. Malik

- Can PRV-2 and PRV-3 infect A. salmon?
- Can PRV-2 and/or PRV-3 efficiently protect A. salmon from PRV-1 & HSMI?

Forskningsrådet

PRV variants can infect Atlantic salmon when injected IP



PRV-1:

- ▸ HSMI ~week 5
- ▸ Transmission to naïve cohabitants
- ▸ Persist over time

PRV-2 & PRV-3 infection:

- ▸ No pathogenesis in Atlantic salmon
- ▸ No transmission to naïve cohabitants

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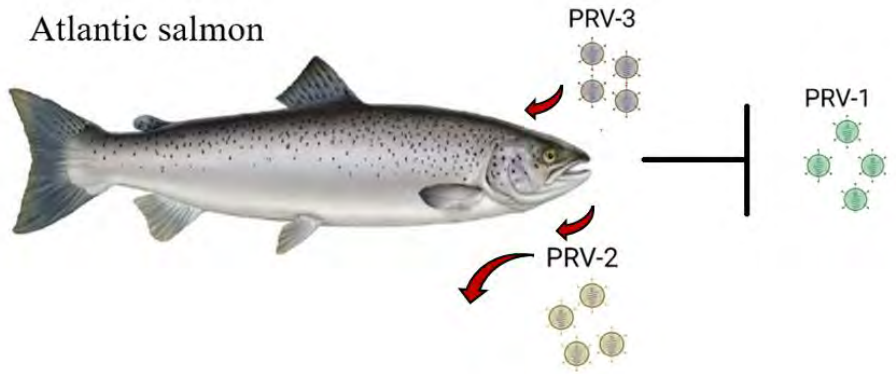
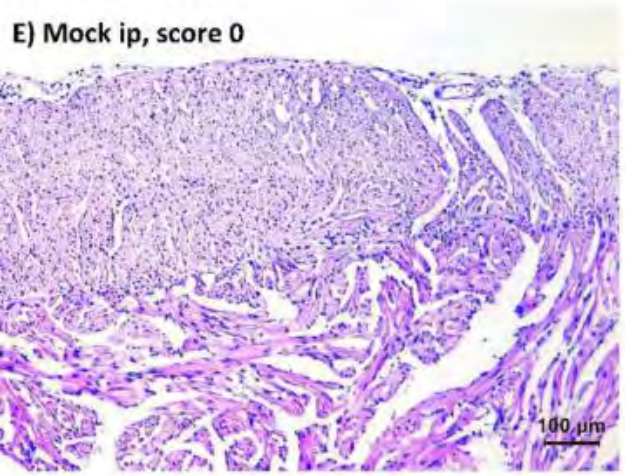
Secondary infection with PRV-1 shedders

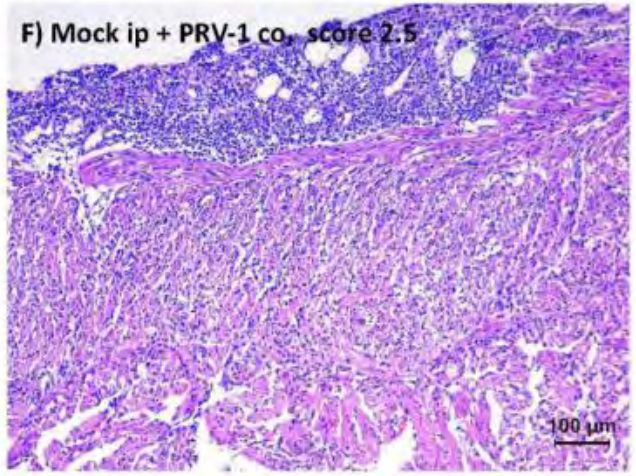


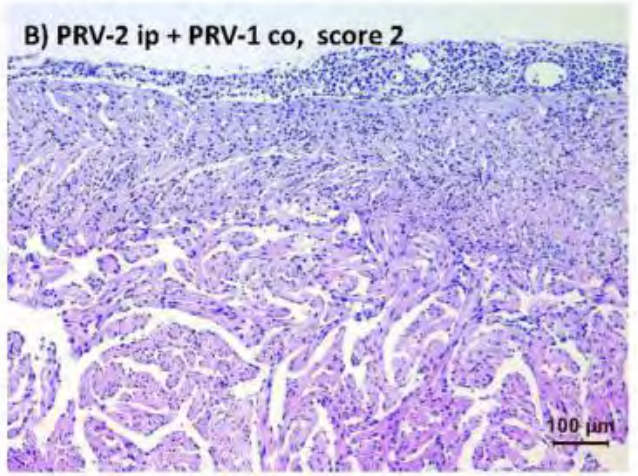
(+) *Non-immunized control* → HSMI (Fig. F)

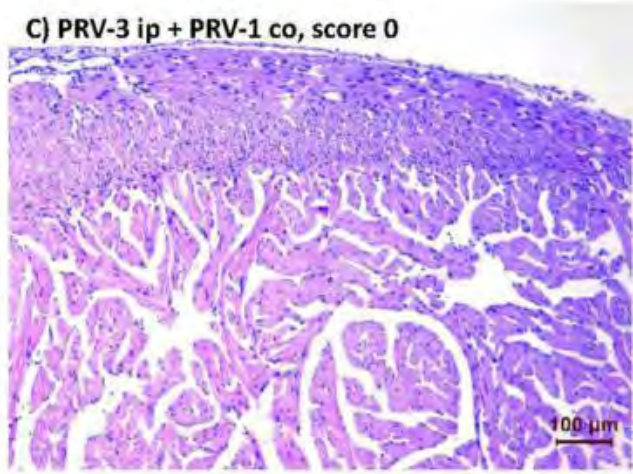
(+) *PRV-2 immunization* → Partial protection against HSMI (Fig. B)

