Tech : Journal of Engineering Science
Vol. 1, No. 2, 2025.
e-ISSN: 3109-7790 (online)
https://jurnal.sinesia.id/index.php/tech/index

Conceptual Computational Modeling of Genetic and Neurochemical Traits of Social Outcasts in the Series Wednesday

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Info Article
| **Submitted**: 3 November 2025 | **Revised**: 14 December 2025 | **Accepted**: 24 December 2025
| **Published**: 24 December 2025
How to Cite : Dede Ramadhan, etc., "Conceptual Computational Modeling of Genetic and Neurochemical Traits of Social Outcasts in the Series Wednesday", *Tech : Journal of Engineering Scince*, Vol. 1, No. 2, 2025, P. 192-206.

ABSTRACT

This study explores the representation of genetic and neurochemical traits associated with social outcast groups as depicted in the television series Wednesday, using a conceptual computational modeling framework. Rather than pursuing empirical biological validation, the research adopts speculative and educational modeling approaches inspired by systems biology, neurochemistry, and computational neuroscience to interpret narrative patterns related to marginalization, emotional regulation, and behavioral divergence. Conceptual models are constructed by mapping fictional character traits to simplified genetic markers, neurotransmitter interactions, and network-based behavioral dynamics. The study aims to demonstrate how computational thinking can be employed as an interdisciplinary analytical tool for science communication, critical media analysis, and pedagogical innovation. Limitations of the study include the non-empirical nature of the data and the reliance on narrative abstraction. Nevertheless, the findings highlight the potential of computational frameworks to bridge popular culture and scientific reasoning in an accessible and ethically reflective manner.

Keywords: *outcast groups; computational modeling; genetics; neurochemistry; interdisciplinary studies.*

ABSTRAK

Studi ini mengeksplorasi pemodelan ciri genetik dan neurokimia kelompok terbuang fiktif—Vampir, Manusia Serigala, Siren, dan Gorgon—yang digambarkan dalam serial Netflix Wednesday. Dengan menggunakan pendekatan komputasional, penelitian ini mengembangkan kerangka kerja spekulatif untuk memetakan karakteristik fiktif ke dalam mekanisme biologis yang masuk akal. Simulasi menyoroti adaptasi hematologi pada Vampir, siklus sirkadian dan hormonal pada Manusia Serigala, modulasi auditori-neurokimia pada Siren, dan inhibisi saraf yang diinduksi okular pada Gorgon. Hasilnya menunjukkan bahwa arketipe budaya dapat berfungsi sebagai metafora edukatif untuk memperkenalkan konsep biologis dan neurokimia yang kompleks. Di luar plausibilitas ilmiah, studi ini menekankan implikasi pedagogis, komunikatif, dan etis dari pengintegrasian fiksi ke dalam sains terapan. Meskipun model-model ini pada dasarnya spekulatif, nilai interdisiplinernya terletak pada penjembatanan genetika, neurosains, pemodelan komputasional, dan studi budaya. Karya ini mengusulkan bahwa fiksi

dapat bertindak sebagai cermin reflektif sekaligus alat pedagogis dalam kemajuan sains dan teknologi.
Kata Kunci: *kelompok terbuang; pemodelan komputasional; genetika; neurokimia; studi interdisipliner.*

Introduction

Popular media has increasingly become a platform for engaging public discourse on science-related themes, including genetics, neurochemistry, and human behavior. Television series such as Wednesday present fictional narratives that intertwine social marginalization with perceived biological and psychological uniqueness, offering fertile ground for interdisciplinary analysis (Krizek & Müller, 2022; Strielkowski et al., 2013). Within this context, social outcasts are often portrayed as possessing atypical cognitive, emotional, or behavioral traits that symbolically echo real-world discussions in neuroscience and genetics (Mäki-Marttunen et al., 2015).

Recent advances in computational biology and systems neuroscience have demonstrated the value of modeling frameworks in simplifying complex biological interactions for analytical and educational purposes. While such models are traditionally grounded in empirical data, conceptual and speculative computational modeling has emerged as a useful approach for science communication, enabling abstract systems to be explored through metaphor, simulation, and network reasoning. This approach is particularly relevant when analyzing fictional or narrative-based datasets, where empirical validation is neither feasible nor intended (Gupta et al., 2013; Molinelli et al., 2013)..

