



# **Impact of some dietary components on rainbow trout development**

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# Impact of some dietary components on rainbow trout development

- **FINE FISH project**

Improving sustainability of European fish aquaculture by **control of malformations**



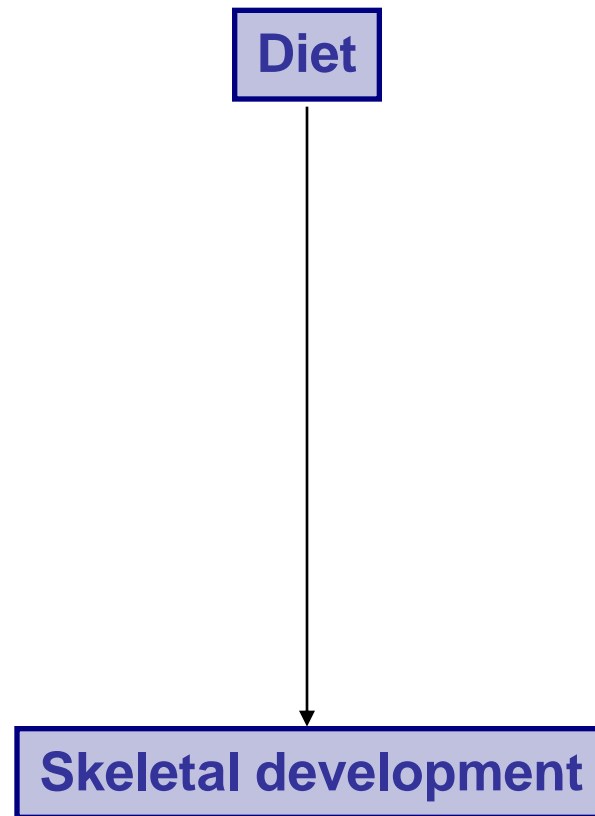
- **Malformations**

- **Skeletal deformities** (spinal column, caudal fin, skull and operculae) ⇒ most important in terms of economy
- Malformations of heart/other internal organs ⇒ less well recognized

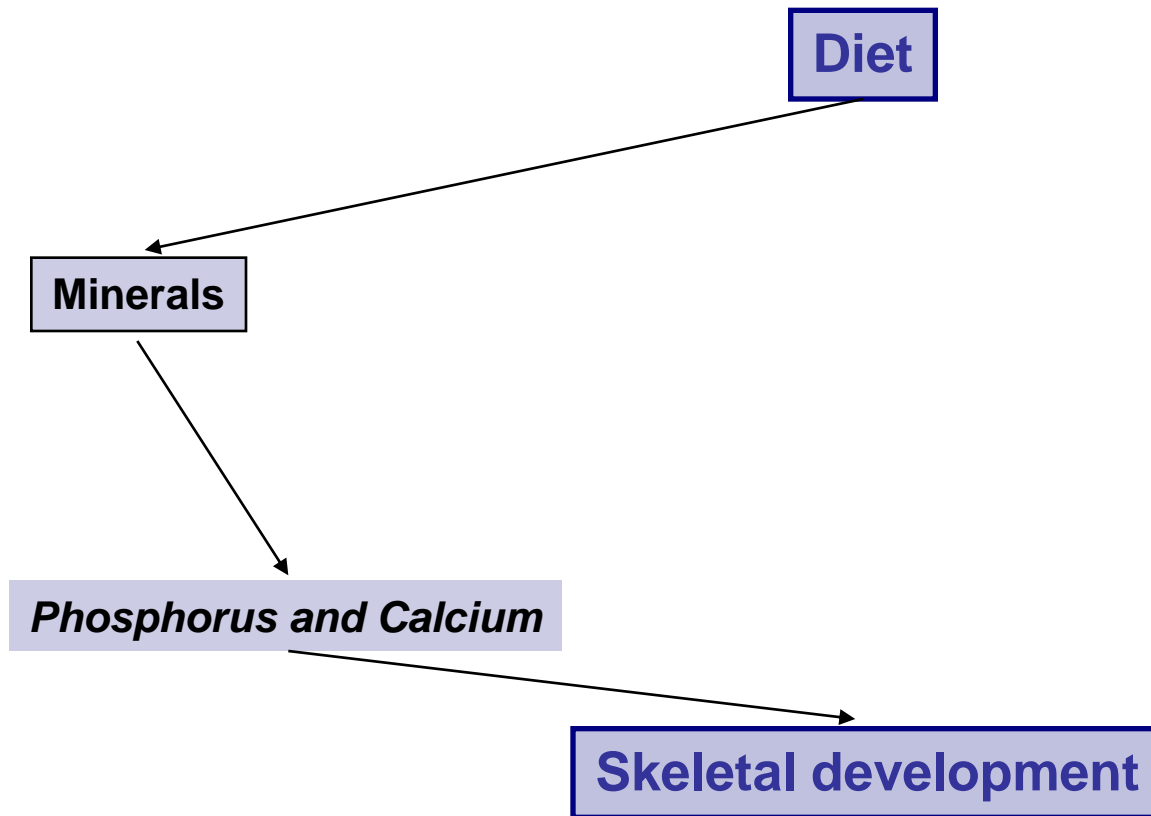
- **Numerous potential causes of skeletal deformities:**

- Three focus areas of research:  
rearing temperature, tank environment and **nutrition**

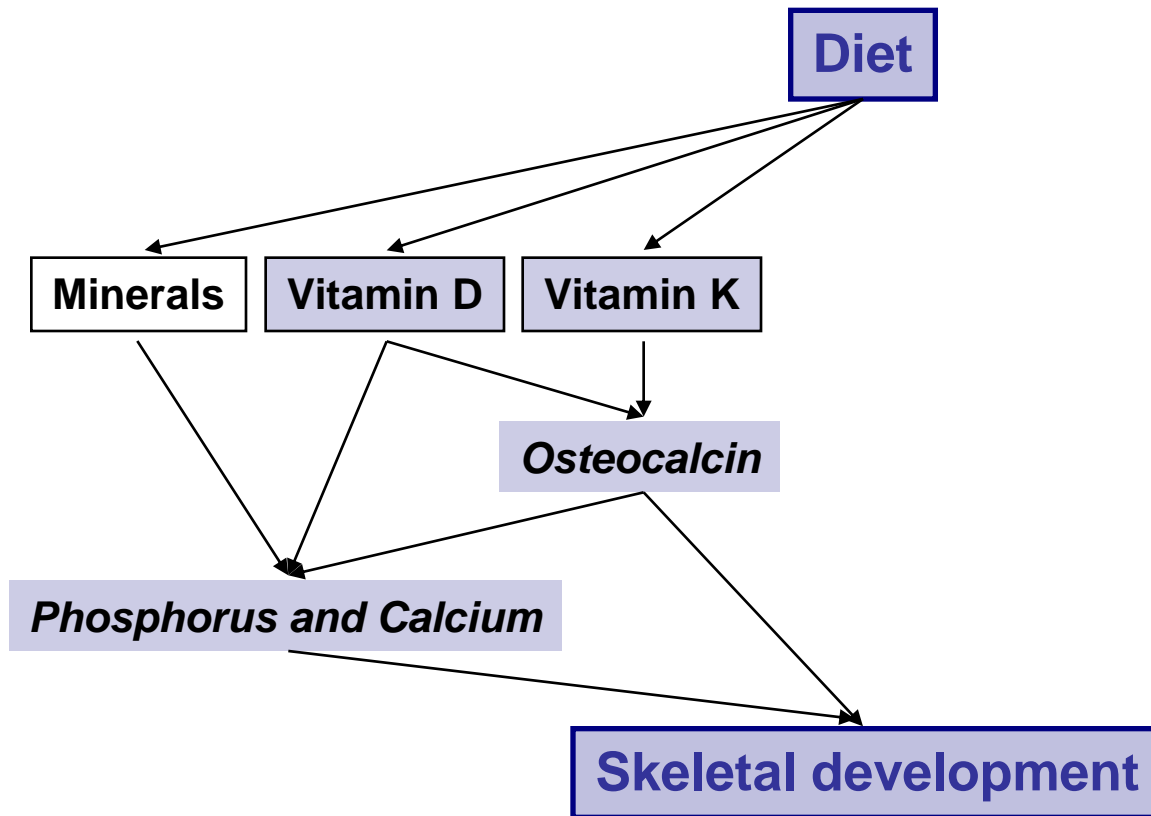
# Impact of some dietary components on skeletal development in fish



