# Marine Biomaterials for Tissue Engineering: Developing Scaffolds for Regenerative Medicine


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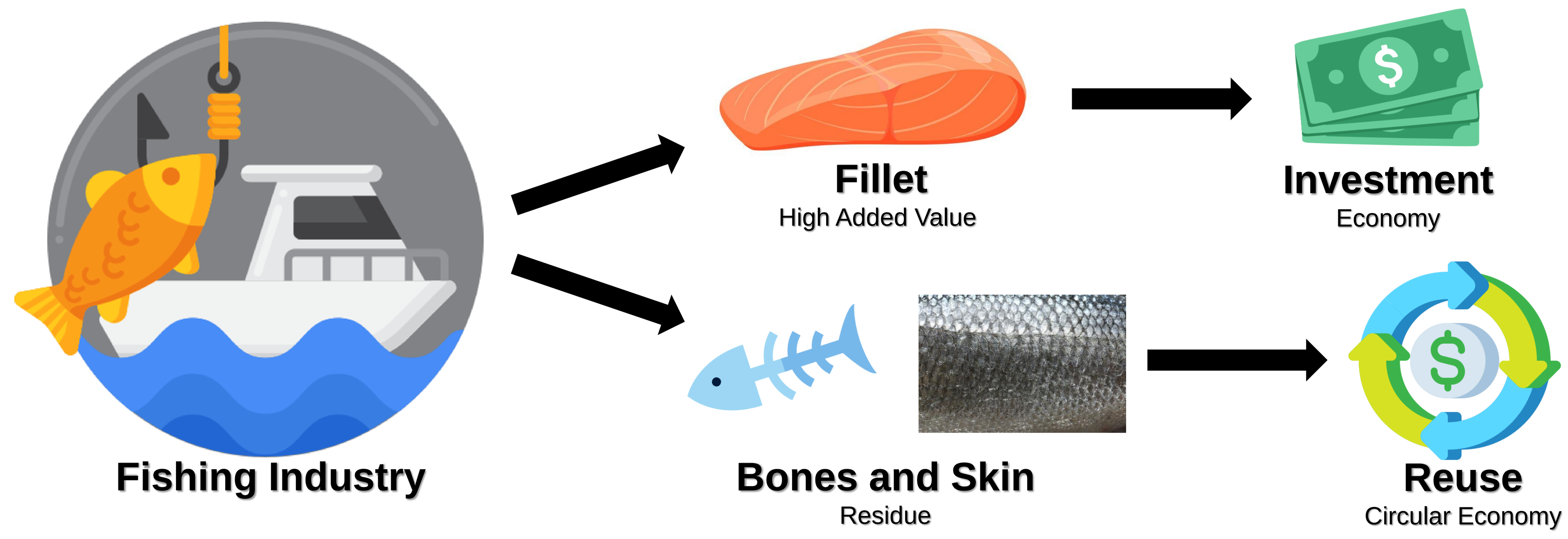
## INTRODUCTION