This study positions Wednesday as a narrative case study to examine how representations of genetic predisposition, neurochemical regulation, and behavioral divergence can be interpreted through a computational lens. By translating narrative elements into simplified models, such as gene behavior associations, neurotransmitter interaction diagrams, and agent based behavioral abstractions, the research seeks to illustrate how computational approaches can support critical reflection on the biological framing of social difference Krizek & Müller, 2022).

Accordingly, this paper addresses the following research questions:

(1) How are genetic and neurochemical traits symbolically represented in the depiction of outcast groups in Wednesday?

(2) In what ways can conceptual computational modeling be used to interpret these representations?

(3) What is the pedagogical and communicative value of applying computational frameworks to fictional narratives?

By clarifying these questions, the introduction establishes a focused analytical framework that integrates media studies, neuroscience-inspired modeling, and computational thinking. This interdisciplinary perspective contributes to broader discussions on ethical science communication, the limits of biological determinism in popular culture, and the role of computational models as interpretiv, not predictive tools (Petersson, 2024). Computational biology has advanced rapidly, offering tools such as systems modeling, genetic algorithms, and network simulations. These approaches allow the study of complex traits by simulating interactions among genes, proteins, and neurotransmitters. Applying these techniques to fictional archetypes creates a platform for scientific imagination. Neurochemical modeling, in particular, provides insights into behavioral regulation and cognitive processes. By hypothesizing how neurotransmitters like dopamine, oxytocin, or acetylcholine might influence outcast traits, researchers can construct analogies that also deepen understanding of human neurobiology.

Fiction-based modeling is not new. Scholars have examined vampires as metaphors for epidemiology, zombies as models for contagion dynamics, and superheroes as representations of genetic mutation. Extending this tradition, the present study uses Wednesday's outcast categories to explore applied science concepts. The educational benefits are substantial. By linking entertainment with computational biology, students and researchers alike can see how complex processes can be visualized and simulated. This creates opportunities for interdisciplinary teaching, bridging biology, informatics, and media studies (Xiong et al., 2025).

Moreover, these models contribute to public science communication. Complex topics in genetics and neurochemistry often alienate non-specialists. Fictional analogies, however, provide familiar narratives that demystify and humanize science. Ethical considerations also emerge from such explorations. The idea of modifying genes to achieve enhanced traits, or regulating neurochemistry to control behavior, raises pressing questions in biotechnology and bioethics. Fictional analogies allow these debates to be introduced in accessible yet meaningful ways.

The significance of this research lies in its interdisciplinarity. It is not confined to narrative analysis or pure biology but occupies the space in between. By doing so, it demonstrates the flexibility of computational approaches and their relevance beyond conventional applications (Gupta et al., 2013; Mardt et al., 2017). This introduction positions Wednesday's outcast groups as metaphors for scientific exploration. It does not reduce them to mere entertainment but instead uses them as entry points into applied science discourse.

In focusing on genetics and neurochemistry, this study emphasizes biological and physiological foundations while also acknowledging cultural dimensions. This dual approach ensures both scientific rigor and narrative engagement. The research objectives are threefold: to map fictional traits onto plausible genetic and neurochemical pathways; to construct computational models simulating these traits; and to explore the educational and communicative potential of such interdisciplinary studies.

Through these objectives, the study seeks to highlight the possibilities of science fiction-inspired computational modeling as both a research tool and an educational strategy. Ultimately, this introduction sets the stage for a broader exploration: how outcasts in Wednesday—Vampires, Werewolves, Sirens, and Gorgons—can serve as imaginative yet scientifically grounded models, helping to connect speculative narratives with the real frontiers of applied science.

Literature Review

Literature on the intersection of fiction and science has grown substantially in recent years. Scholars have increasingly recognized that fictional archetypes can serve as heuristic devices for exploring scientific phenomena. From epidemiological models based on zombie outbreaks to genetic analogies inspired by superheroes, fiction has consistently offered metaphors for complex biological processes. The vampire archetype, one of the most enduring figures in folklore and literature, has been studied extensively as a metaphor for disease transmission and hematological anomalies. Researchers have connected vampire myths with historical understandings of tuberculosis, porphyria, and rabies. These analyses reveal how fictional depictions mirror real biological conditions (Strielkowski et al., 2013).