(+) *PRV-3 immunization* → Protection against PRV-1 infection & HSMI (Fig. C)

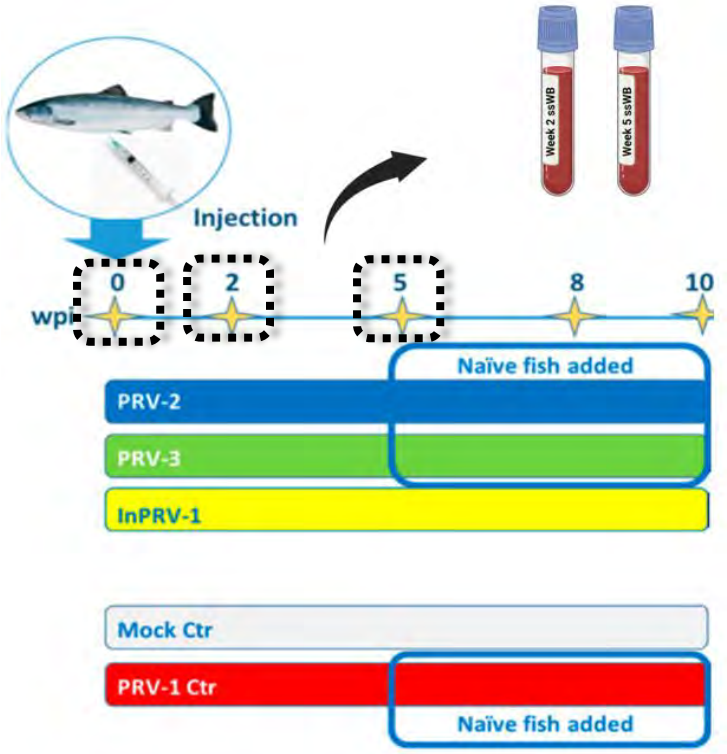


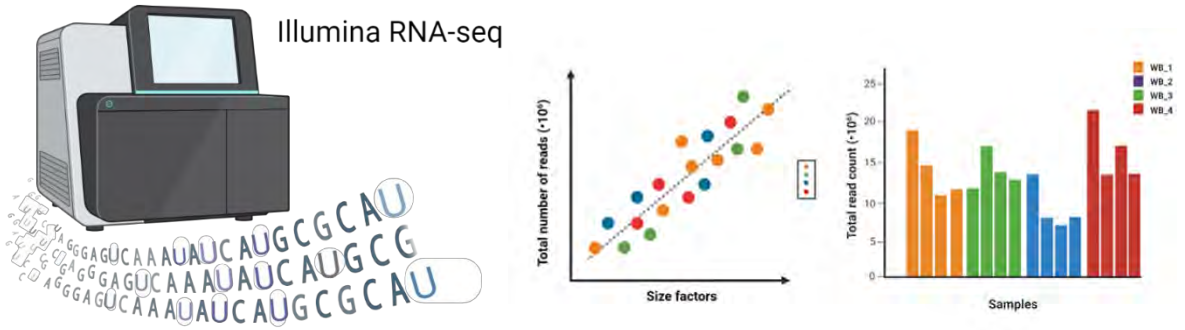


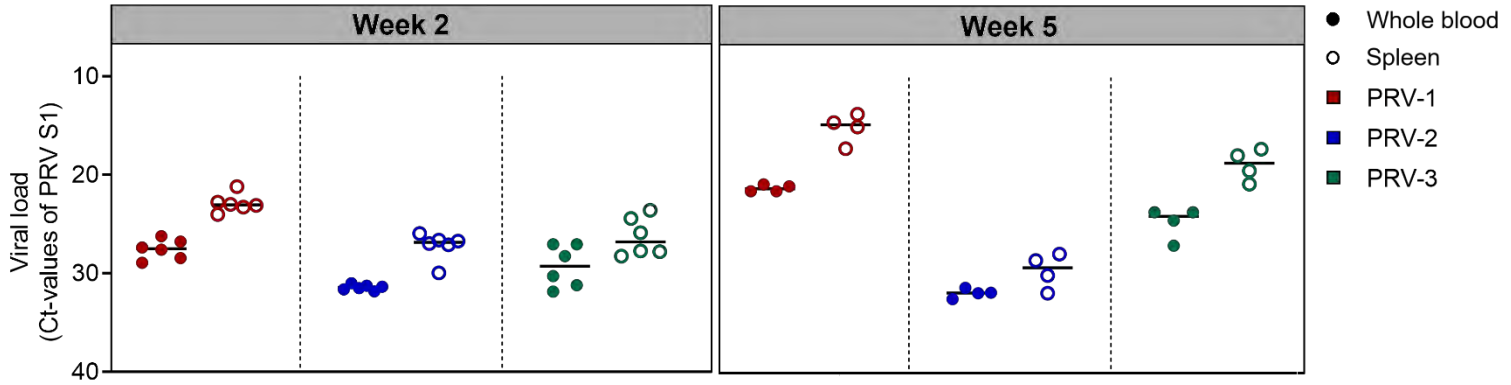




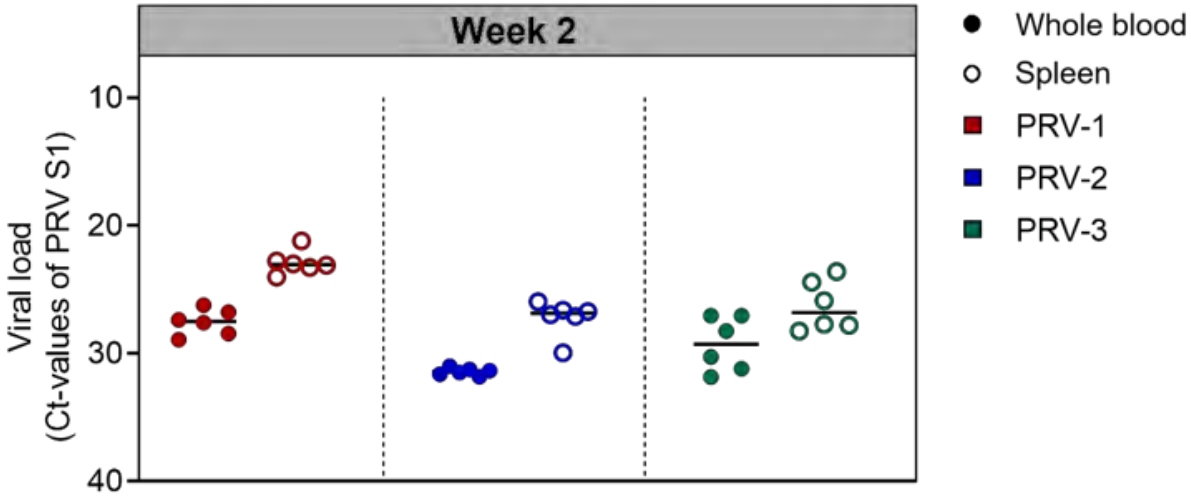
Any transcriptional differences in whole blood of Atlantic salmon infected by PRV-1, PRV-2 & PRV-3?

