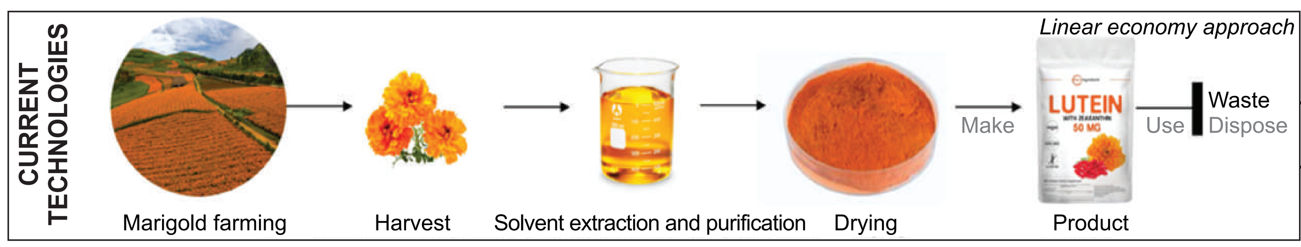
HIGH-THROUGHPUT AUTOMATED SCREENS FOR MAXIMISING PIGMENT PRODUCTION IN CYANOBACTERIA AND MICROALGAE

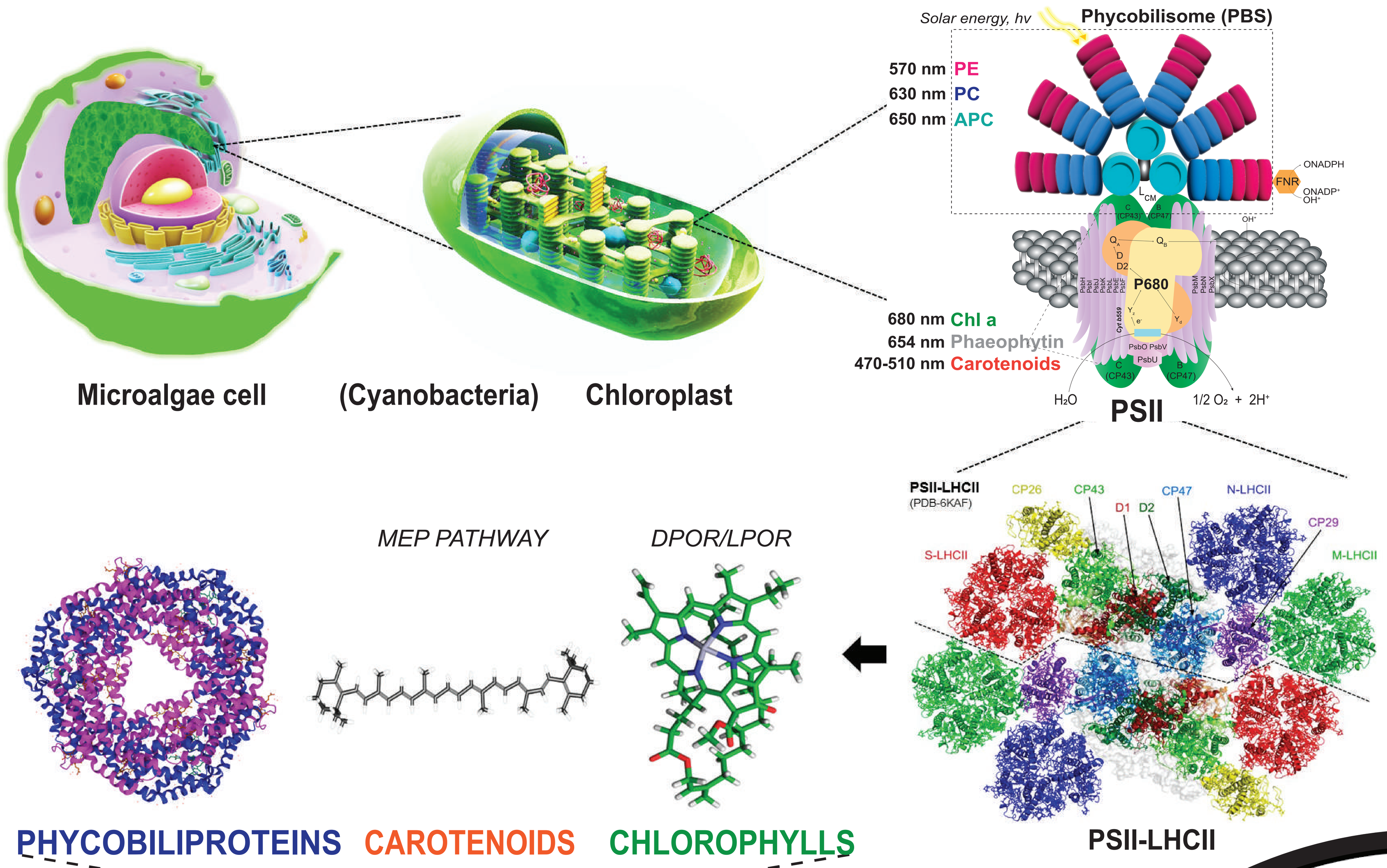
Charu Deepika*, Juliane Wolf, Ben Hankamer