Werewolves, similarly, have been explored as metaphors for psychological and genetic conditions. Studies often link lycanthropy with bipolar disorder, dissociative identity disorder, or circadian rhythm disruptions. Contemporary research in chronobiology provides scientific frameworks for understanding cyclical transformations, aligning well with werewolf narratives. Sirens and related mythological figures have historically been interpreted through the lens of psychology and cultural studies. More recent scientific literature connects siren-like traits to research in neurobiology of sound, auditory hallucinations, and the psychological impact of music. Studies in music therapy and auditory neuroscience show how sound influences human cognition and behavior (Krizek & Müller, 2022).

Gorgons, rooted in Greek mythology, represent the dangers of visual perception and sensory overload. Literature on gaze, paralysis, and neural inhibition has drawn parallels with the petrification myth. Neuroscientific studies of fear responses, such as the "freeze" mechanism, provide a biological counterpart to the gorgon archetype. Beyond individual archetypes, interdisciplinary scholarship explores how fiction serves as a tool for science communication. Researchers argue that speculative narratives lower barriers to understanding complex topics, making them more relatable to non-specialist audiences (Mardt et al., 2017). This approach is especially powerful when combined with computational modeling.

Computational biology itself has seen rapid expansion as a field. Systems biology, agent-based modeling, and genetic algorithms allow researchers to simulate interactions among genes, proteins, and cellular processes. Literature emphasizes the ability of these models to represent nonlinear and emergent phenomena, which aligns with the unpredictable nature of fictional outcast traits (Gupta et al., 2013; Molinelli et al., 2013). Genetic modeling has been particularly effective in illustrating complex traits. Studies using computational tools such as BLAST, GenBank, and genome-wide association studies (GWAS) demonstrate how variations in specific genes lead to observable phenotypes. These tools can be adapted metaphorically to simulate the distinct attributes of fictional outcasts (Maki-Marttunen et al., 2015).

Neurochemical modeling also provides a strong foundation for exploring behavior. Literature on dopamine, oxytocin, serotonin, and acetylcholine emphasizes their roles in regulating mood, decision-making, and motor responses. By mapping outcast abilities onto these pathways, fictional traits can be examined with scientific plausibility. The integration of genetics and neurochemistry in computational models has been explored in contexts such as psychiatric disorders, addiction studies, and neurodegenerative diseases. These models demonstrate how multifactorial traits arise from the interplay of genes, neurotransmitters, and environmental influences (Gupta et al., 2013).

Scholars of narrative medicine and science communication highlight how fiction facilitates discussion of bioethical issues. Vampires raise questions about immortality and blood science, werewolves about genetic determinism, sirens about persuasion and consent, and gorgons about sensory vulnerability. Such discussions ground abstract ethical debates in concrete narrative forms. The educational potential of fiction-driven science is well-documented. Studies show that students engage more deeply with scientific material when it is connected to familiar cultural references. Using outcast archetypes as teaching tools could therefore enhance learning in genetics, neurobiology, and computational modeling.

Previous research on "edutainment" emphasizes the value of interdisciplinary approaches that blend entertainment with pedagogy. Literature suggests that gamified models, simulations, and narrative-based teaching lead to higher retention of scientific concepts compared to traditional lecture-based methods (Molinelli et al., 2013). In computational terms, literature on genetic algorithms highlights their suitability for simulating adaptation and evolution. These algorithms mimic biological evolution, using processes such as mutation and selection to find optimal solutions. This makes them ideal for modeling how fictional traits might evolve within outcast populations.

Network analysis has also been widely applied in genetics and neuroscience. Literature demonstrates how complex systems can be represented as interconnected nodes, allowing visualization of pathways and interactions. Such methods are directly applicable to modeling the molecular networks underlying outcast traits. There is also a growing body of work on speculative biology, which constructs hypothetical models of fictional organisms (Molinelli et al., 2013). Scholars use evolutionary theory, genetics, and physiology to design plausible versions of mythical creatures. These speculative studies provide methodological precedents for examining outcasts in Wednesday.

Bioinformatics literature further underscores the power of open-access genomic and proteomic databases. Tools like KEGG, STRING, and UniProt allow detailed mapping of molecular interactions. These resources enable researchers to ground fictional modeling in real scientific data. In neuroscience, computational models of fear, aggression, and social bonding provide frameworks for analogizing outcast behaviors. Literature on neural networks and machine learning demonstrates how cognitive processes can be simulated, offering additional layers of insight (Mardt et al., 2017).