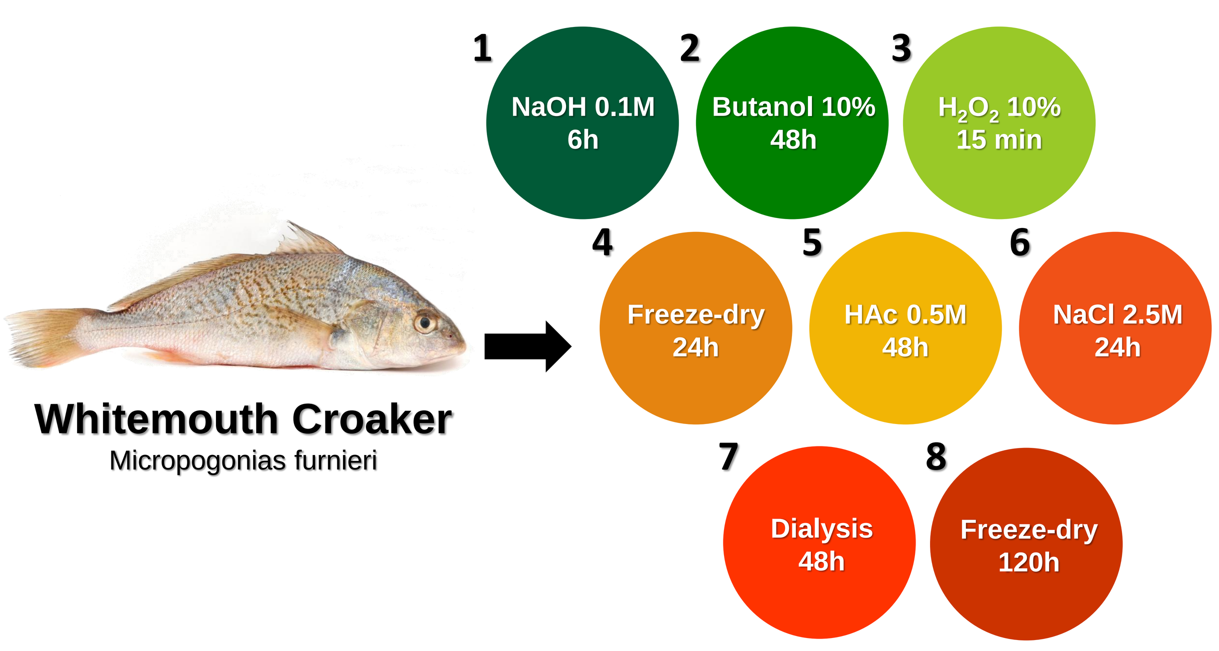



The global fishing industry generates substantial amounts of waste each year, including fish skins, shells, and other inedible by-products. Traditionally discarded or used for low-value applications, these residues are now recognized as valuable sources of biomolecules and structural components that can be transformed into high-value biomaterials. Instead of allowing these materials to accumulate as environmental burdens, innovative research is finding ways to upcycle them into advanced technologies. This shift not only addresses sustainability concerns but also supports a more circular economy, where waste is continually reintegrated as a resource, reducing the need for virgin materials and minimizing environmental impact.

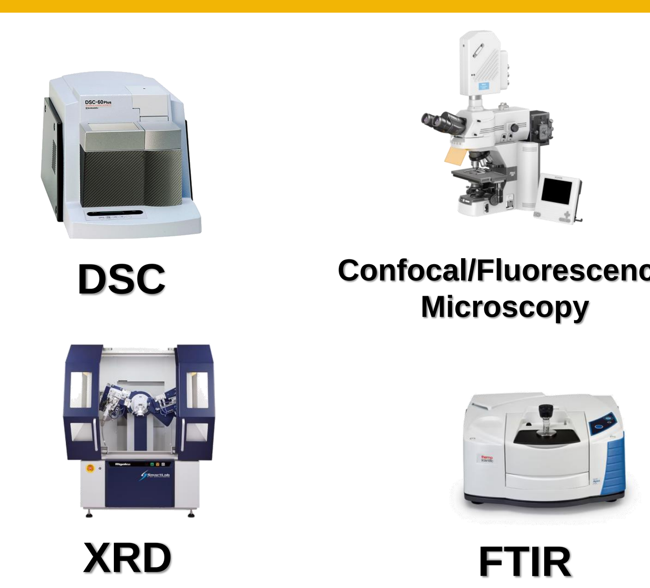
In particular, the extraction of collagen from fish skin and chitosan from marine invertebrate shells exemplifies the potential of leveraging marine-derived biomolecules for biomedical and industrial applications. By relying on abundant, renewable feedstocks rather than petroleum-based polymers, these processes embody the principles of green chemistry—minimizing hazardous substances, energy consumption, and waste. The resulting biomaterials can be tailored for applications in tissue engineering and regenerative medicine, among other fields, providing economically viable solutions that bridge environmental responsibility with technological innovation. Together, these efforts highlight a promising path toward sustainable materials science, catalyzing a future where industries not only reduce waste but also enhance product value and ecological integrity.