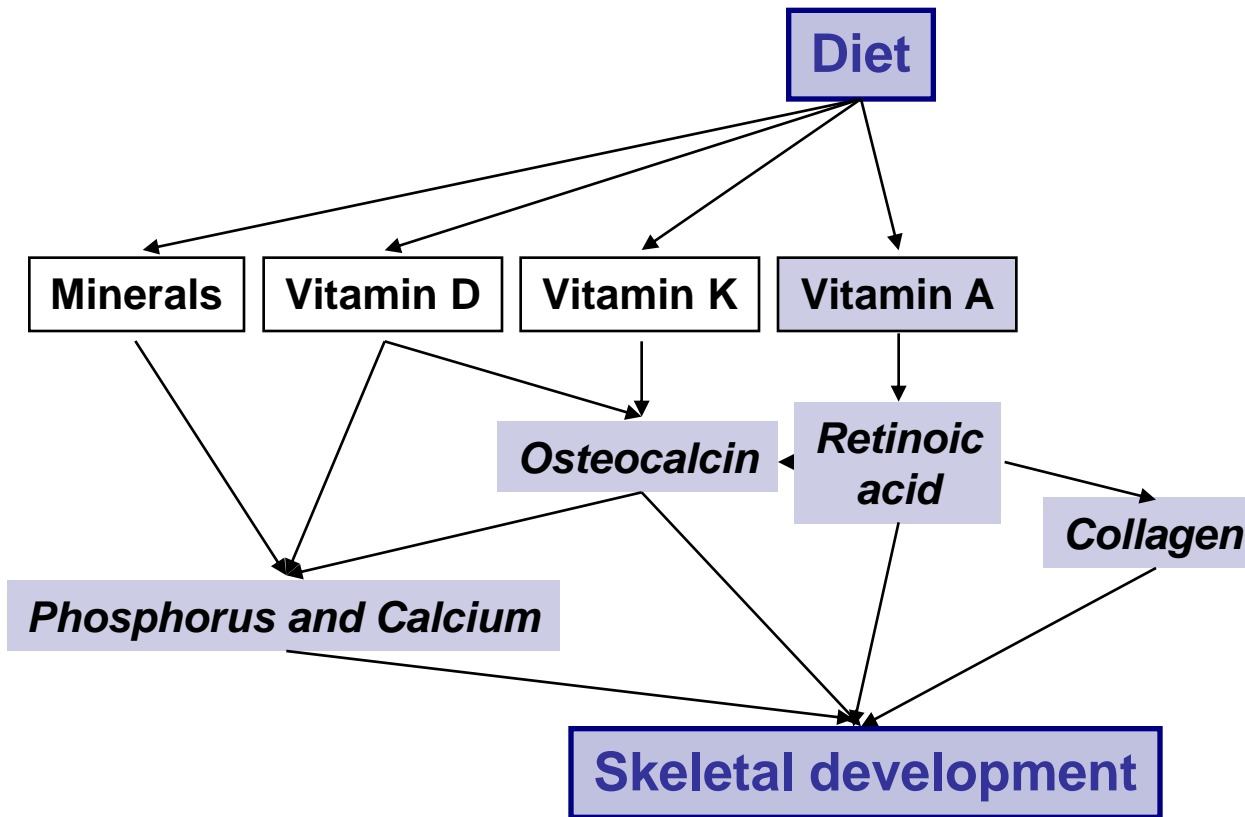
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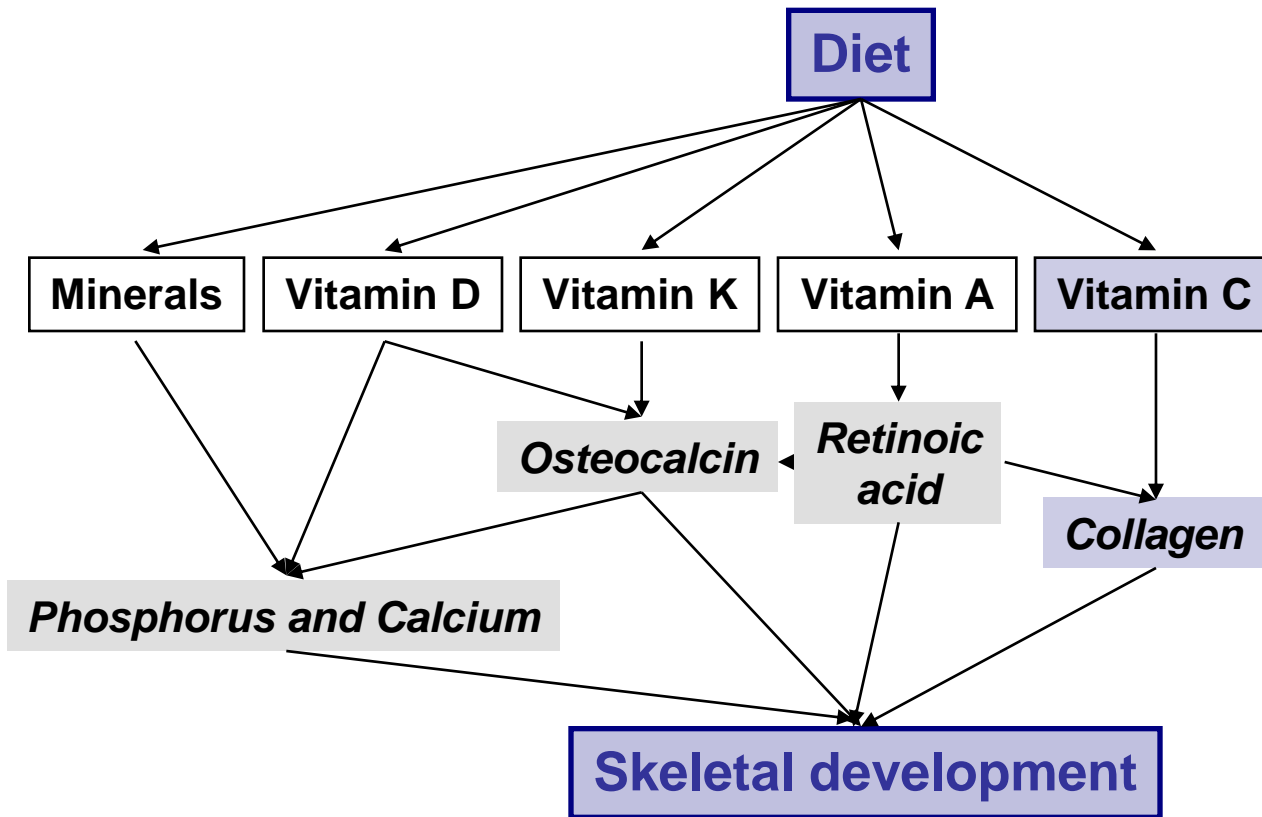