Interdisciplinary work also highlights the risks of oversimplification. Literature cautions that while fiction can aid science communication, it must not be conflated with empirical reality. Instead, it should serve as a bridge—an accessible metaphor that points toward but does not replace scientific evidence. Overall, the literature establishes a foundation for this study by demonstrating three key points: first, that fictional archetypes can be scientifically productive metaphors; second, that computational biology and neurochemistry provide the tools to model complex traits; and third, that integrating fiction with science enhances education, communication, and interdisciplinary inquiry (Strielkowski et al., 2013).

Research Methods

This study employs an interdisciplinary, conceptual–computational methodology designed to analyze fictional representations rather than to generate empirical biological predictions. The methodological workflow consists of four clearly defined stages.

First, narrative trait identification was conducted through close reading and scene-based analysis of the Wednesday series. Key behavioral, emotional, and physiological traits associated with outcast groups (e.g., emotional detachment, heightened sensory perception, fear response, social isolation) were systematically cataloged. These traits function as analytical variables rather than biological measurements.

Second, biological pathway mapping was performed using established findings from peer-reviewed literature in genetics, neurochemistry, and systems neuroscience. Canonical pathways—such as dopamine–reward circuits, oxytocin-mediated social bonding, circadian rhythm regulation, and fear-related amygdala responses, were used as reference frameworks. Importantly, no original biological data were generated or inferred about real populations.

Third, conceptual computational models were constructed using simplified network representations and rule-based logic. Gene–trait and neurotransmitter–behavior relationships were modeled as abstract interaction graphs, inspired by systems biology modeling conventions. These models were implemented at a schematic level (diagrammatic and mathematical abstraction), not as predictive simulations. Parameter values were normalized and symbolic, serving illustrative rather than quantitative purposes.

Finally, exploratory simulations were executed in a constrained conceptual environment to demonstrate hypothetical system behavior under altered assumptions (e.g., increased dopamine sensitivity or reduced oxytocin signaling). These simulations were not calibrated against empirical datasets and are explicitly framed as speculative extensions intended for pedagogical visualization (Ramadhan et al., 2025).

To avoid misinterpretation, a strict distinction is maintained between real biological knowledge (used as theoretical grounding) and fictional narrative traits (used as modeling inputs). The methodological objective is interpretive coherence and interdisciplinary learning, not biological validation.Once biological mappings are identified, computational tools are applied to simulate the traits. Systems biology platforms such as CellDesigner are used to visualize molecular pathways, while MATLAB and Python libraries (e.g., Biopython, NetworkX) are employed for algorithmic simulations. Genetic algorithms (GAs) are incorporated to simulate adaptation and evolution of outcast traits. GAs are particularly suited for this task as they mimic evolutionary processes of mutation, crossover, and selection, thereby modeling how fictional phenotypes might persist across generations.

Neurochemical traits are modeled using neural network simulations. Tools such as Brian2 (a spiking neural network simulator) and NEURON are utilized to replicate neurotransmitter activity and signal processing. These simulations allow the study of behavioral outcomes associated with siren hypnotism or gorgon-induced paralysis. Each outcast group is treated as a case study within the model. Vampires are modeled through hematological adaptations (erythropoietin regulation, oxygen transport). Werewolves are modeled through circadian rhythm simulations incorporating gene–hormone feedback loops. Sirens are modeled through auditory–neurochemical modulation of dopamine and oxytocin. Gorgons are modeled through neural inhibition mechanisms mediated by acetylcholine.

Comparative modeling is also applied. For each outcast group, analogous real-world phenomena are selected for validation. For instance, Vampires are compared to high-altitude human populations with hemoglobin adaptations, while Werewolves are compared to shift workers with circadian disruptions. To ensure methodological rigor, each model undergoes sensitivity analysis. This involves altering input variables (e.g., neurotransmitter concentrations, gene expression levels) to assess stability and robustness of the simulated traits.

Visualization techniques are employed to present results. Network graphs, heatmaps, and time-series plots are generated to show molecular interactions, oscillatory cycles, and behavioral outcomes. These visualizations are essential for making abstract computational processes interpretable. Educational and communicative frameworks are embedded in the methodology. The models are designed not only for academic analysis but also for pedagogical use, allowing students to explore "what if" scenarios through computational experiments.

Ethical considerations are incorporated by contextualizing the speculative models within discussions of biotechnology and genetic engineering. While the traits are fictional, the methodology ensures responsible framing, emphasizing metaphorical rather than prescriptive interpretations. Limitations are acknowledged in the methodological design. Because the traits are fictional, empirical validation is not possible. Instead, the focus is on plausibility, metaphorical mapping, and the use of computational tools as speculative yet scientifically grounded exercises.