## METHODS

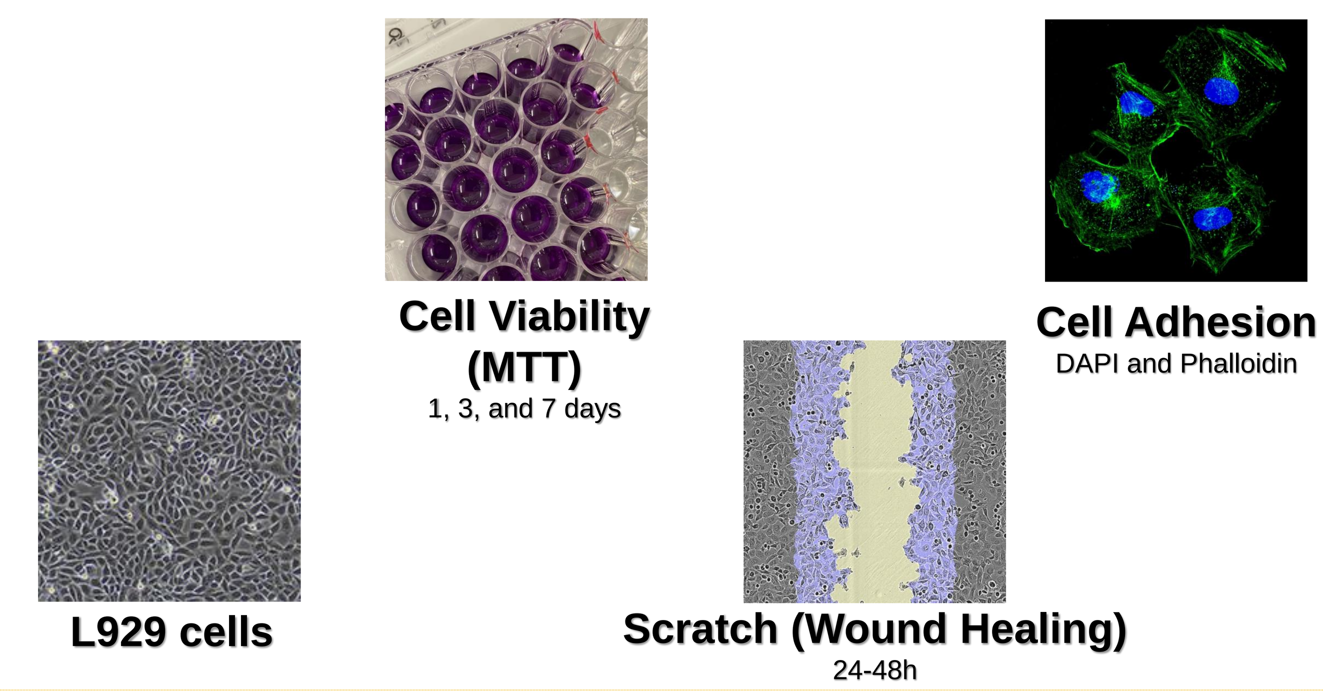
### Extraction




### Characterizations




### In vitro assays




## RESULTS

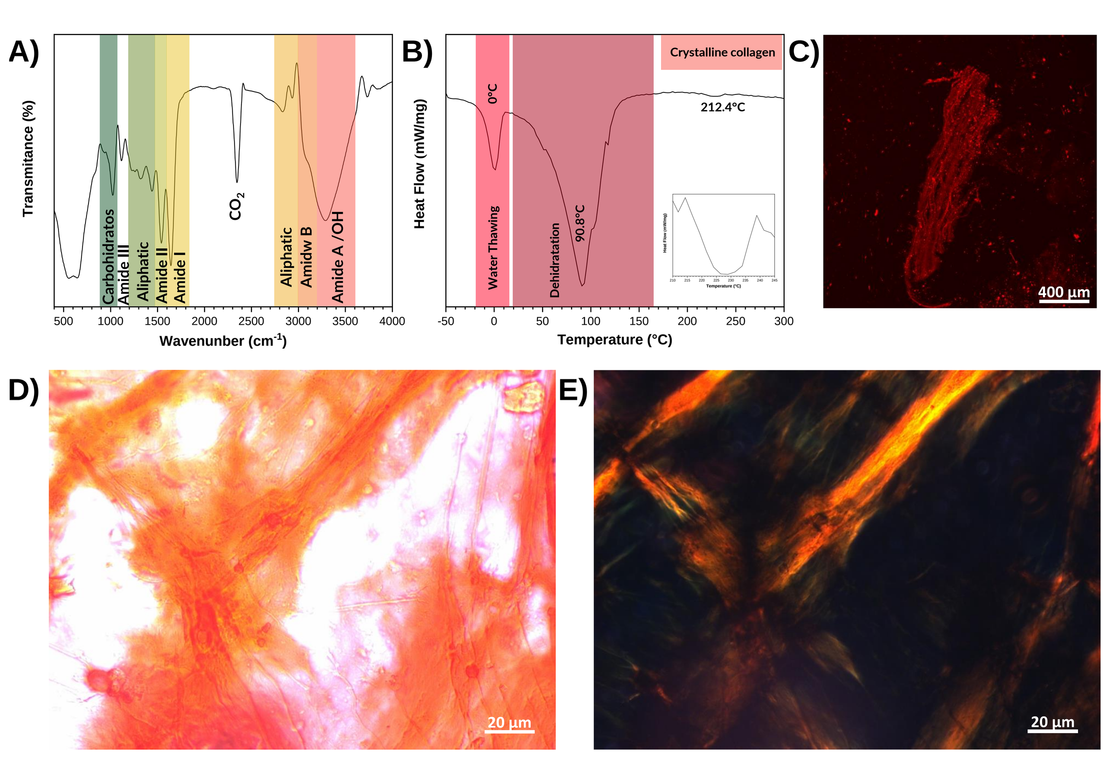



**Figure 1.** Collagen characterization. **A)** FTIR spectra, **B)** DSC curve, and C) confocal microscopy. Picrosirius fluorescence under **D)** polarized light microscopy and **E)** fluorescence microscopy.