Institute of Molecular Bioscience, The University of Queensland, QLD 4072, Brisbane, Australia

Background and Aims

- Natural pigments are environmetally friendly [1].
- Photosynthetic pigments are highly potent bioactives.
- Microalgae are robust production platforms for high-value bioproducts.
- High growth rates and increased biosafety.
- Microalgae biorefineries will contribute to meet 12 UN SDG's[2].





Major biological role

- Light Harvesting and Regulation
- Stabilise Photosystems
- Energy dissipation & Photoprotection

Strain-specific Pigment Extraction Optimisation

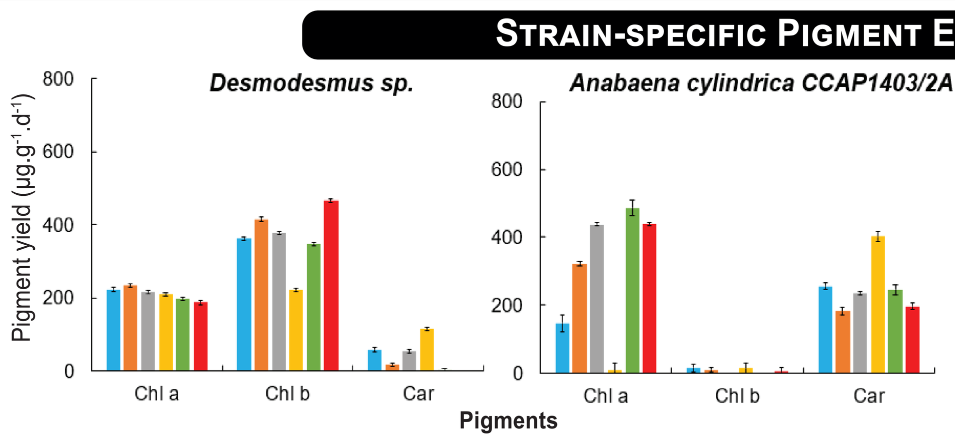


Fig 2: Solvent extraction comparison.
(Increasing polarity DEE < Acetone < DMSO < DMF < Ethanol < Methanol)

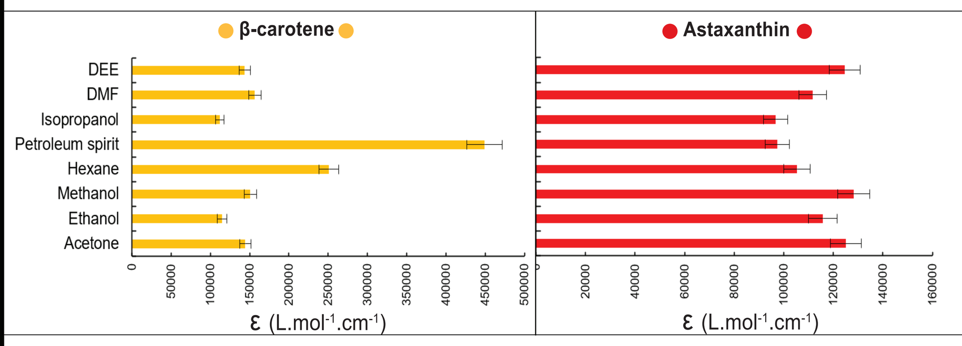
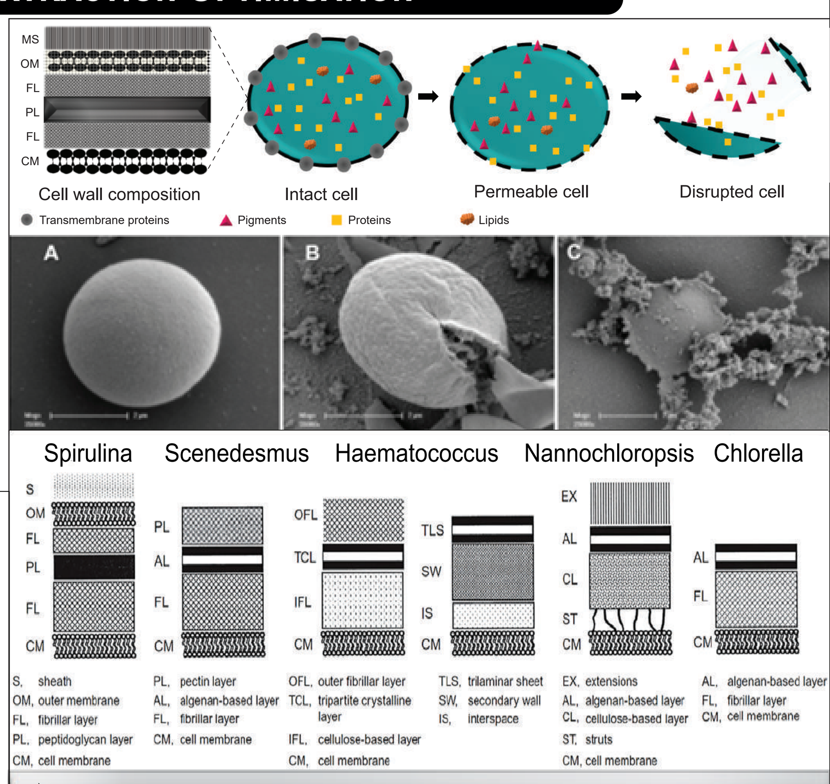