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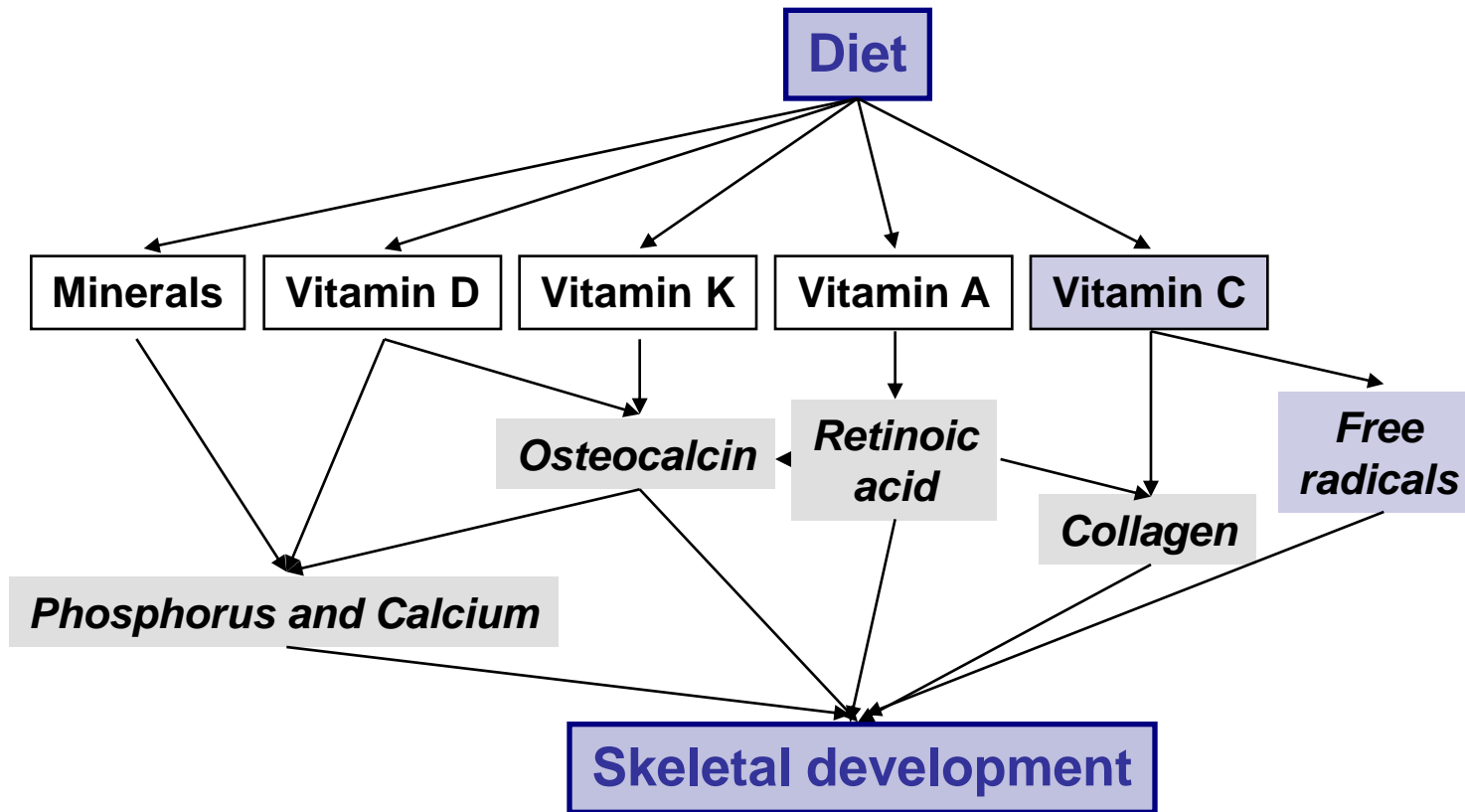
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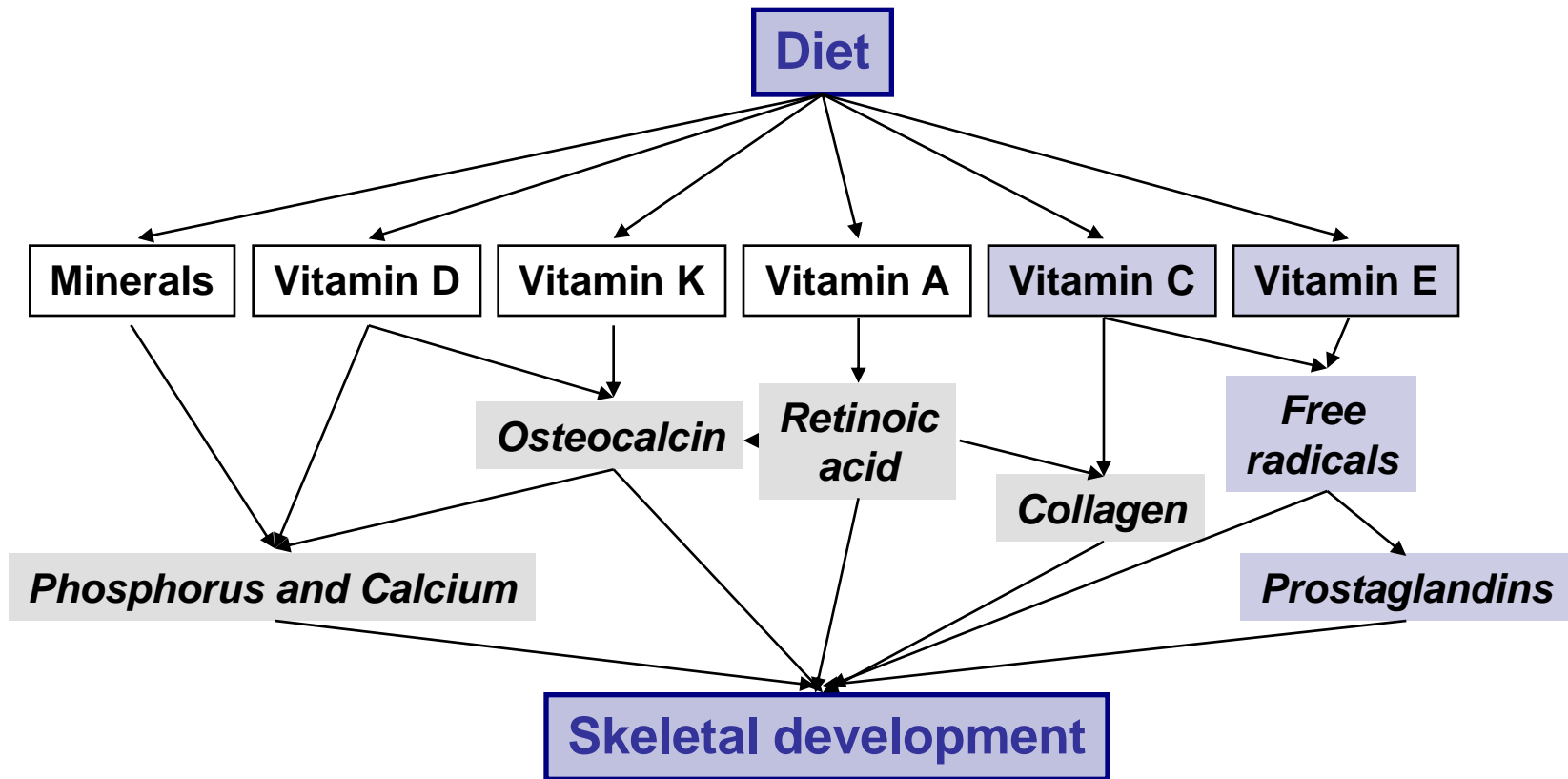