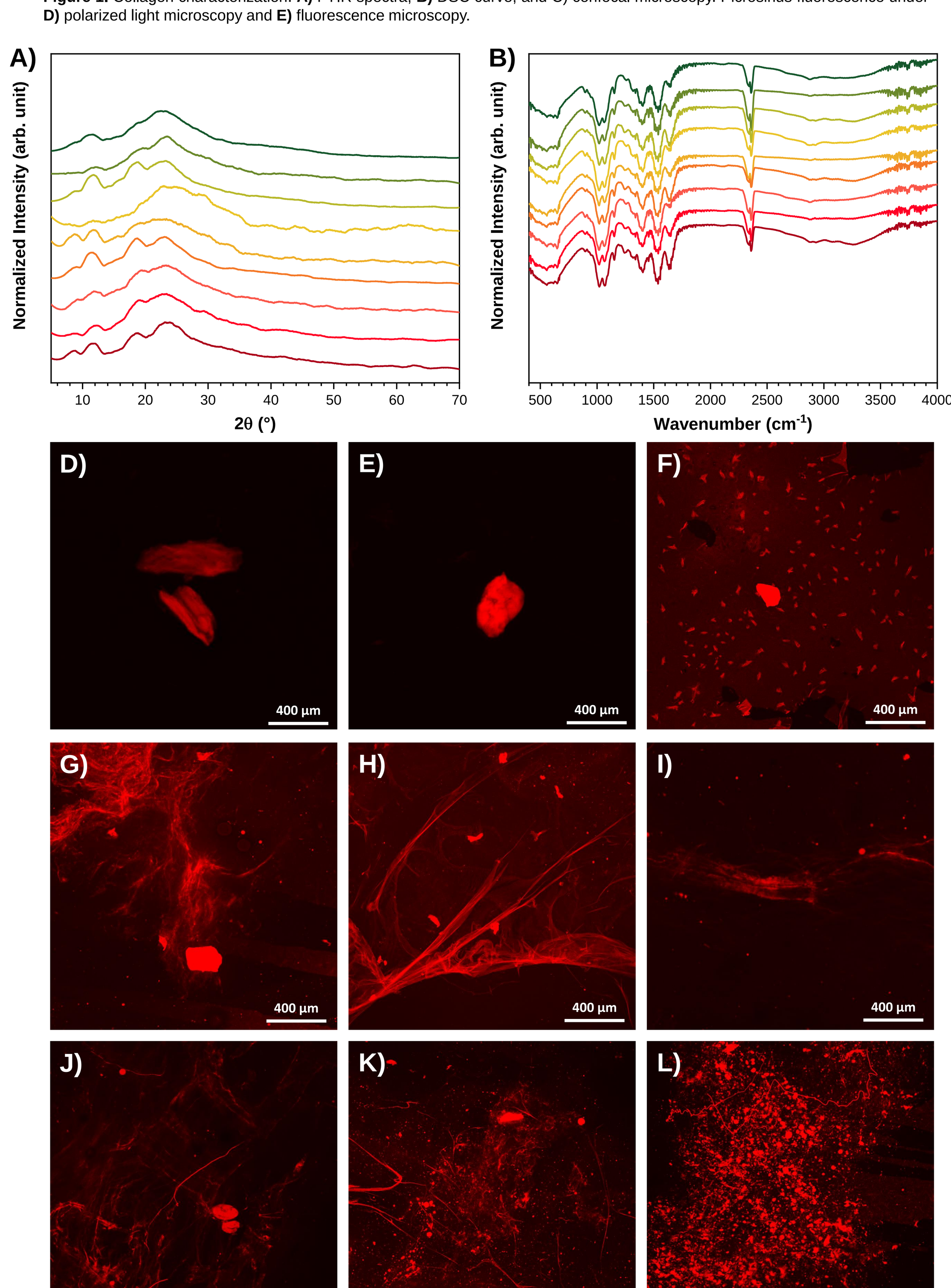



**Figure 2.** Characterization of chitosan/collagen blends. **A)** XRD and **B)** FTIR spectra. Confocal microscopy of the samples **C)** CH, **D)** CM, **E)** CL, **F)** 7CH-3FC, **G)** 7CM-3FC, **H)** 7CL-3FC, **I)** 5CH-5FC, **J)** 5CM-5FC, and **K)** 5CL-5FC.