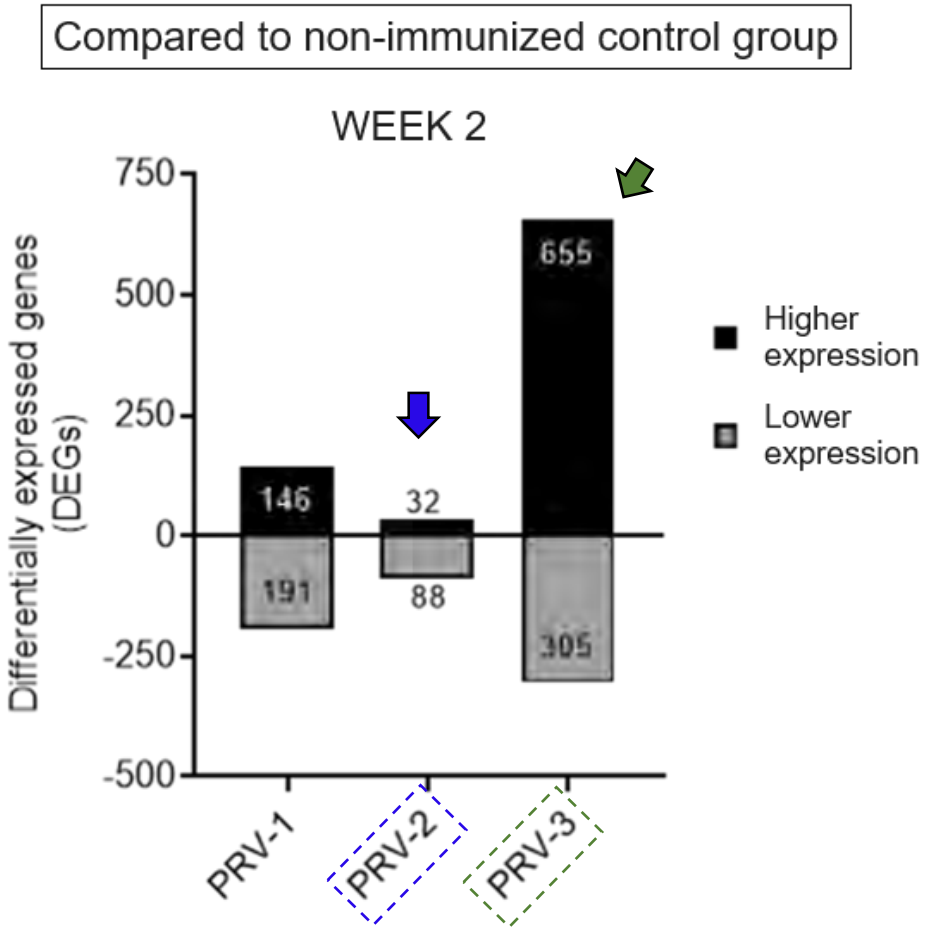




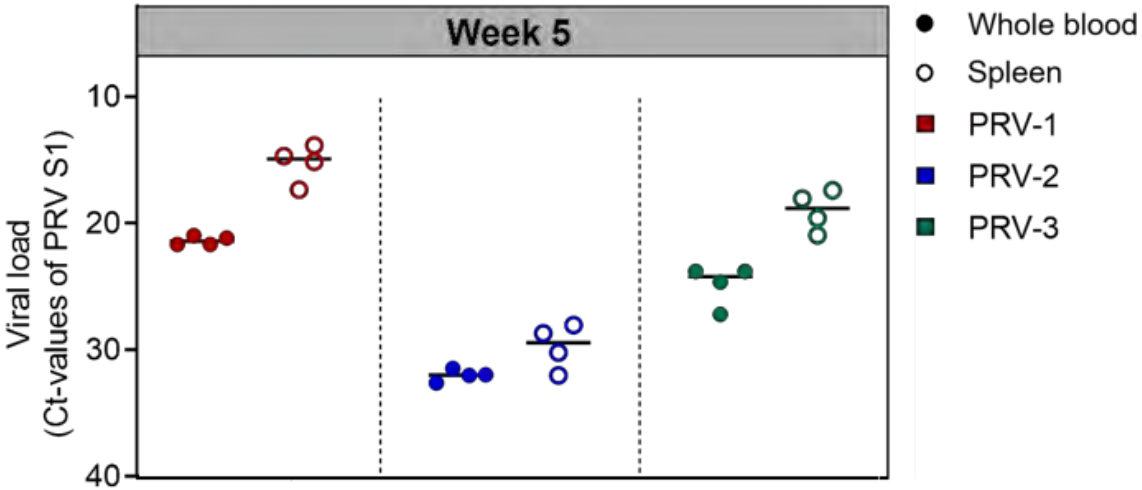


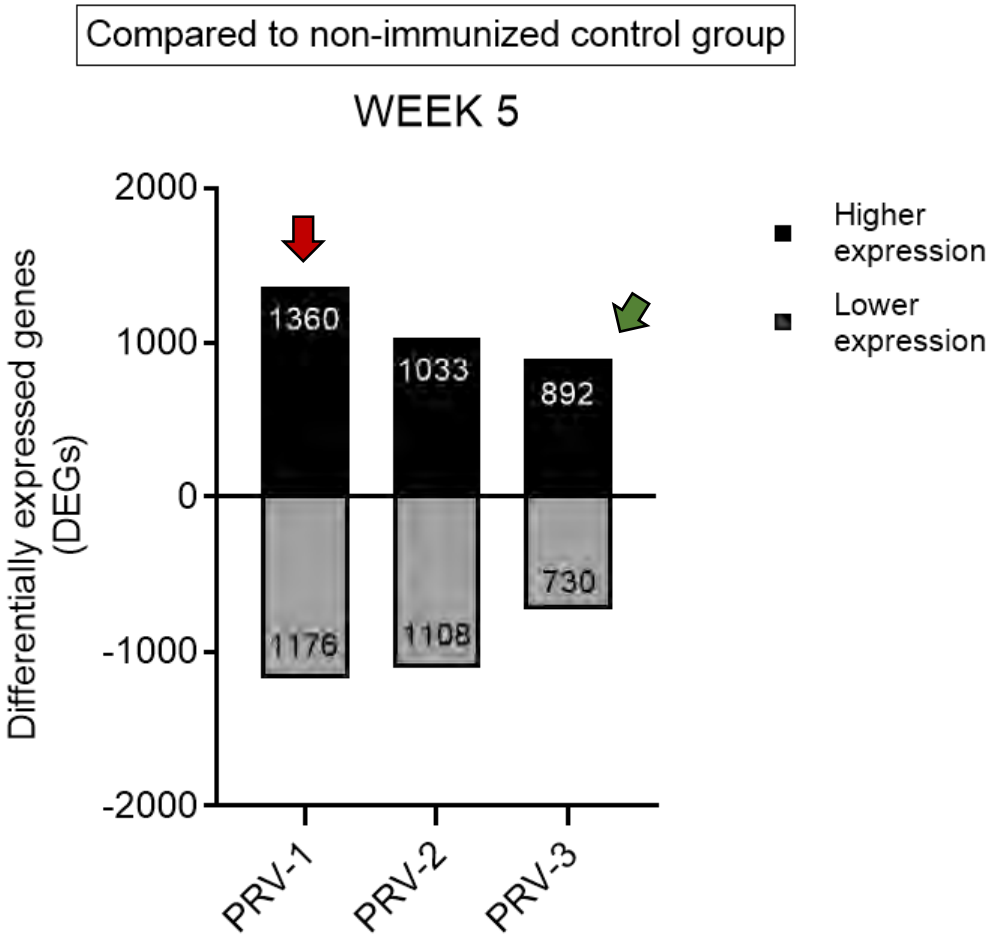
PRV-3 triggered the strongest transcriptional responses at week 2