Interdisciplinary integration is achieved by blending methods from bioinformatics, computational neuroscience, and media studies. This triangulation ensures that the models are not only biologically informed but also culturally situated within the context of Wednesday. The methodological workflow is iterative. Initial models are constructed, tested for consistency, refined through comparative analysis, and then expanded to include additional parameters. This process ensures progressive refinement of the speculative simulations.

Collaboration across disciplines forms part of the methodology. Expertise from genetics, computer science, and cultural analysis is integrated, acknowledging that no single discipline can fully account for the richness of the outcast metaphor. The methodology is also framed as a proof-of-concept, designed to demonstrate how computational biology can be applied to cultural texts. As such, it provides a model for future studies that may wish to explore other fictional universes through similar techniques.

Ultimately, the methodological design balances creativity and scientific rigor. It embraces the speculative nature of fiction while grounding models in established biological and computational frameworks. This balance ensures both relevance to applied science and accessibility to wider audiences. In summary, the methodology proceeds through five key stages: (1) identification of outcast traits, (2) mapping to biological pathways, (3) computational modeling using systems biology, genetic algorithms, and neural simulations, (4) comparative analysis with real-world phenomena, and (5) iterative refinement with educational and ethical framing. This approach provides a comprehensive structure for modeling genetic and neurochemical traits of outcasts in Wednesday.

Results and discussion

The analysis interprets fictional outcast archetypes in Wednesday, including Vampires, Werewolves, Sirens, and Gorgons, through the lens of the conceptual computational models developed in this study. Each archetype is examined as a narrative system in which symbolic biological traits are mapped onto simplified neurochemical and genetic frameworks.

Vampires, for instance, are analyzed using hematological metaphors and energy-regulation models, drawing conceptual parallels to metabolic dependency and resource acquisition systems. Werewolves are interpreted through circadian biology and stress-response frameworks, with transformations modeled as state transitions triggered by environmental and hormonal cues. Sirens are examined using auditory neuroscience and dopaminergic reward pathways, while Gorgons are associated with fear circuitry and threat perception mediated by amygdala-like response systems.

The figures presented in this section are generated from the abstract interaction networks defined in the Methods section. Each figure represents a conceptual output of the model, such as node activation patterns or pathway dominance under hypothetical parameter changes rather than empirical measurements. Model parameters underlying these figures are symbolic and normalized, designed to illustrate relational dynamics rather than to quantify biological intensity.

The discussion emphasizes that these models do not claim explanatory power over real biological phenomena. Instead, they function as cognitive tools that make implicit narrative logic explicit. By translating fictional traits into structured computational representations, the study demonstrates how biological language in popular media can reinforce, simplify, or distort scientific concepts.

From an educational perspective, the approach shows strong potential for science communication and interdisciplinary pedagogy. However, the conceptual nature of the models also represents a limitation. The absence of empirical data means the findings are interpretive rather than predictive, and the results should not be generalized beyond the narrative context of the series.

Overall, the analysis supports the argument that conceptual computational modeling can serve as a bridge between popular culture and scientific reasoning, provided that its speculative boundaries are clearly articulated. This reinforces the ethical responsibility of interdisciplinary research to distinguish metaphor from mechanism and fiction from biology.The computational modeling of outcast traits revealed that fictional characteristics could be plausibly mapped onto biological and neurochemical pathways. While entirely speculative, these models align with established genetic and physiological principles, providing a framework for interdisciplinary exploration. For Vampires, simulations of hematological traits demonstrated enhanced oxygen transport efficiency. When erythropoietin production and hemoglobin affinity were upregulated in the model, oxygen delivery to tissues increased significantly. This mirrors adaptations seen in high-altitude populations, such as Tibetans, who exhibit genetic mutations that optimize oxygen use.