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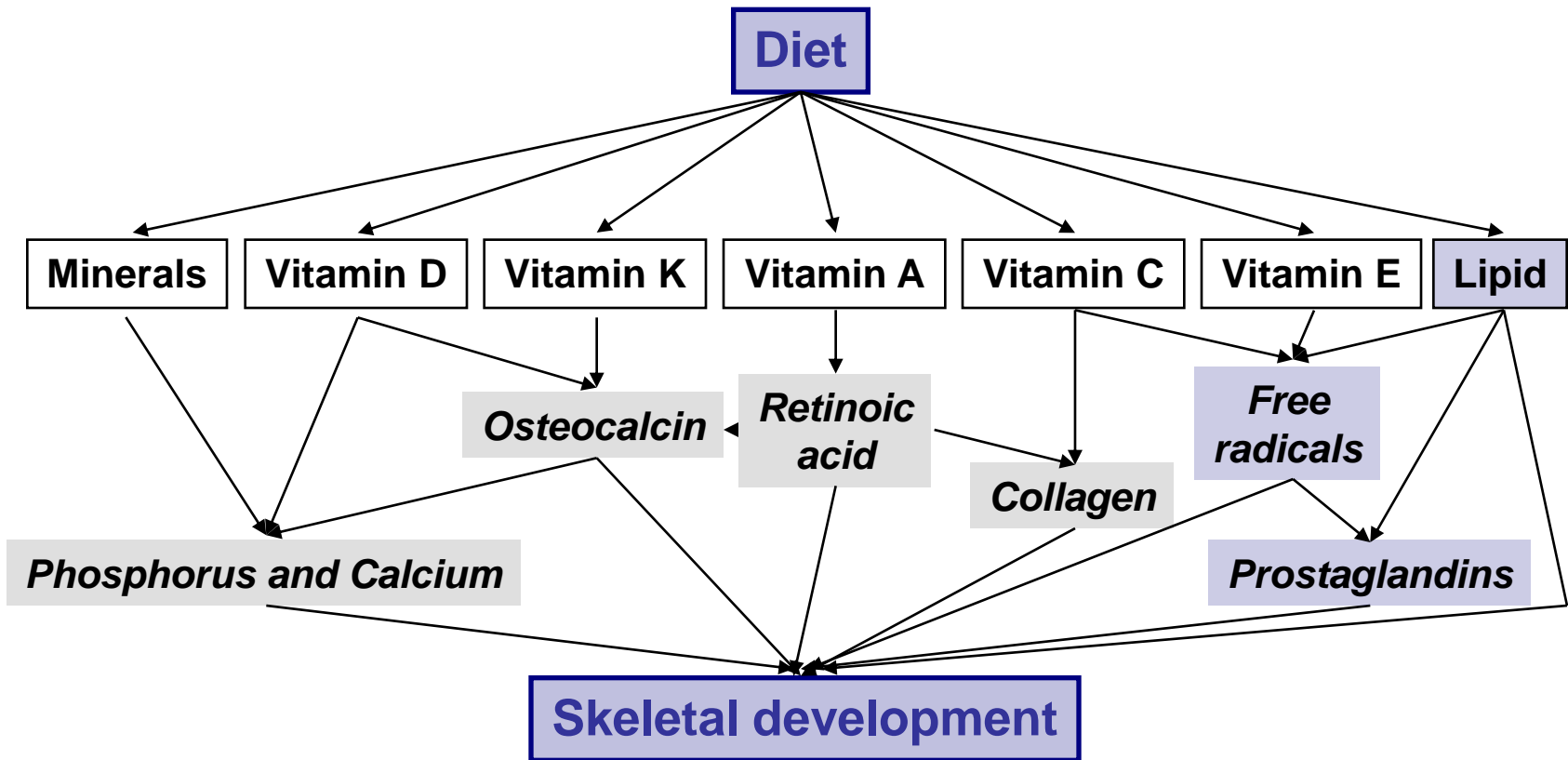
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