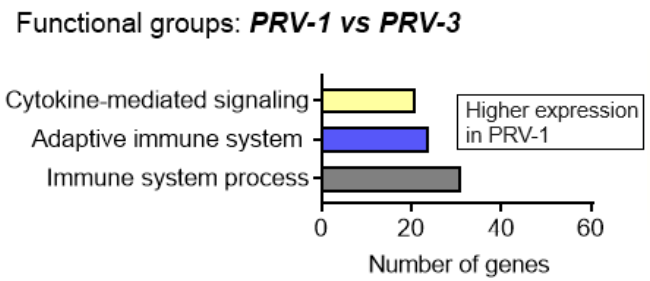


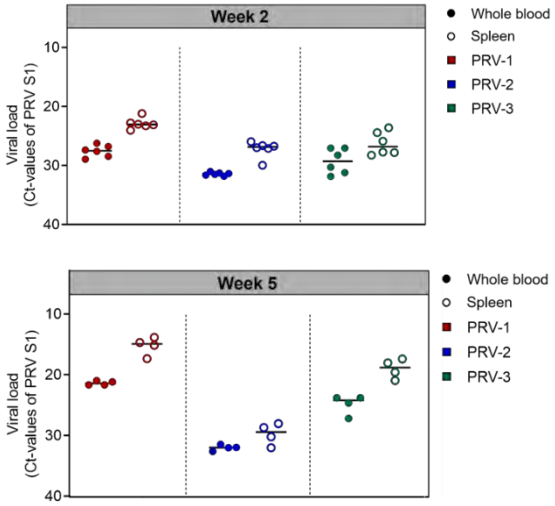
PRV-1 triggered the strongest transcriptional responses at week 5