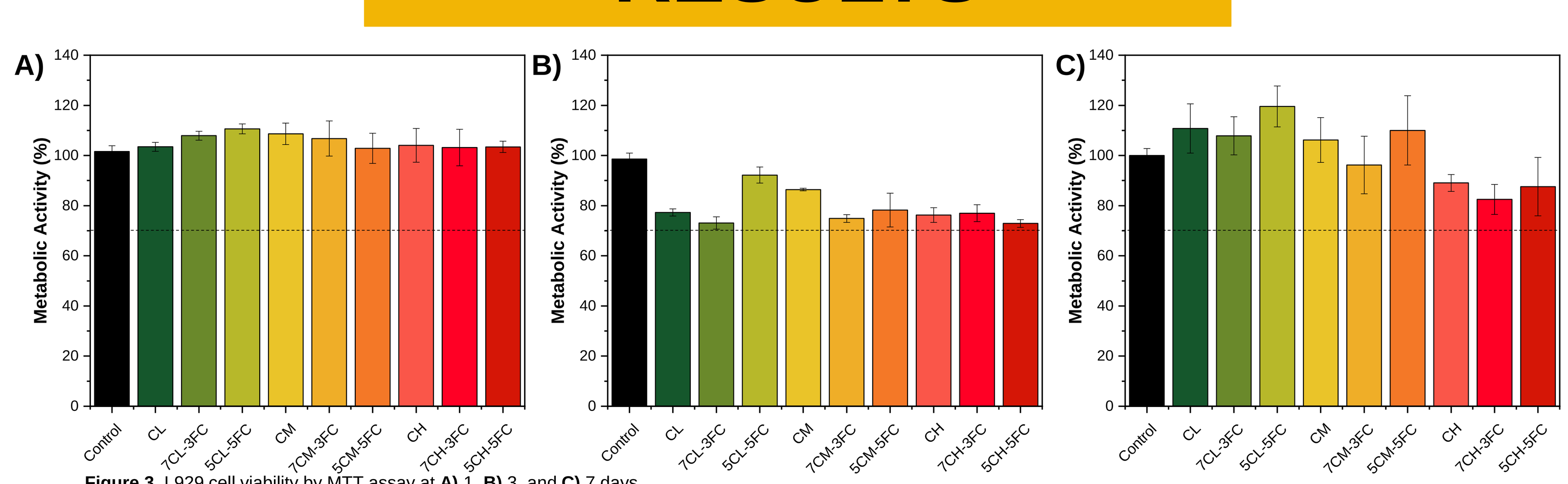



**Figure 3.** L929 cell viability by MTT assay at **A)** 1, **B)** 3, and **C)** 7 days.