Fig 3: Variations in molar extinction coefficient calculated



- Individual strain analysis - Identified best disruption technique for the strain.
- Overall analysis - Identified best disruption technique for HT screen.

Challenges Addressed
- Variable product yields
- Bioprocess challenges
- Extraction and Quality Refinement
- Energy Efficiency

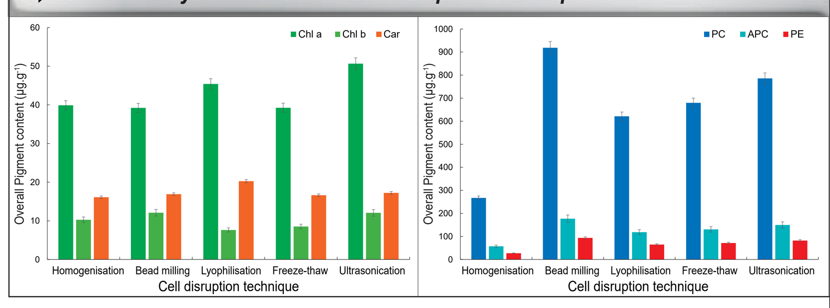


Fig 4: Comparison of cell disruption techniques

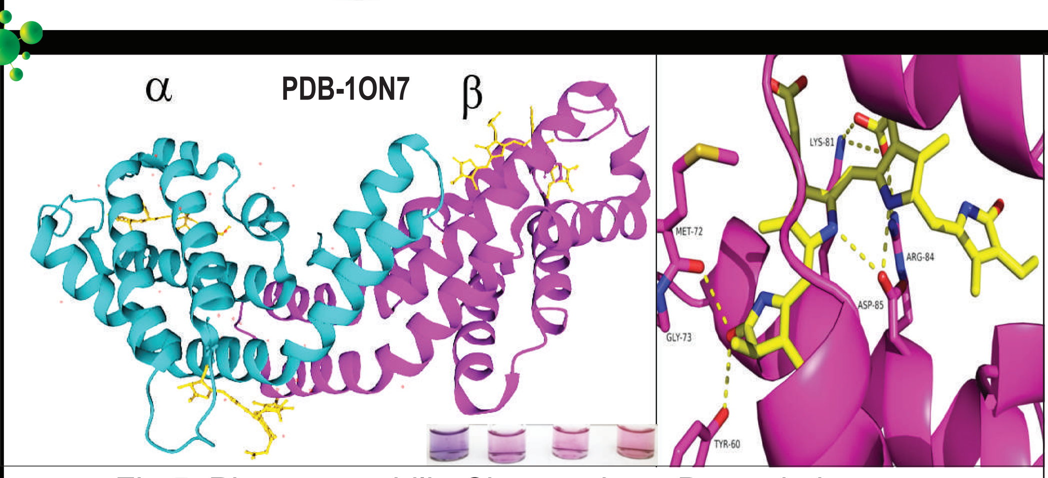
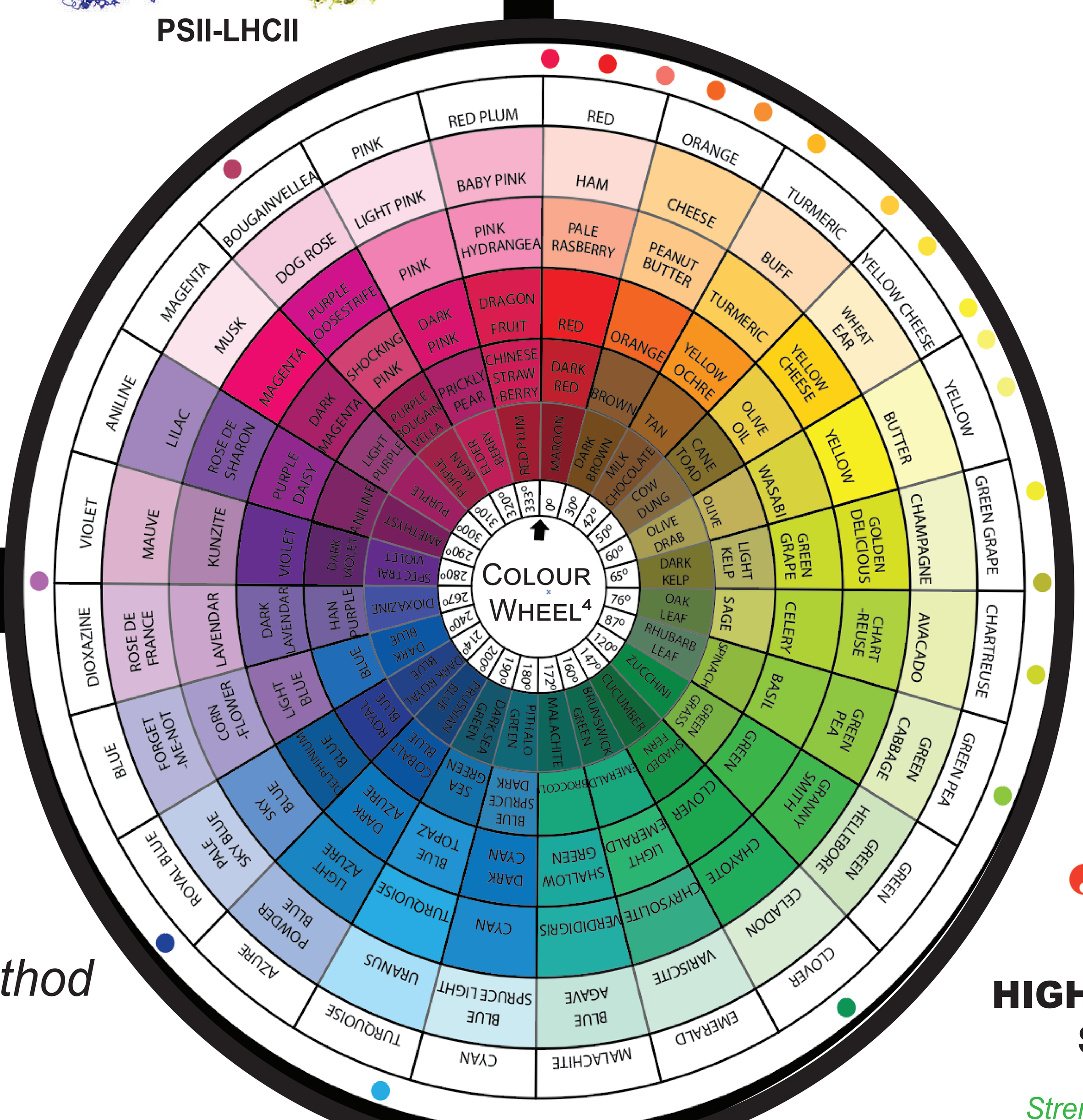


Fig 5: Phycocyanobilin Chromophore Degradation



Stabilty
Oxidation
Metal chelation

Spectra - Peak shift
Solvent refractive index
Bathochromic shift
Hypsochromic shift
Solute concentration