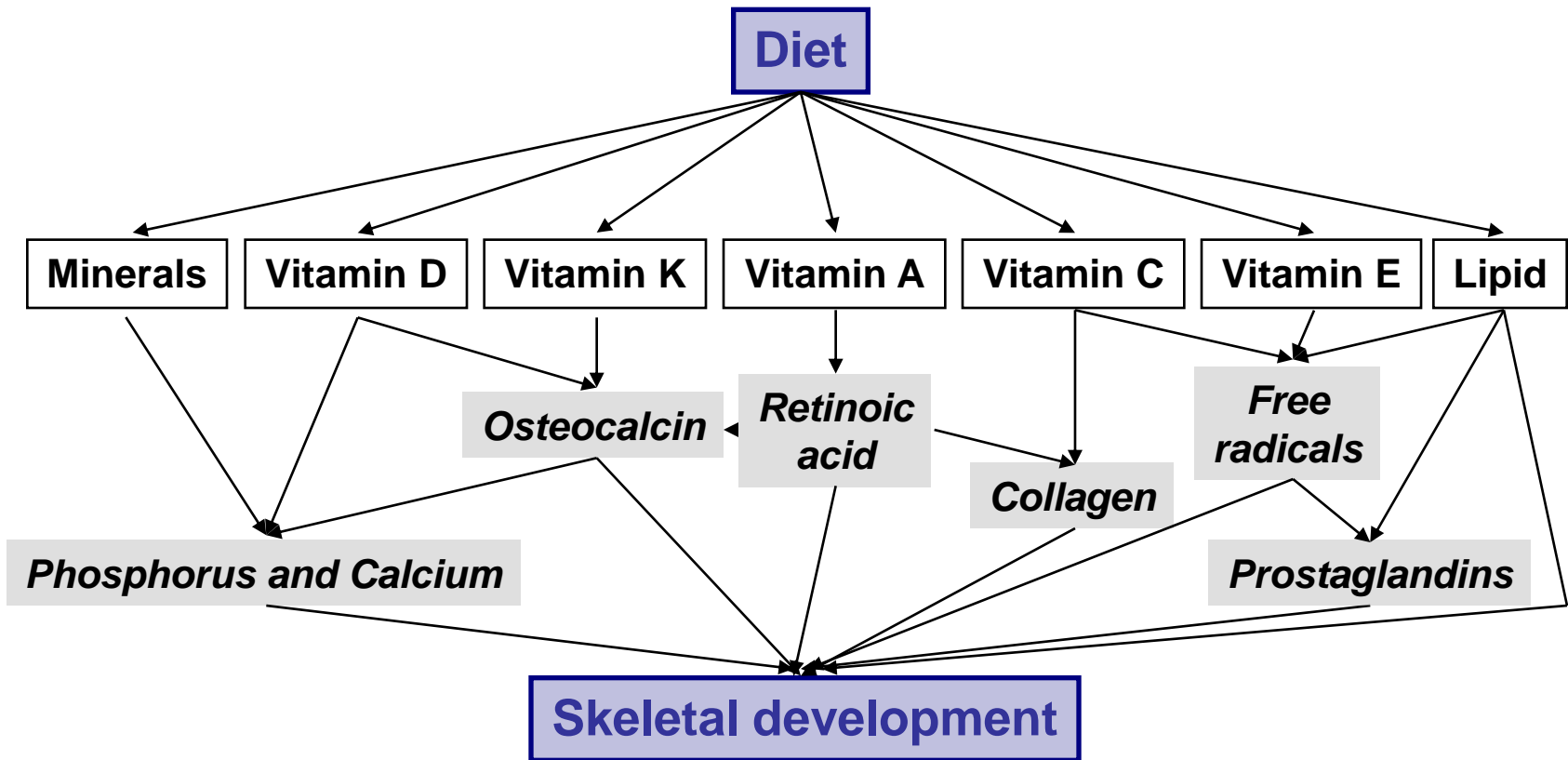
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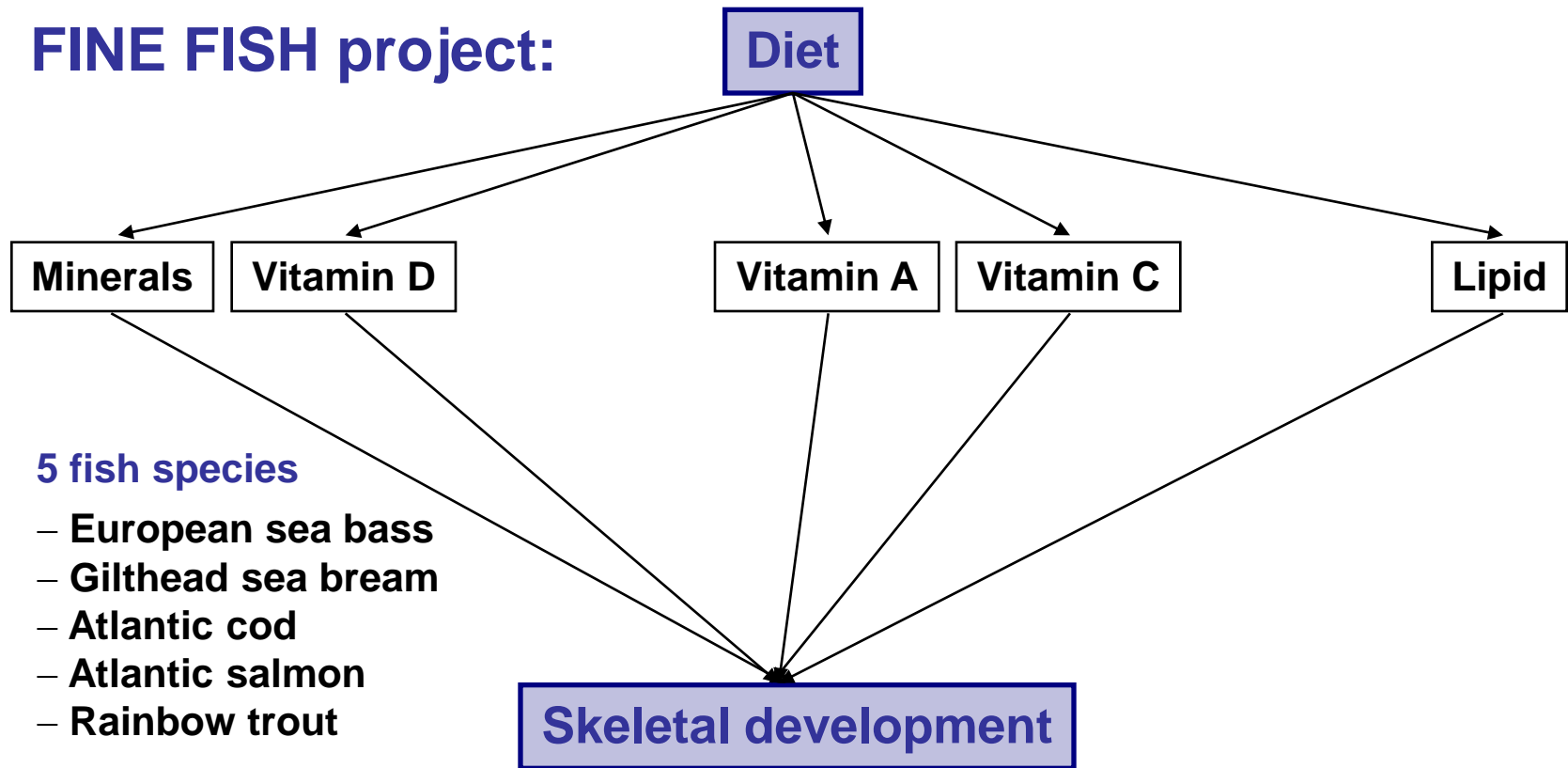