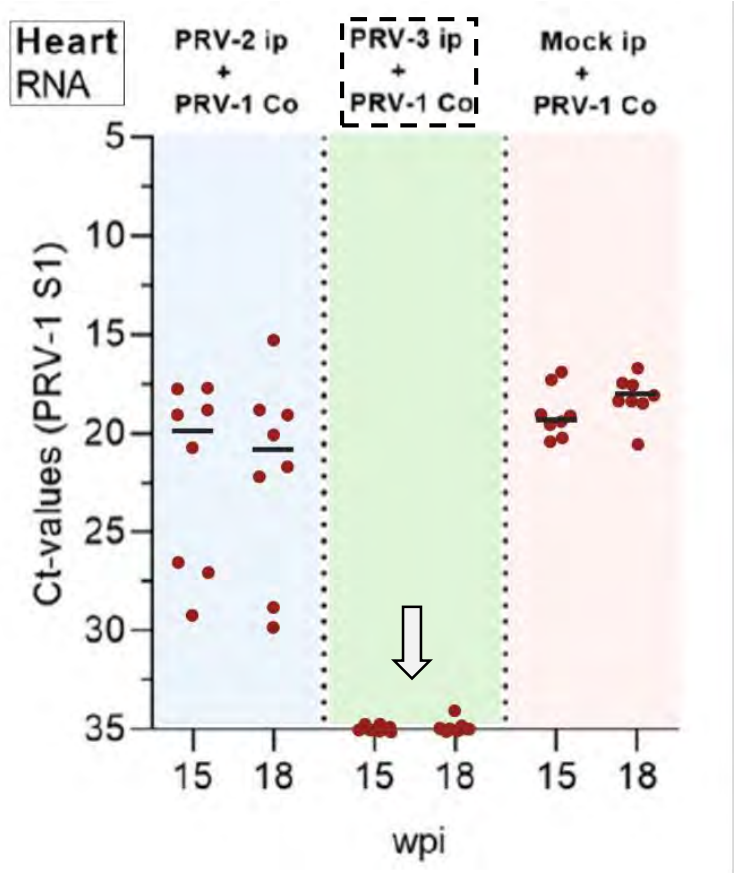




PRV-3 induces immune responses **similar** to PRV-1 **but earlier**

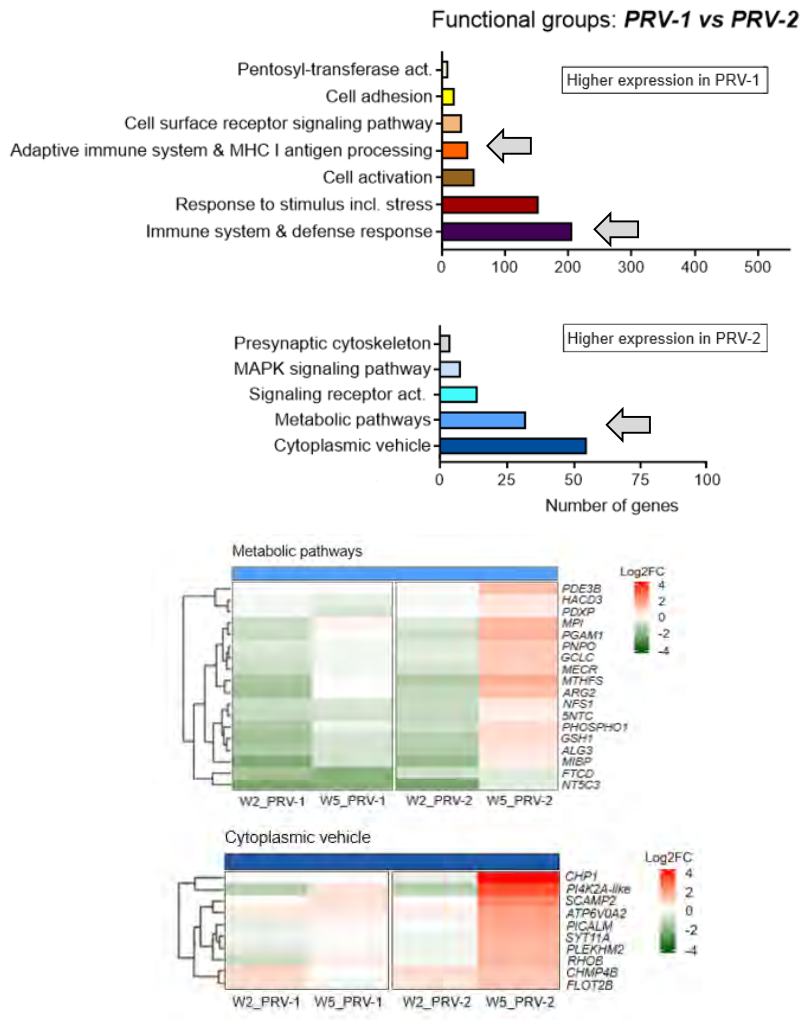


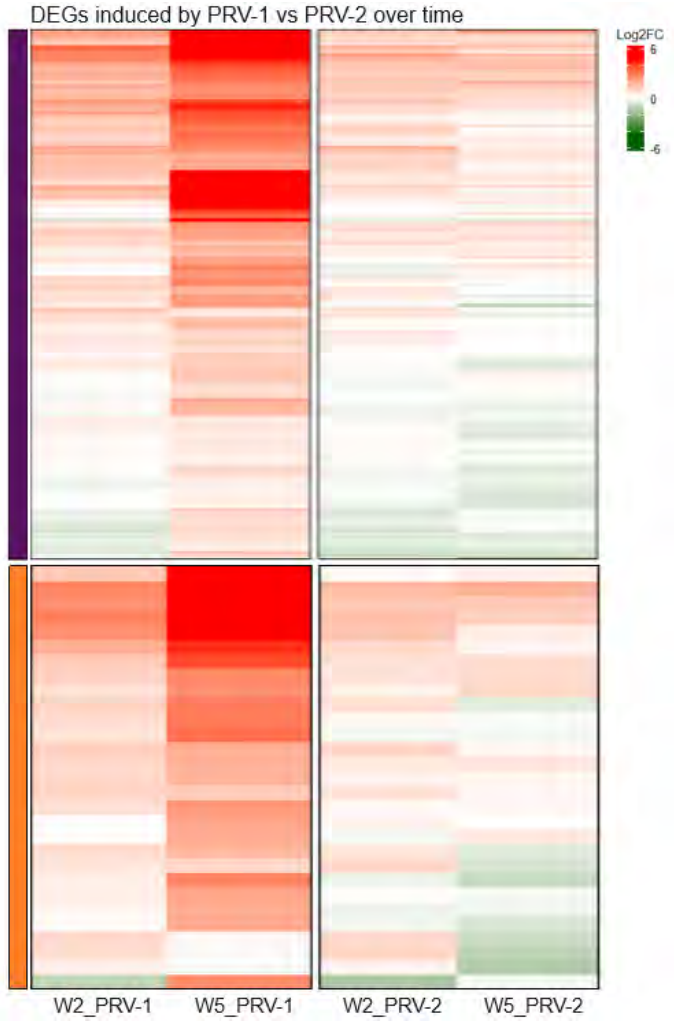


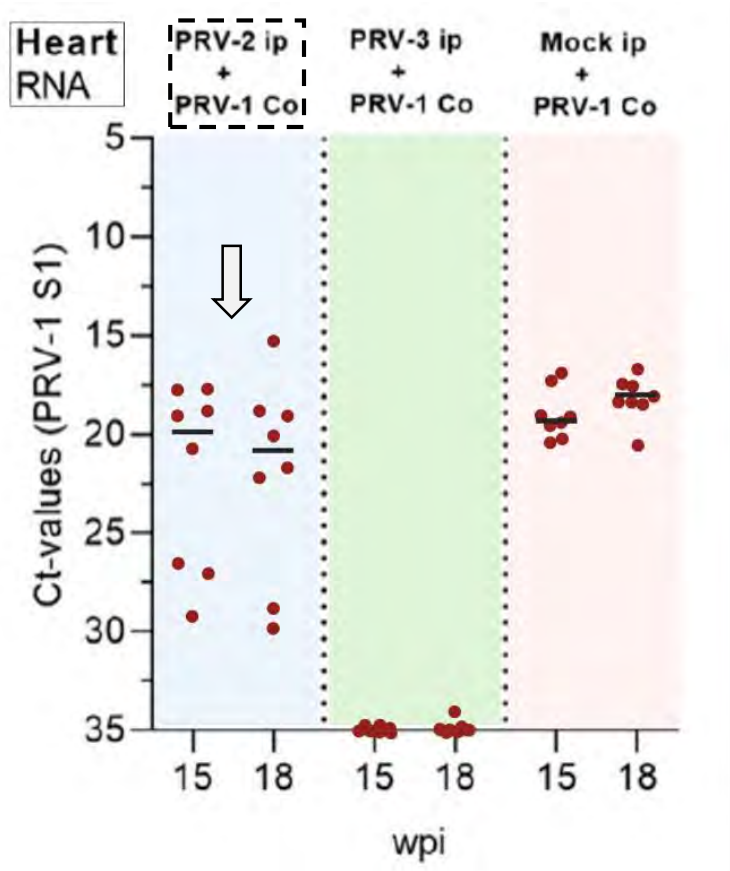


- No detection of PRV-1 in the heart
- Protection against HSMI

PRV-2 has a **similar expression** pattern to PRV-1 at **week 2** and only induces effectors of **metabolic pathways** at **week 5**