Peak broadening
Molecular interactions
Temperature sensitivity
Light sensitivity

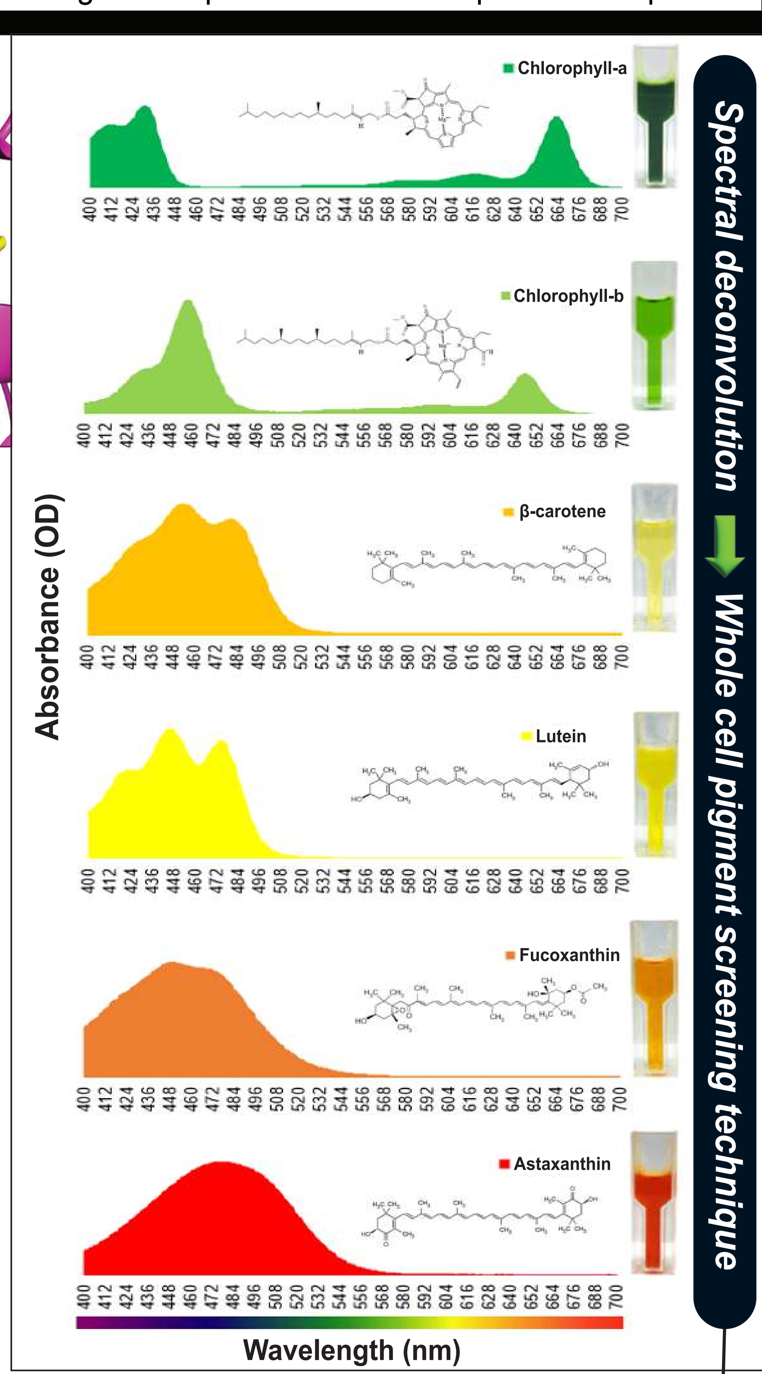
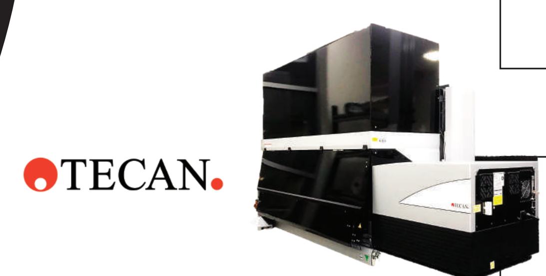


