Designing a novel biosensor for the detection of infectious pancreatic necrosis virus

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Infectious Pancreatic Necrosis Virus

- Infectious Pancreatic Necrosis Virus (IPNV, *Birnaviridae Aquabirnavirus)* causes a life-long, highly contagious disease in Salmonid Fish[1,2]

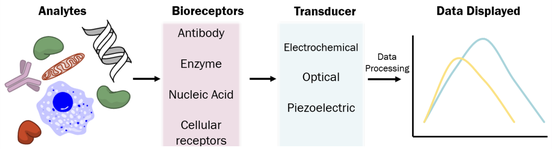
IPNV infection causes necrosis of pancreatic and other tissues

- Effects salmonoid fish at all ages but most devasting for young, 70% mortality rate[3]
- Large implications for the Salmonoid industry

- Virus unable to infect human cells in-vitro[3]
  - However, infected salmon consumption correlated with gastrointestinal infections[3]
- Careful detection needed to alleviate health and economic concerns as no treatment exists[4]

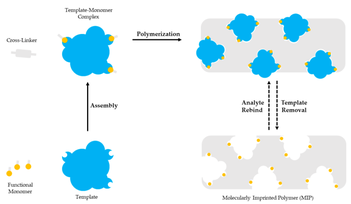
Biosensors

Used as diagnostic tools to detect analytes in a matrix
Composed of following:



Biosensors offer multiple advantages for IPNV detection[4]:

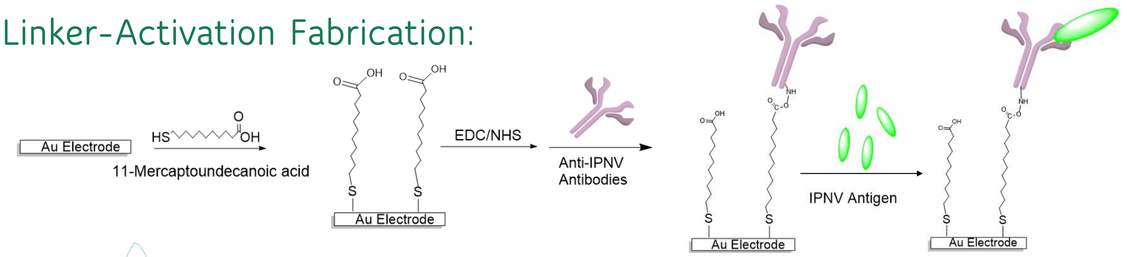
- Aquaculture farmers can screen for IPNV themselves
- Cost-effective
- Modification of surface to improve bioreceptor immobilization, detection, and sensitivity of detection
  - Molecular Imprinting polymer (MIP) modification, creates an artificial bioreceptor from a template[5]

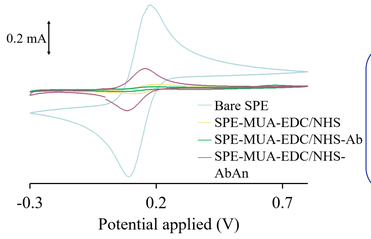


Advantages:
- Cost-effective
- No need for refrigeration
- Sensitive and selective technique
- Greater stability
- Reusability

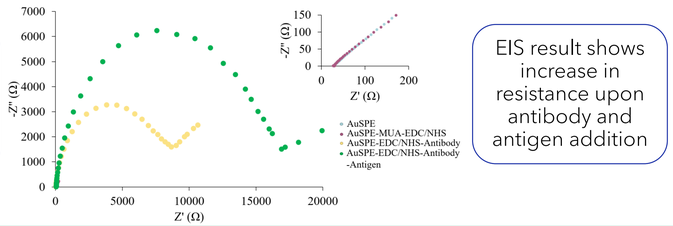
Methods & Results

Linker-Activation Fabrication:



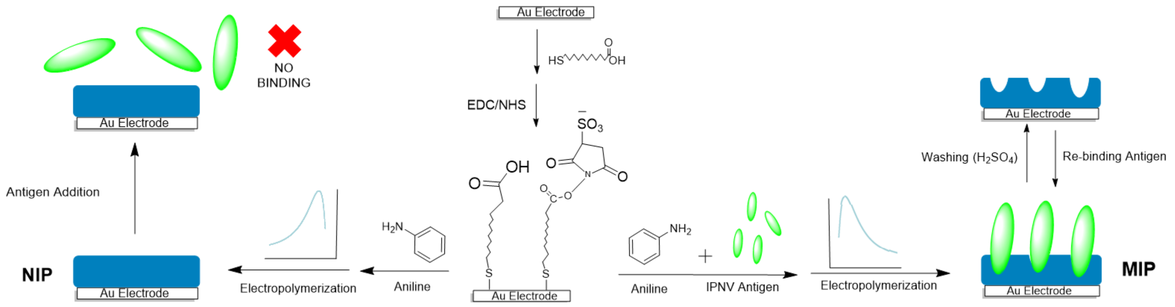


CV result indicating successful fabrication of the biosensor

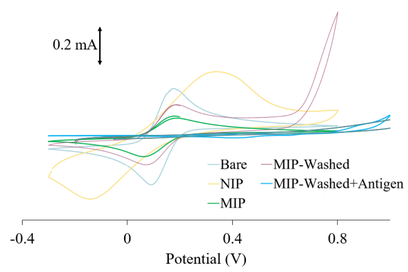


EIS result shows increase in resistance upon antibody and antigen addition

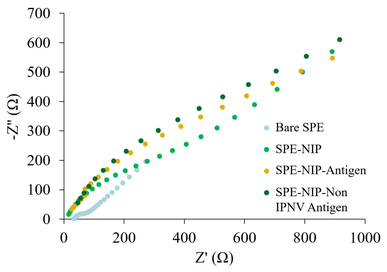
Molecular Imprinting Polymer Fabrication:



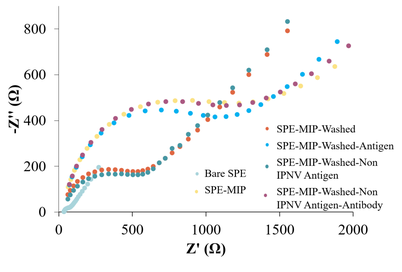
CV used to tract MIP formation, showed successful formation



Non-imprinting polymer (NIP) showed no sites for antigen binding as expected

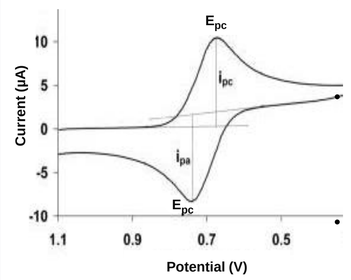


MIP showed specific sites where only Antigen bound, while non-antigen proteins did not



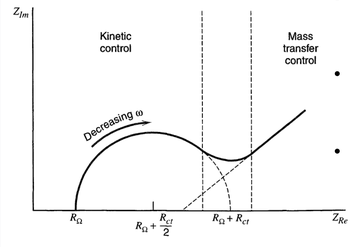
Decoding the Graphs

Cyclic Voltammetry (CV) plots:



- Redox probe, $Fe(CN)_{6,}$ potentials are tracked: E_{pc} is oxidation peak, E_{pa} is reduction peak
- Size of peak indicates the resistance, as greater resistance reduces redox reactions, reducing both peak currents
- Used to track changes in Resistance on sensor during fabrication and testing

EIS Nyquist plots:



- Two regions: Semicircle at high frequency and Straight line at low frequency
- Semicircle diameter = charge transfer resistance (Rct)
- Analyte binding to biosensors increases Rct, hence increasing semicircle diameter

Conclusion and Next Steps

IPNV Antigen was successfully detected using a variety of biosensor fabrications techniques

- MIP Fabrication showed promising results
  - Continue with fabrication to generate a calibration curve (determine detection limits)

Experiment successful on pure antigens, future experimentation on real samples (e.g. Salmon meat)

References:

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(3) Ørpetveit, I.; Küntziger, T.; Sindre, H.; Rimstad, E.; Dannevig, B. H. Infectious Pancreatic Necrosis Virus (IPNV) from Salmonid Fish Enters, but Does Not Replicate in, Mammalian Cells. Virol. J. 2012, 9 (1), 1–6. \
(4) Li, S.; Hu, Y.; Li, X.; Han, S.; Zhang, B.; Yan, Z.; Xue, R.; Gao, Q.; Wu, J.; Zhao, X.; Liu, J. Development of a Live Vector Vaccine against Infectious Pancreatic Necrosis Virus in Rainbow Trout. Aquaculture 2020, 524 (December 2019), 735275.
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