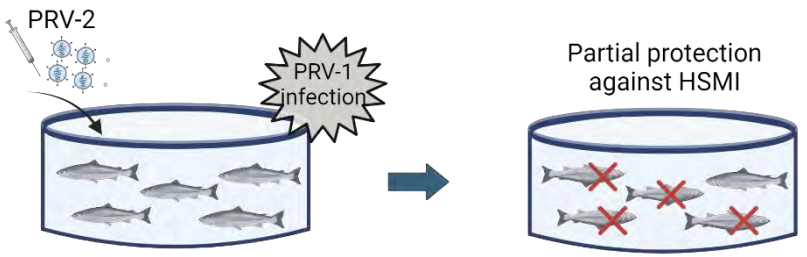






- Detection of high PRV-1 levels in the heart
- Some protection against HSMI

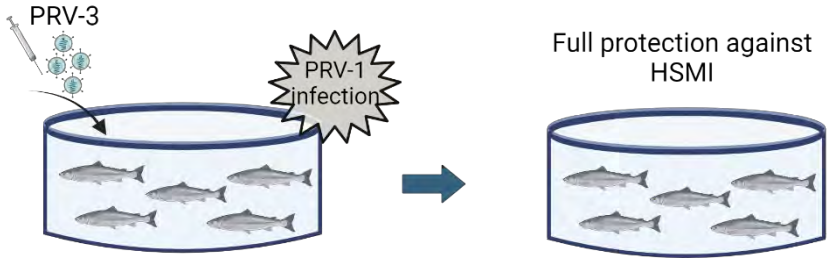
To sum up:



PRV-2:

- similar expression profile with PRV-1 at week 2
- interfere with metabolic processes at week 5

→ Small protection efficiency



PRV-3:

- strong immune responses at week 2, similar to PRV-1 at week 5

→ Successful protection against PRV-1 and HSMI

→ ***Development of a vaccine based on PRV-3 responses****?*

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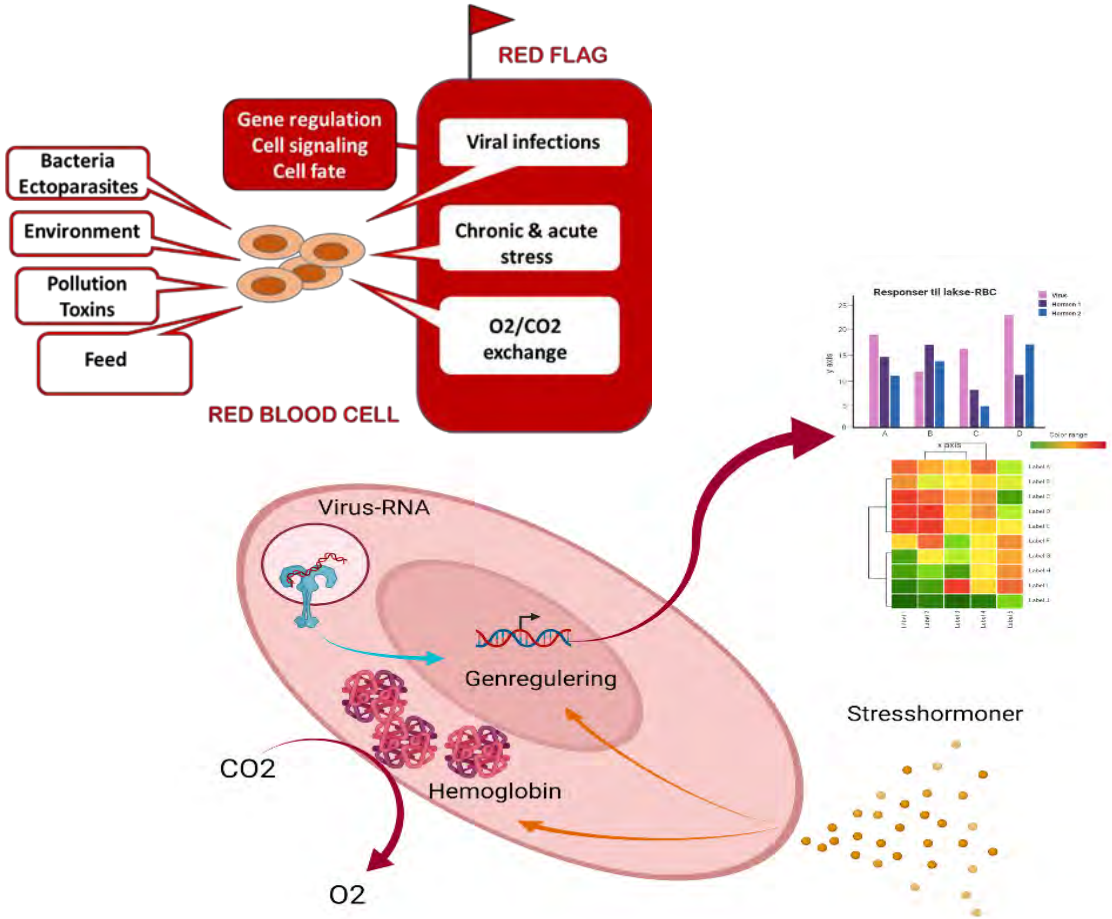
RED FLAG

Forskningsrådet

Salmonid red blood cells as sensors of stress and infection



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Vitenskapet

KUNNSKAP OM FISKEHELSE
I denne spalten vil Veterinærinstituttet i hvert nummer bidra med oppdatert kunnskap om fiskehelse.
Ansvarlig for spalten er forsker Mona Gjessing
mona.gjessing@vetinst.no

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Røde blodceller
– er de sensorer for laksens helsetilstand?

Det er ikke tvil om at røde blodceller er livsviktige, siden de forsyner kroppen med oksygen, og laksens blodceller frakter oksygen kanskje enda mer effektivt enn våre blodceller gjør. Men det er ikke det eneste de røde blodcellene i laksen kan. De har en cellekjerne som kan

De røde blodcellene hos fisk og fugl har cellekjerne og er svært forskjellige fra våre Hvis vi ser i mikroskopet på cellene i blodet fra fisk og fugl og sammenlikner med vårt eget blod er det helt åpenbare forskjeller. Fiskens røde blodceller er større enn våre, selv større enn de hvite blodcellene (figur 1). Dette er motsatt i oss mennesker, der de røde blodcellene er små og flat-trykte uten cellekjerne. I fisk og fugl fyller cellekjernen fiskens blodcelle ut til en stor oval form. Men ellers er cellene fulle av orthoreovirus (PRV), bruker røde blodceller til å produsere nye virus, og at Infeksiøs lakseanemi-virus (ILAV), binder seg til de røde blodcellene og kan gi alvorlig anemi. I laks som er syke pga laksepoxviruset så ser vi også i mange tilfeller at de røde blodcellene brytes ned. Men har cellene i seg selv enda mer å fortelle oss? I prosjektet RED FLAG vil vi studere hvordan cellene reagerer på ytre stimuli. Vi har nemlig en hypotese om at de røde blodcellene kan fortelle oss om