Fig 6: Absorbance spectrum of pigments

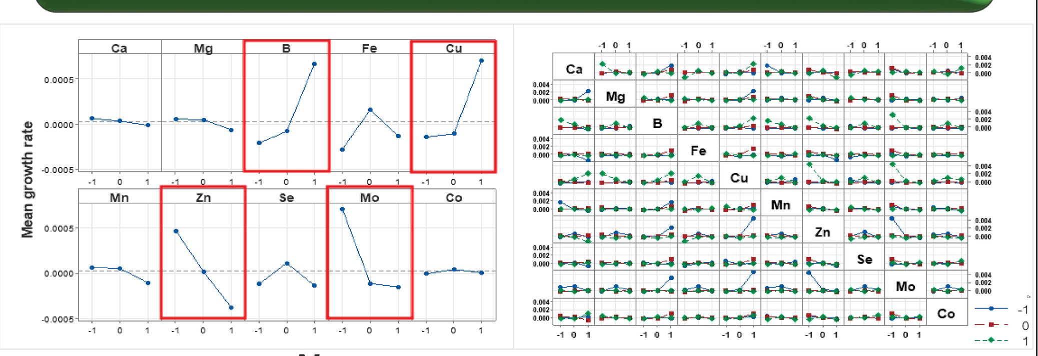


HIGH-THROUGHPUT SCREENING

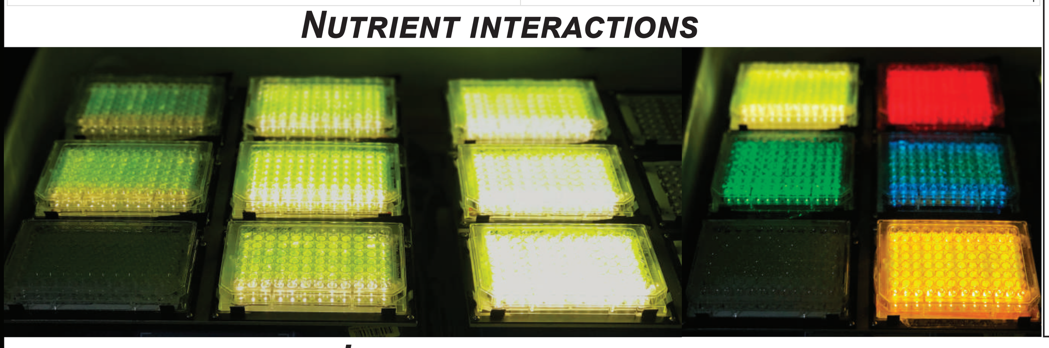
Strengths — Novelty

- Assay developed for cyanobacterial morphology - area scans.
- In vivo pigment quantification - validated with fluorescence data.
- Replicate data, QC measures in check, Statistical validation.

"7x higher growth rate and 3x phycocyanin yield"