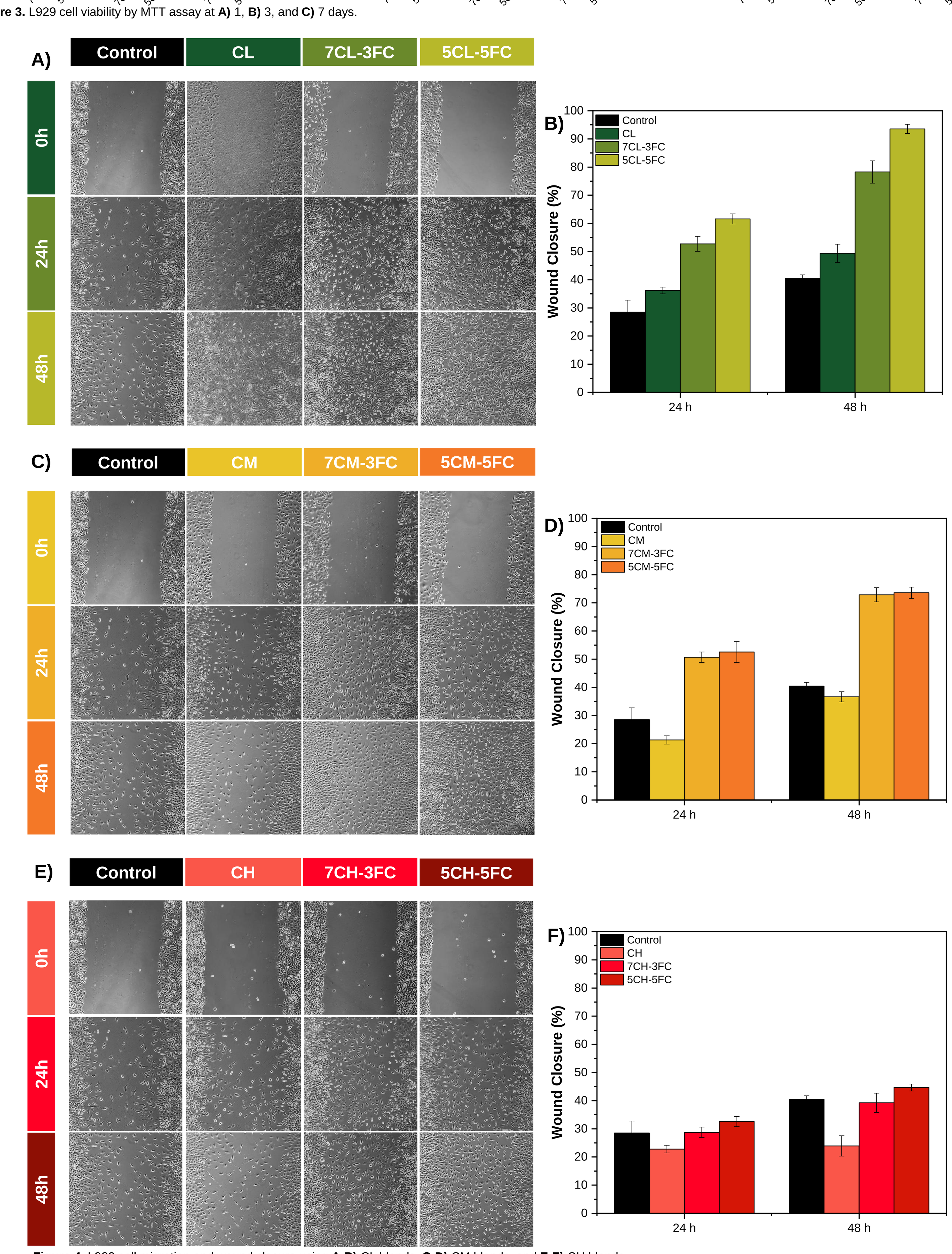



**Figure 4.** L929 cell migration and wound closure using **A-B)** CL blends, **C-D)** CM blends, and **E-F)** CH blends.