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**FINE FISH project:**

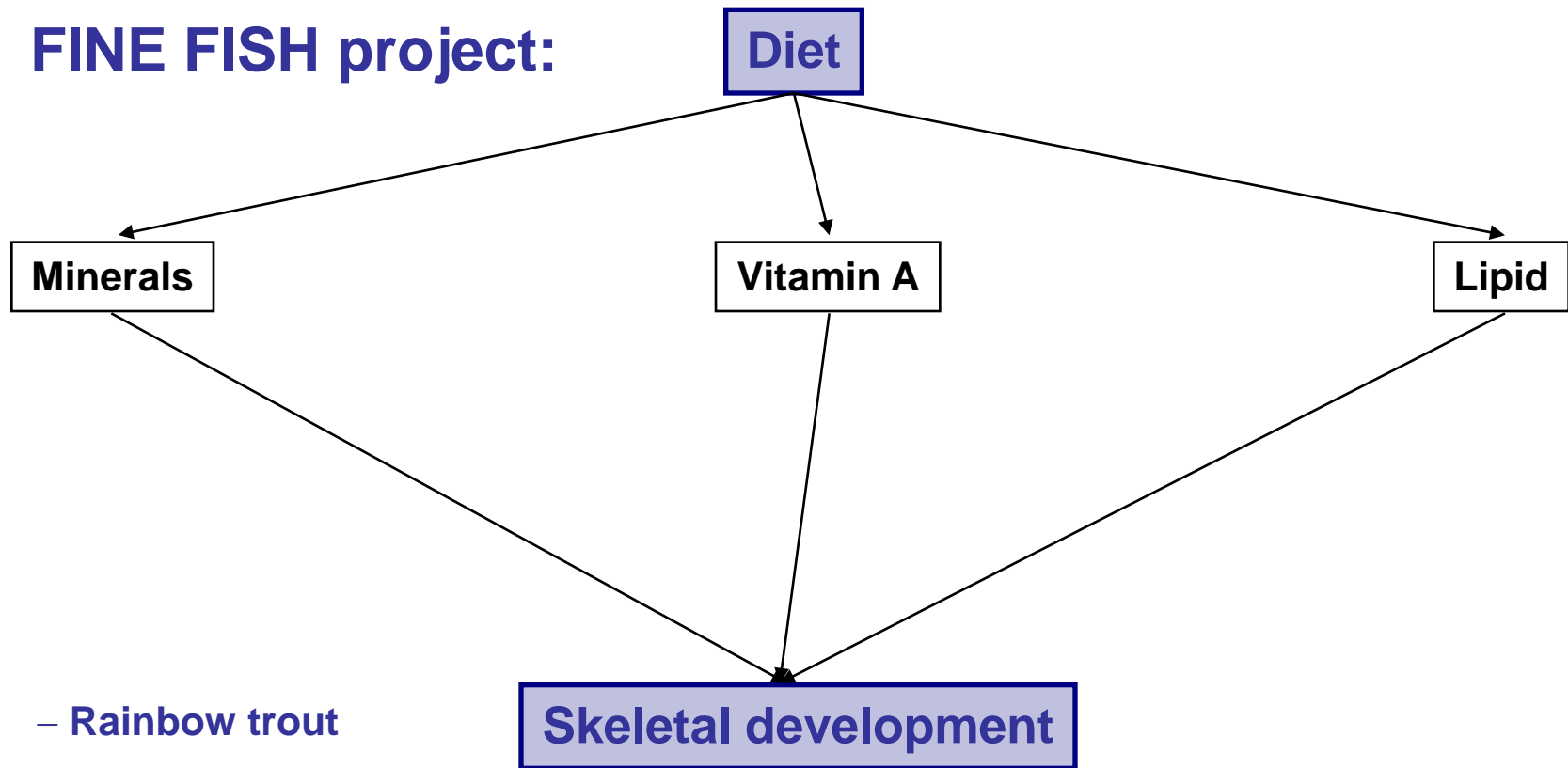


**5 fish species**

- European sea bass
- Gilthead sea bream
- Atlantic cod
- Atlantic salmon
- Rainbow trout

# Impact of some dietary components on skeletal development in fish

**FINE FISH project:**



# Impact of some dietary components on rainbow trout development

## FINE FISH project:

- **Minerals (phosphorus and calcium)**
  - Involved in the development/maintenance of skeletal system
  - In fish feeds, availability can vary (plant/marine ingredients)
    - ⇒ important to define their impact on the conformation of fish
- **Vitamin A**
  - Vitamin required for reproduction
    - but its metabolite, retinoic acid, is highly teratogenic
    - ⇒ important to define the right level in broodstock diets
- **Lipid**
  - Significant amounts in skeletal tissues including collagen which are particularly susceptible to lipid peroxidation
    - ⇒ important to define their impact on the conformation of fish

# Impact of dietary minerals on rainbow trout development

- FineFish project: identify critical components of dietary minerals in juvenile rainbow trout
- ➔ Assess the influence of dietary P and Ca levels on bone mineralization
- **FineFish experimental design**

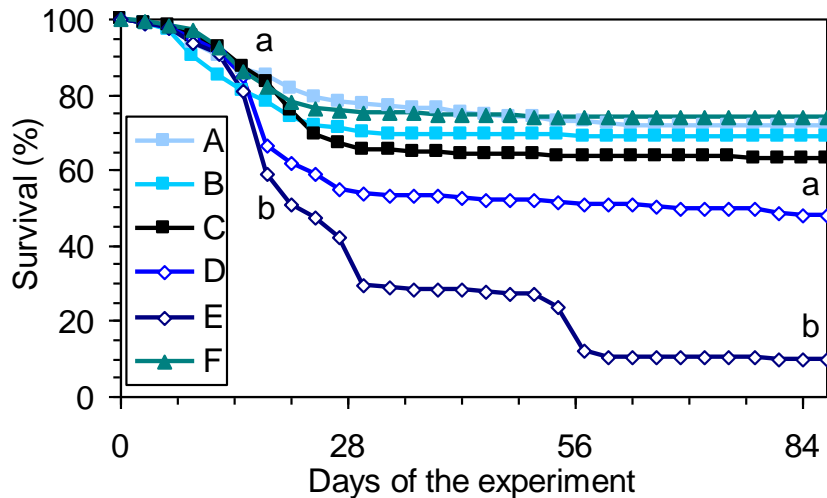
## 6 diets:

| Diet         | A | B   | C   | D   | E   | F   |
|--------------|---|-----|-----|-----|-----|-----|
| Available P  | - | 0.4 | 0.8 | 1.2 | 1.6 | 0.8 |
| Available Ca | 1 | 1   | 1   | 1   | 1   | -   |