NUTRIENT INTERACTIONS



LIGHT DEPENDENCY

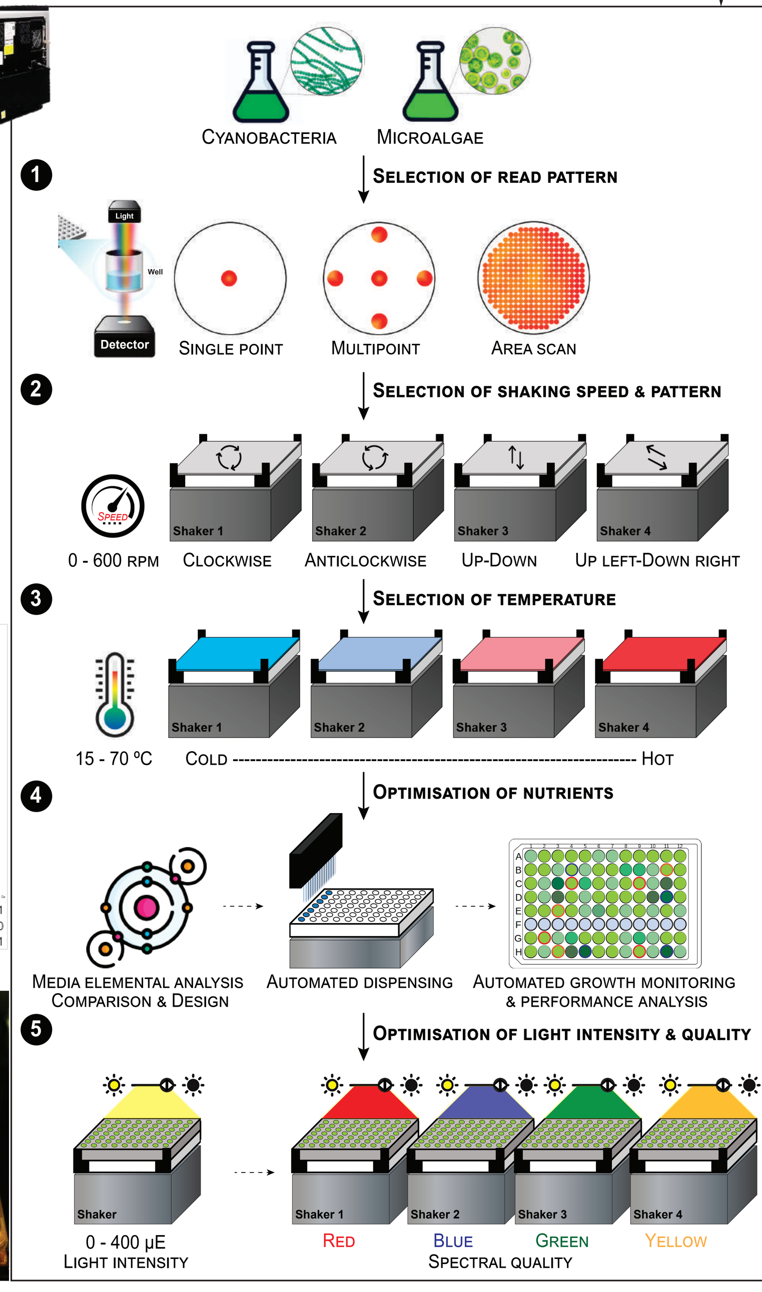