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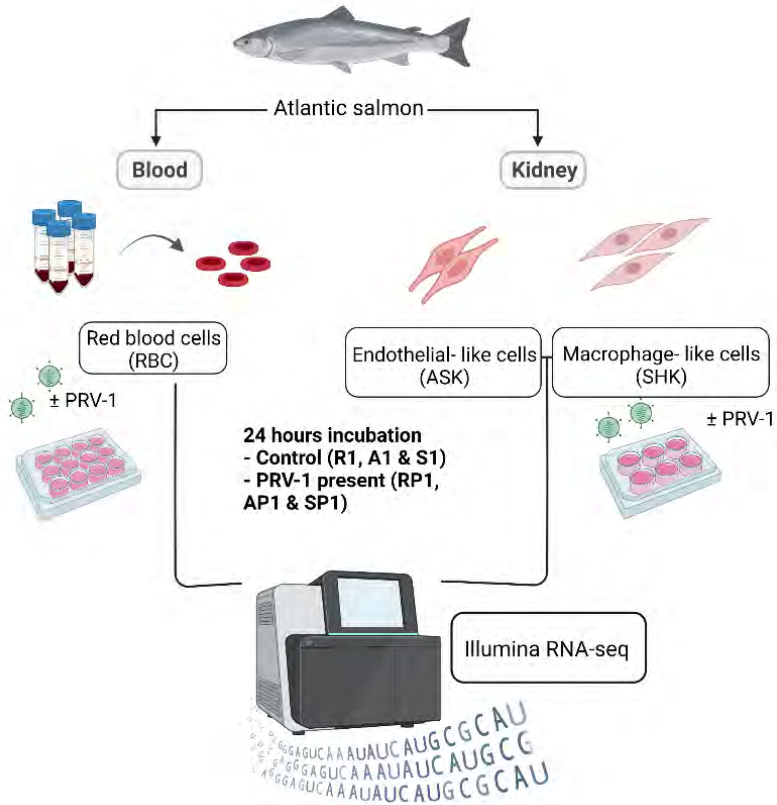
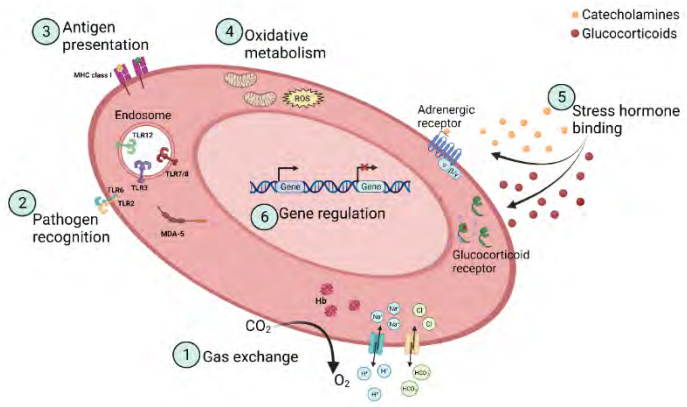
Transcriptomics of early responses to purified Piscine orthoreovirus-1 in Atlantic salmon (Salmo salar L.) red blood cells compared to non-susceptible cell lines

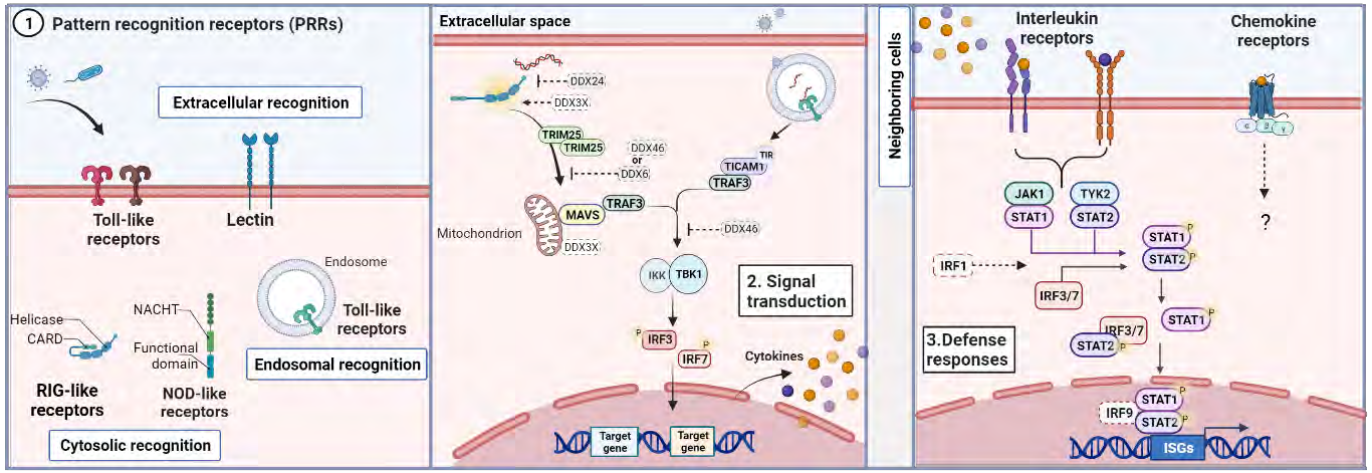
Thomais Tsoulia[1,2] Arvind Y. M. Sundaram[1,3] Stine Braaen[4] Jorunn B. Jørgensen[2]

Espen Rimstad[4] Øystein Wessel[4] Maria K. Dahle[1,2*]

[1] Departments of Aquatic Animal Health and Analysis and Diagnostics, Norwegian Veterinary Institute, Ås, Norway
[2] Department of Biotechnology, Fisheries and Economy, UiT Arctic University of Norway, Tromsø, Norway
[3] Department of Medical Genetics, Oslo University Hospital, Oslo, Norway
[4] Department of Veterinary Medicine, Norwegian University of Life Sciences, Ås, Norway







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Thank you!

Acknowledgments:

RED FLAG

Salmonid red blood cells as sensors of stress and infection

Forskningsrådet

Supervisors & colleagues (left to right)

Øystein Wessel
Mona Gjessing
Maria K. Dahle
Jorunn Jørgensen
Arvind Sundaram
Marit Amundsen

&

Espen Rimstad

UiT The Arctic University of Norway

Norwegian University of Life Sciences