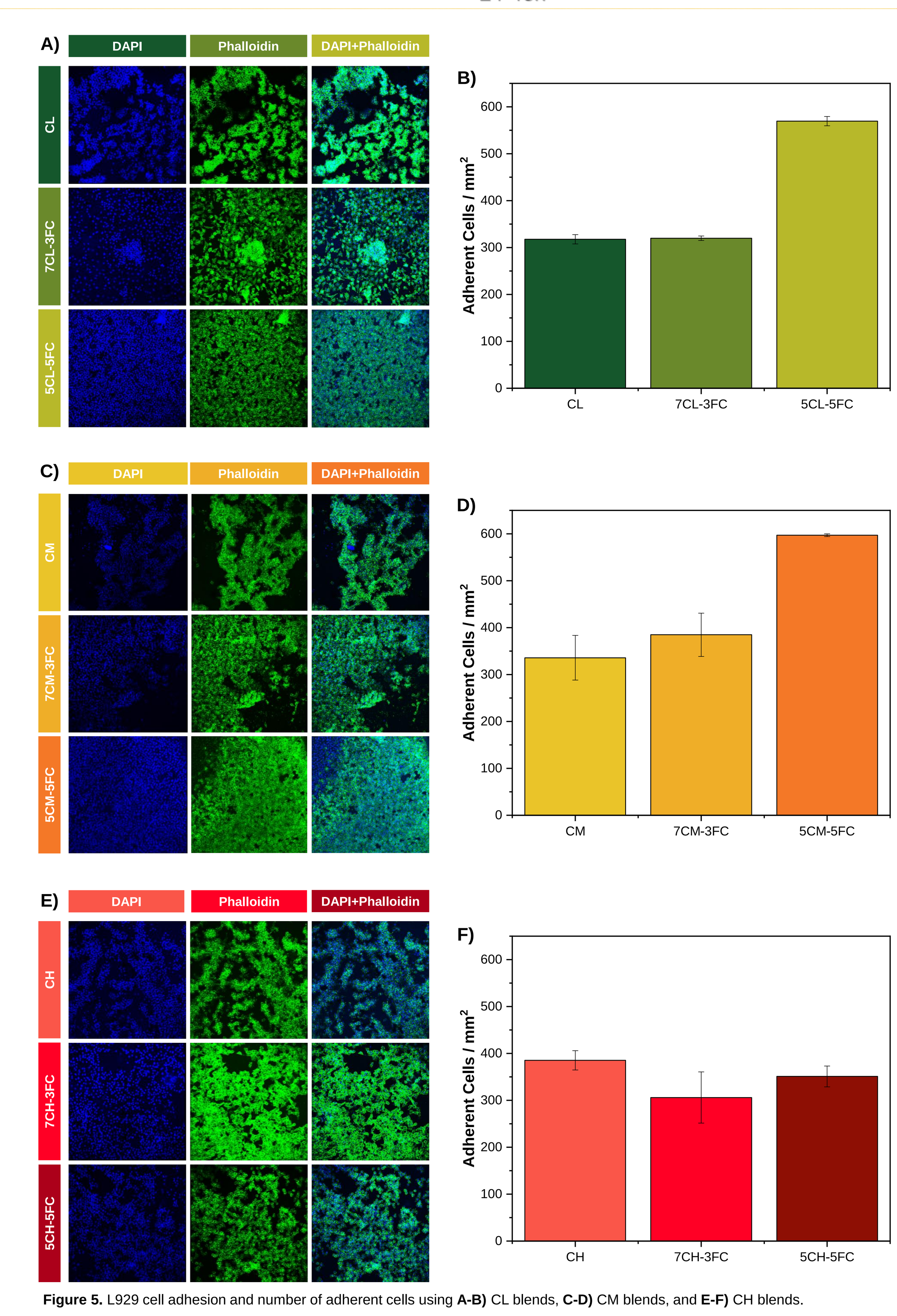



**Figure 5.** L929 cell adhesion and number of adherent cells using **A-B)** CL blends, **C-D)** CM blends, and **E-F)** CH blends.

## CONCLUSIONS

These findings demonstrate the successful extraction of collagen from Corvina fish skin and the production of collagen-chitosan blends using chitosans of varying molecular sizes. While XRD and FTIR analyses revealed no significant structural differences, confocal microscopy showed that the molecular size of chitosan influences its distribution within the collagen fibers. Biological assays with L929 cells confirmed the absence of cytotoxic effects throughout the testing periods (metabolic activity >70%), and the smaller molecular weight chitosan, due to its higher solubility, notably improved both cell migration and adhesion compared to medium and high molecular weight variants. Overall, these promising results underscore the potential of these marine-derived collagen-chitosan blends in advancing sustainable and effective approaches for tissue engineering applications.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