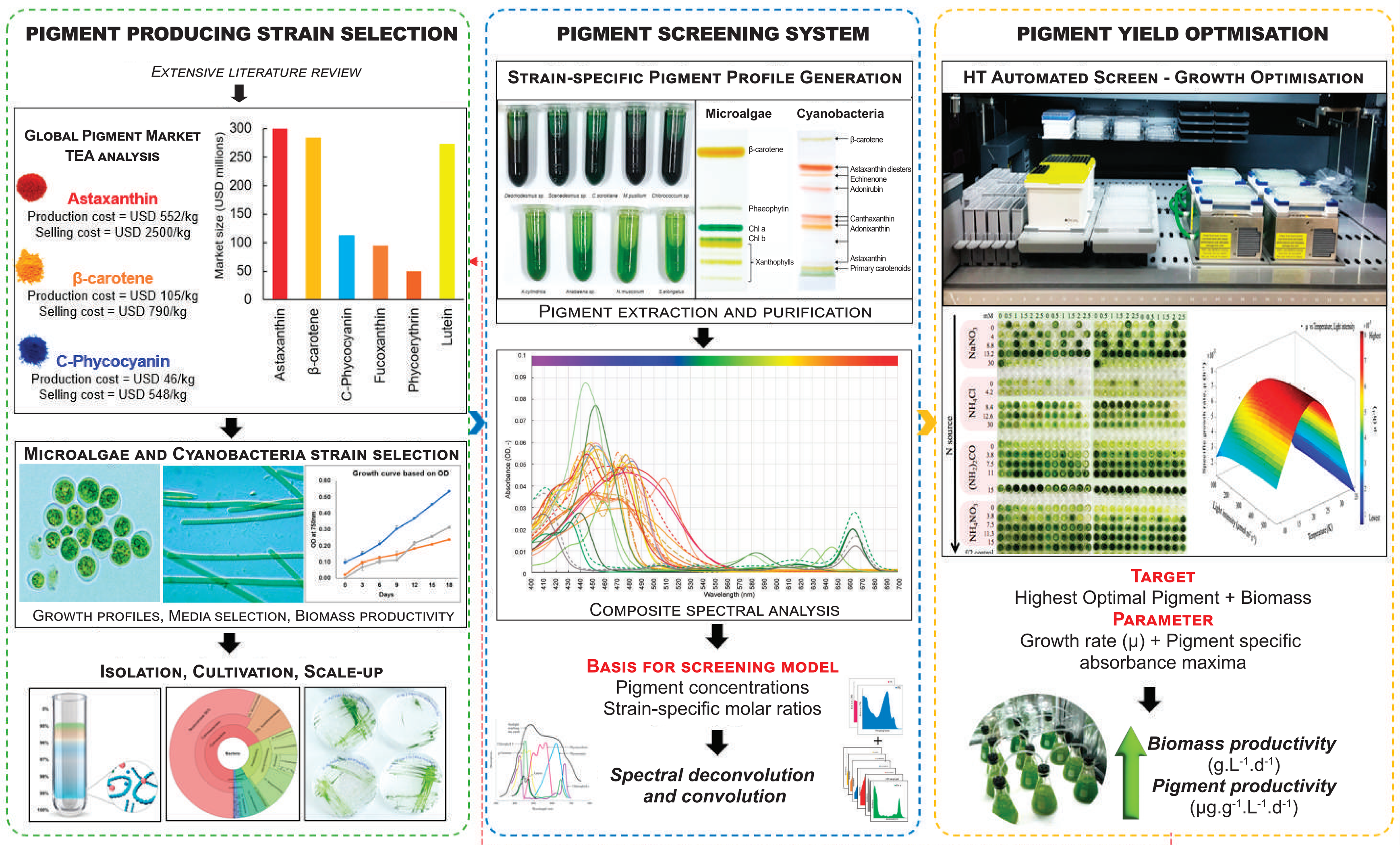