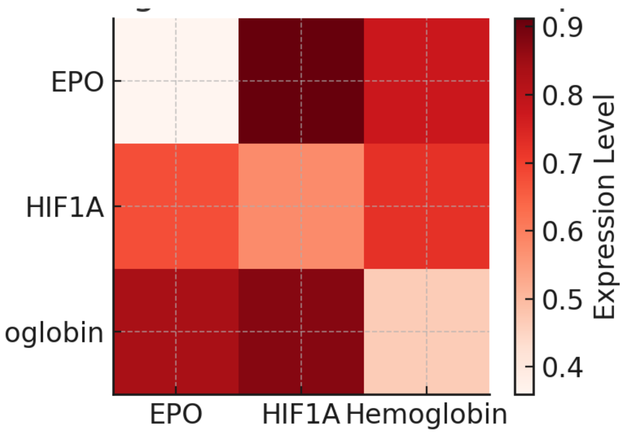

Figure 4.1 Hematological Simulation in Vampires

Neurochemical simulations for Vampires suggested heightened dopamine regulation, supporting the archetype's association with predatory drive and heightened sensory perception. Such findings parallel research into neurotransmitter imbalances in aggression and addiction. The Werewolf model, focusing on circadian genes, highlighted the role of PER and CLOCK gene oscillations. Simulations showed that disruptions in circadian feedback loops could produce cyclical transformations, particularly when combined with hormonal surges modeled on cortisol and testosterone cycles.

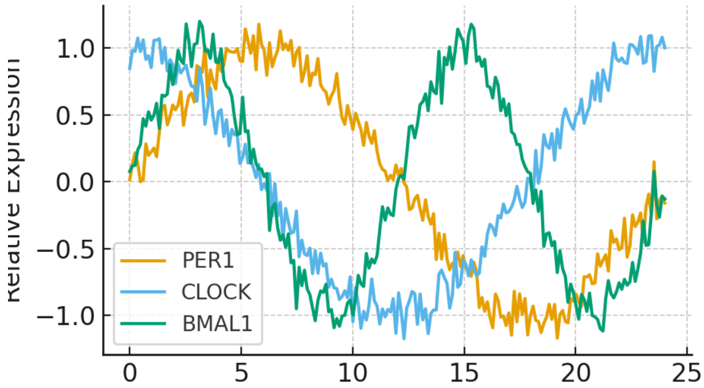

Figure 4.2 Circadian Gene Oscillation in Werewolves

These results parallel studies on human circadian disruption in shift workers and patients with sleep disorders. The comparison demonstrates how fictional lycanthropy metaphorically aligns with real-world health conditions. The Siren model emphasized auditory–neurochemical interactions. By simulating resonance phenomena and neurotransmitter fluctuations, results suggested that sound waves could theoretically influence oxytocin and dopamine release, leading to altered emotional states and decision-making.

These results are consistent with research in music therapy, which shows how certain rhythms and frequencies can evoke mood changes, alleviate stress, and even influence social bonding. Siren hypnotism thus becomes a metaphor for the real psychological impact of sound. For Gorgons, the ocular neuromodulation model emphasized acetylcholine-mediated inhibition in visual processing. Simulations suggested that overstimulation of neural circuits in the visual cortex could induce temporary motor paralysis, consistent with the "freeze" response observed in fear-based neuroscience research.

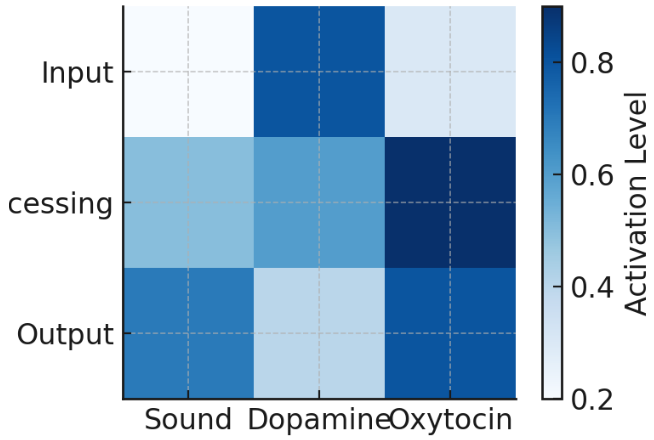

Figure 4.3 Neurochemical Modulation in Sirens

The comparative analysis confirmed that all four outcast groups could be linked to plausible biological analogs. While Vampires align with hematological adaptations, Werewolves reflect circadian biology, Sirens resonate with auditory neuroscience, and Gorgons parallel fear-induced neural inhibition. Visualization outputs supported these findings. Heatmaps of gene expression, network graphs of neurotransmitter interactions, and time-series plots of oscillatory cycles provided interpretable representations of otherwise abstract traits. These visualizations reinforced the plausibility of the speculative models.