From first-feeding onwards, 12-week growth trial at 17 °C

# Impact of dietary minerals on rainbow trout development

- Results: impact of dietary phosphorus level



**Lower survival of rainbow trout fry fed the high-P diet E**

# Impact of dietary minerals on rainbow trout development

- Results: impact of dietary phosphorus level



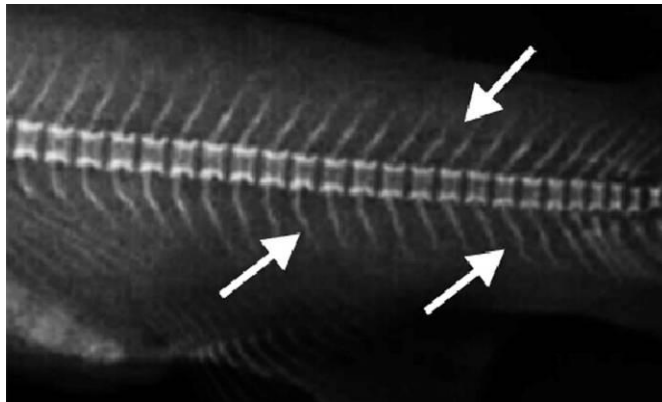
fish fed low-P diet A  
stained with Alcian  
blue for cartilage  
and Alizarin red for  
calcified bone

fish fed control diet C  
stained with Alcian  
blue for cartilage  
and Alizarin red for  
calcified bone

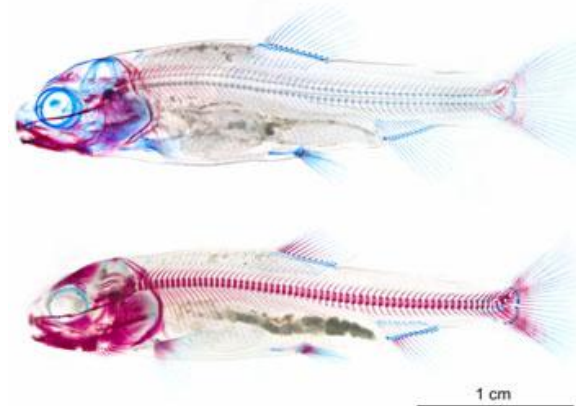
**Lower skeletal mineralization  
in fish fed low-P diet A**

# Impact of dietary minerals on rainbow trout development

- **Results: impact of dietary phosphorus level**



**Higher incidence of abnormalities with irregular placement of vertebrae and twisted arches in fish fed low-P diet A**



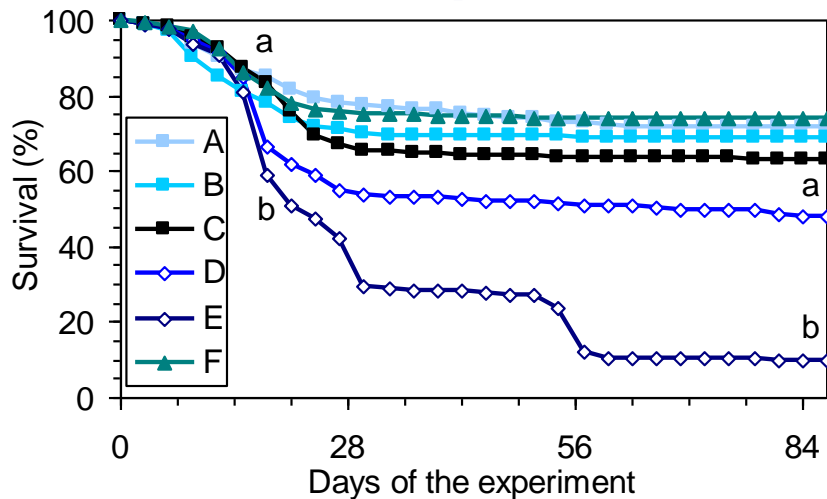
fish fed low-P diet A stained with Alcian blue for cartilage and Alizarin red for calcified bone

fish fed control diet C stained with Alcian blue for cartilage and Alizarin red for calcified bone

**Lower skeletal mineralization in fish fed low-P diet A**

# Impact of dietary minerals on rainbow trout development

- Results: impact of dietary phosphorus level



fry fed low-P diet A stained with Alcian blue for cartilage and Alizarin red for calcified bone



fry fed control diet C stained with Alcian blue for cartilage and Alizarin red for calcified bone

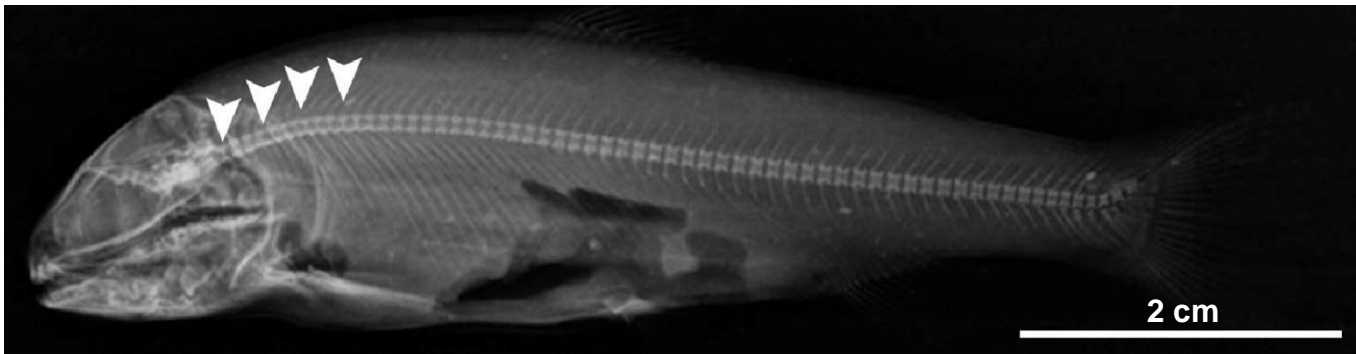
Lower survival of rainbow trout fry fed the high-P diet E

Lower skeletal mineralization in fry fed low-P diet A

➔ Both dietary deficiency and excess of P are detrimental to rainbow trout fry development

# Impact of dietary minerals on rainbow trout development

- **Results: impact of dietary calcium level**
  - No effect on growth performance and whole body composition
  - Effect on bone mineralization was less clear:  
Ca deficiency appears to exert some delay in ossification processes  
with an impact on the vertebral column morphology



Kyphosis in the cranial region with smaller vertebrae in fish fed low-Ca diet F

# Impact of dietary minerals on rainbow trout development

- **Conclusion**

**Importance of dietary mineral supply  
for adequate skeletal mineralization**

**Special attention should be paid to the level and availability  
of phosphorus in the formulation of diets  
for normal vertebral development  
during early ontogeny of rainbow trout  
(~1% available P)**

# Impact of dietary vitamin A on rainbow trout development

- **FineFish project: assess the influence of vitamin A level in broodstock diets on trout fry development**