Fig 7: Stages of HT automated screens

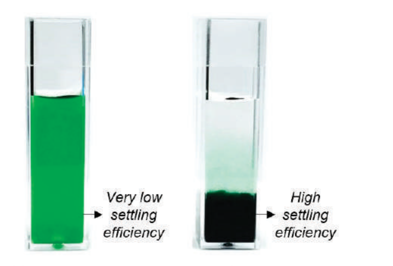
Methodology

- Cyanobacteria & Microalgae strain screening[3]
- Strain-specific pigment profile generation
- Development of in vivo pigment screening method
- Automated pigment optimisation screens
- Technoeconomic Analysis (TEA)



Results

- Novel
- Rapid
- Gentle
- Beneficial



Diazotrophic Cyanobacteria Isolation Technique

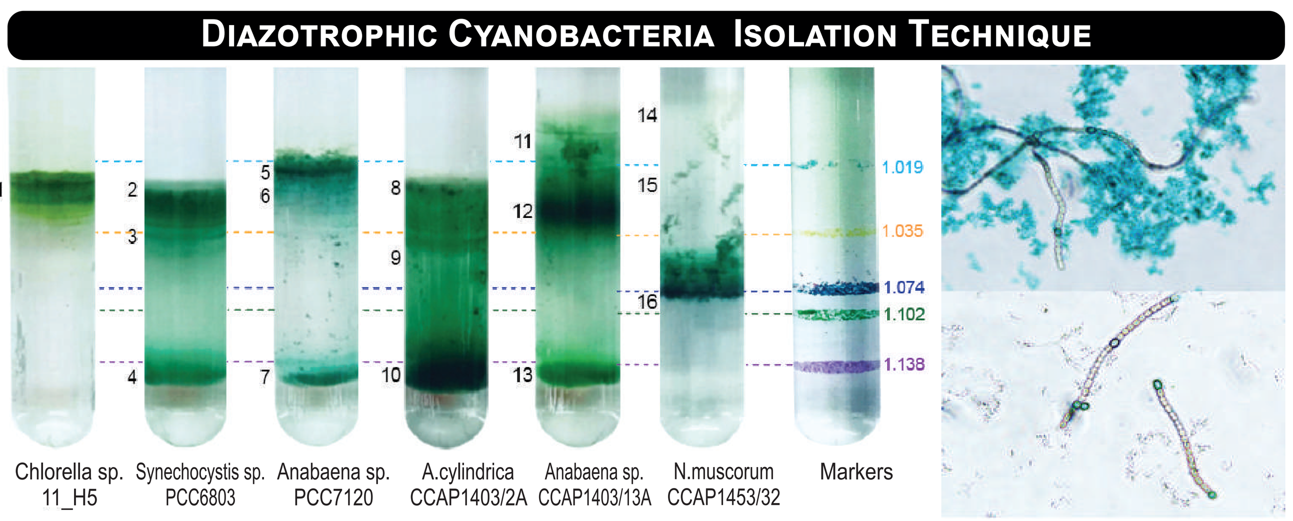


Fig 1: Cyanobacteria diazotrophic filament isolation - Percoll gradients & AB Staining

Conclusion

Development and process optimisation leads to efficient recovery of valuable pigments playing a significant role in medicinal and food industry.

Solar-driven photosynthetic microalgae and cyanobacteria offer significant new routes for the production of sustainable natural pigments for use in wide range of industries.

Future Perspectives

- Modelling sustainable algae coproduction platforms.
- Sequential extraction techniques for biorefinery.
- Pigment-specific encapsulation.

Acknowledgements - UQ and IMB Student Development Bursary.

References

1. Britton, G., The biochemistry of natural pigments. 1983: Cambridge University Press.
2. Kim, R.C., Can creating United Nations Sustainable Development Goals (UN SDGs) collaborate for a better world? Sustainability, 2018. 10(11): p. 4128.
3. Wolf, J., et al., High-throughput screen for high performance microalgae strain selection and integrated media design. Algal Research, 2015. 11: p. 313-325.
4. Martian Colour Wheel. Warren Mars (http://warrenmars.com/visual_art/theory/colour_wheel/colour_wheel.htm).

CENTRE FOR SOLAR BIOTECHNOLOGY — The University of Queensland, Australia — IMB