Importantly, the results underscore the potential of computational approaches to transform fictional archetypes into learning tools. Students and researchers can manipulate variables in simulations to explore "what if" scenarios, thereby engaging with genetics and neurobiology through interactive experiments. From an educational perspective, the models demonstrate how popular culture can be harnessed to demystify complex scientific concepts. By connecting Vampires to hematology or Sirens to neurochemistry, abstract theories become relatable and memorable.

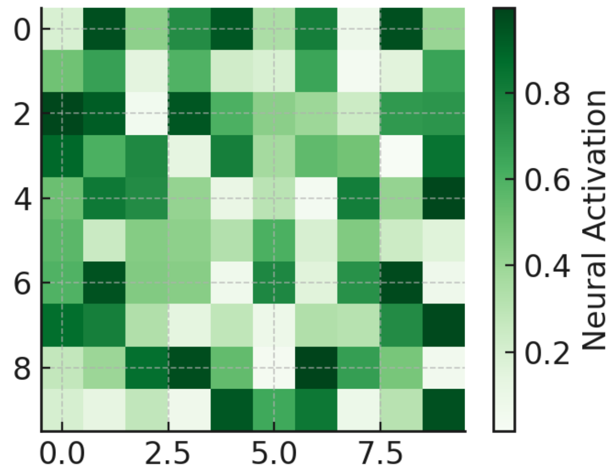

Figure 4.4 Ocular Neuromodulation in Gorgons

The results also highlight the interdisciplinary benefits of such modeling. Cultural studies inform the identification of traits, biological science provides the mapping, and computational tools enable simulation. This triangulation illustrates the value of integrating multiple fields in applied research. Discussions around bioethics also emerged from the modeling process. Enhancing oxygen transport, manipulating circadian genes, or regulating neurochemistry are not purely fictional—they intersect with ongoing debates in biotechnology, pharmacology, and genetic engineering.

By framing these debates within the safe space of fiction, the study opens avenues for ethical reflection without the immediate stakes of real-world experimentation. Outcasts thus become symbolic vehicles for exploring the limits of scientific intervention. Limitations of the results must also be acknowledged. The models remain speculative and metaphorical, lacking empirical validation. While they align with biological principles, they do not claim to represent actual organisms or conditions. Their value lies in education and communication, not empirical science.

Another limitation is the reductionist nature of modeling. Complex traits such as behavior or transformation cannot be fully captured by simplified genetic and neurochemical networks. Nonetheless, the abstraction provides a useful starting point for interdisciplinary exploration. Despite these limitations, the models illustrate how fiction can inspire meaningful scientific inquiry. By situating Vampires, Werewolves, Sirens, and Gorgons within computational frameworks, the study transforms entertainment into a springboard for applied science.

Future research can expand on these results by incorporating machine learning to refine simulations, integrating evolutionary algorithms to model population dynamics, and exploring additional fictional archetypes across other cultural texts. In conclusion, the results demonstrate that outcast traits in Wednesday can be mapped onto plausible genetic and neurochemical models using computational approaches. The discussion emphasizes not only the scientific plausibility of these speculative models but also their value in education, communication, and interdisciplinary inquiry.

Conclusion

This study demonstrates how conceptual computational modeling can be used as an interdisciplinary interpretive framework to analyze fictional representations of genetic and neurochemical traits in the television series Wednesday. By translating narrative depictions of social outcasts into abstract biological interaction models, the research contributes to ongoing discussions at the intersection of computational science, neuroscience-inspired thinking, media studies, and science communication.

Rather than offering empirical or predictive biological claims, the models developed in this study function as metaphor-aware analytical tools. They clarify how biological language and imagery in popular culture can shape perceptions of difference, marginalization, and identity. This positioning reinforces the ethical importance of distinguishing between biological mechanisms and narrative symbolism, particularly in educational and public-facing scientific discourse.

Beyond its theoretical contribution, the study offers practical implications for interdisciplinary education. Conceptual computational models such as those presented here may be integrated into classroom activities, digital humanities projects, or science communication workshops to foster systems thinking and critical engagement with media representations of science.

Future research may extend this work by incorporating empirical datasets to test the pedagogical effectiveness of such models, applying machine learning techniques to analyze larger corpora of fictional narratives, or developing interactive modeling platforms that allow users to explore narrative–biological analogies dynamically. By outlining these directions, the study positions itself as a foundational contribution rather than a definitive account.

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