- **FineFish experimental design**

3 different dietary supplementations of vitamin A as retinyl acetate

| Dietary supplementation →      | Dietary level         |
|--------------------------------|-----------------------|
| • 0 IU/g diet in <b>A1</b> →   | 20 IU/g in <b>A1</b>  |
| • 20 IU/g diet in <b>A2</b> →  | 40 IU/g in <b>A2</b>  |
| • 200 IU/g diet in <b>A3</b> → | 200 IU/g in <b>A3</b> |

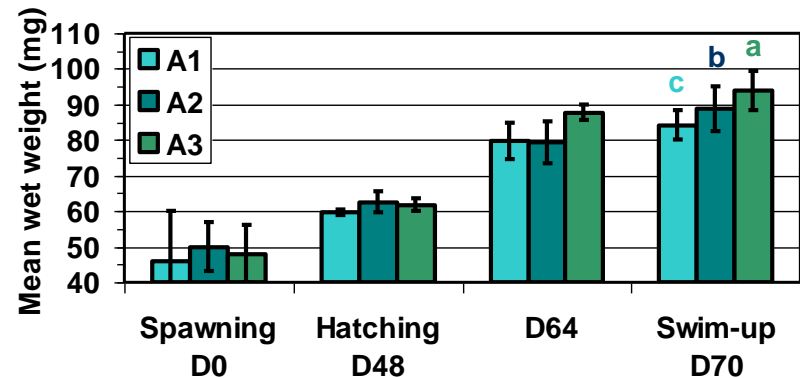
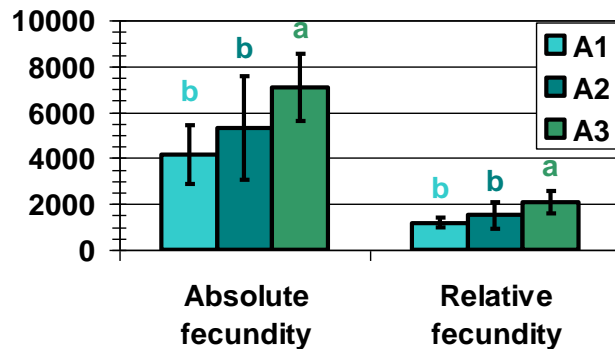
6-month trial (prior to spawning) at 7 1 C



Small trays for egg incubation

# Impact of dietary vitamin A on rainbow trout development

## • Results



⇒ **Best fecundity, early growth and potential of muscle development with the highest level of vitamin A**

⇒ **Very low level of external malformations (<0.5%) in all groups of rainbow trout fry (approximately 5g)**

⇒ **Low impact of broodstock diets on skeletal development of trout fry (small delay in ossification processes in A3 group)**

# Impact of dietary vitamin A on rainbow trout development

- **Conclusion**

**High dietary level of vitamin A is recommended for rainbow trout broodstock (~ 200 IU/g)**

**⇒ beneficial for reproduction and larval growth  
(no effect on skeletal development)**

**Level of retinoic acid, the active metabolite of vitamin A, appears to be well controlled in eggs of rainbow trout (no difference between dietary groups contrary to other retinoids)**

# Impact of dietary lipids on rainbow trout development

Previous studies have highlighted the influence of dietary lipids on the incidence and development of malformations

- **FineFish project: assess the impact of dietary lipids (phospholipid content and level of peroxidation) on rainbow trout fry development**
- **FineFish experimental design**

## 6 diets:

| Diet                  | Diet              | R1  | R2  | R3  | R4  | R5  | R6  |
|-----------------------|-------------------|-----|-----|-----|-----|-----|-----|
| Phospholipid source   | Soybean lecithin  | 6%  | 6%  | -   | -   | -   | -   |
|                       | Egg lecithin      | -   | -   | 6%  | 6%  | -   | -   |
|                       | Soybean oil       | -   | -   | -   | -   | 6%  | 6%  |
| Level of peroxidation | Fresh fish oil    | 12% | -   | 12% | -   | 12% | -   |
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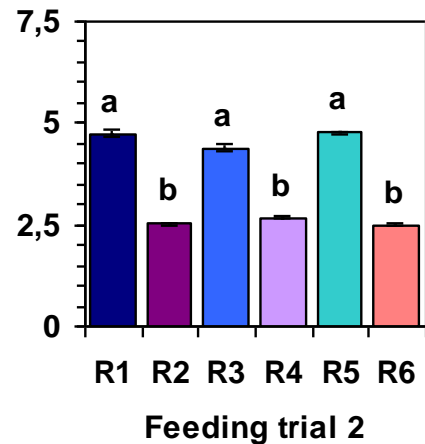
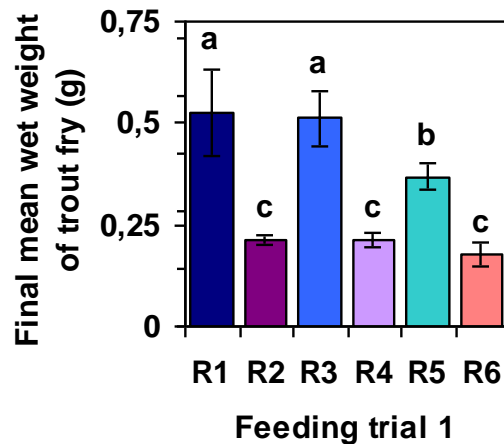
# Impact of dietary lipids on rainbow trout development

- **FineFish experimental design**

From first-feeding onwards or 8 weeks after this stage

Two 4-week feeding trials at 17 °C

- **Results**



⇒ Decreased growth with diets R2, R4 and R6 containing oxidised lipid

⇒ Improved early growth with dietary phospholipid supplementation (R1-R3 vs. R5)

# Impact of dietary lipids on rainbow trout development

- Results**



⇒ Very low level of external malformations



⇒ Skeletal development of fish was not affected by dietary oxidised lipid



⇒ Lower mineralization in trout fry fed diet R5 without phospholipids



**4-week trout fry  
fed diet R1  
with phospholipids**

**4-week trout fry  
fed diet R5  
without phospholipids**

# Impact of dietary lipids on rainbow trout development

- Conclusion

Special attention should be paid to the **control of lipid peroxidation in fish feeds** for normal growth of trout fry

 if feeds contain large amounts of polyunsaturated fatty acids  
⇒ correct supply of antioxidants

Importance of **dietary phospholipid supply** for **early growth**  
and **adequate skeletal mineralization**

phospholipid requirement for lipid absorption  
in early developmental stages  
(ratio dietary phospholipid/neutral lipid = 1/2)

# **Impact of some dietary components on rainbow trout development**

- **Conclusion**

- **nutritional components affect skeletal development**

**Compared to other fish species, in rainbow trout fry  
the impact of nutritional components on the development  
of external malformations is quite low**

- **“plasticity” of rainbow trout to different nutritional conditions**

- **at first-feeding, rainbow trout is well developed**