Project Notes:

Predicting Vitiligo Antigens Utilizing Machine Learning: Independent Research Project
Name: Lauren Kim

Note Well: There are NO SHORT-cuts to reading journal articles and taking notes from them. Comprehension is paramount. You will most likely need to read it several times, so set aside enough time in your schedule.

Contents:

Knowledge Gaps:

This list provides a brief overview of the major knowledge gaps for this project, how they were resolved and where to find the information.

Knowledge Gap	Resolved By	Information is located	Date resolved
What is vitiligo?	9/15/24	Article 1 in project notes	9/13/24
What are JAK inhibitors?	9/20/24	Article 7 in project notes	9/18/24
Are there patents related to NLRP1 gene therapy?	10/10/2024	Patent 2 in project notes	10/10/2024
Can vitiligo be modeled in C. Elegans?	10/10/2024	Article 11 in project notes	10/10/2024

Literature Search Parameters:

These searches were performed between (Start Date of reading) and XX/XX/2019.
List of keywords and databases used during this project.

Database/search engine	Keywords	Summary of search
Google	Telemedicine and Patient Outcome	Most were about the benefits of telemedicine, many journal papers and scientific articles.
Science.org	Vitiligo	Many papers about treatment, all scientific articles. Would search again.
Google	Machine Learning used in healthcare	Potential, significance, and benefits of machine learning.
Google	Vitiligo Gene Therapy	Identification of certain genes, genetic vitiligo, passing down
Google Scholar	Autoimmune disease gene therapy	Several articles from 2000s, lots of old research of model organisms
Google Patent Search	Vitiligo gene therapy	JAK1 inhibition, several patents on topical and photo therapy treatments.

Tags:

Tag Name	
#introduction	#vitiligo
#AI	#machinelearning
#background	#telemedicine

#medical	#antigen
#methods	#genetherapy
#melanoma	#CD8+TCells

Article #0 Notes: Title

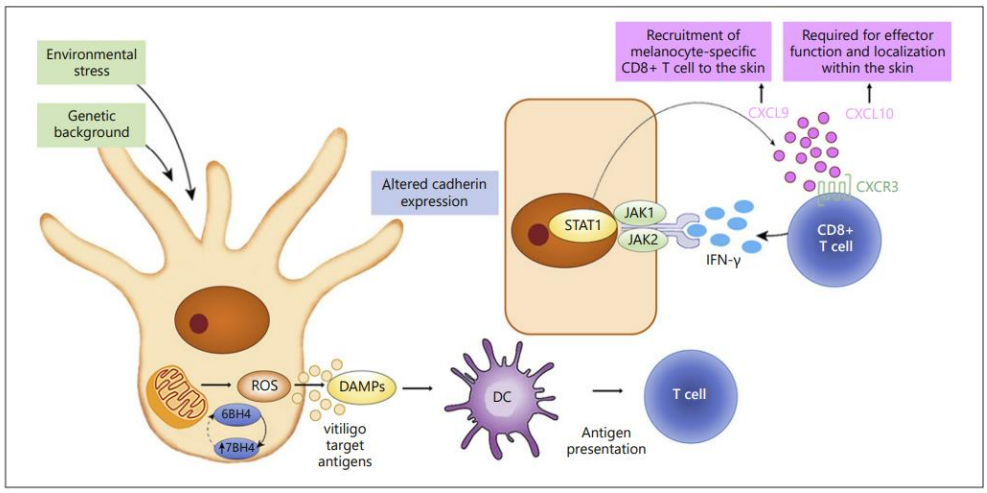
Article notes should be on separate sheets

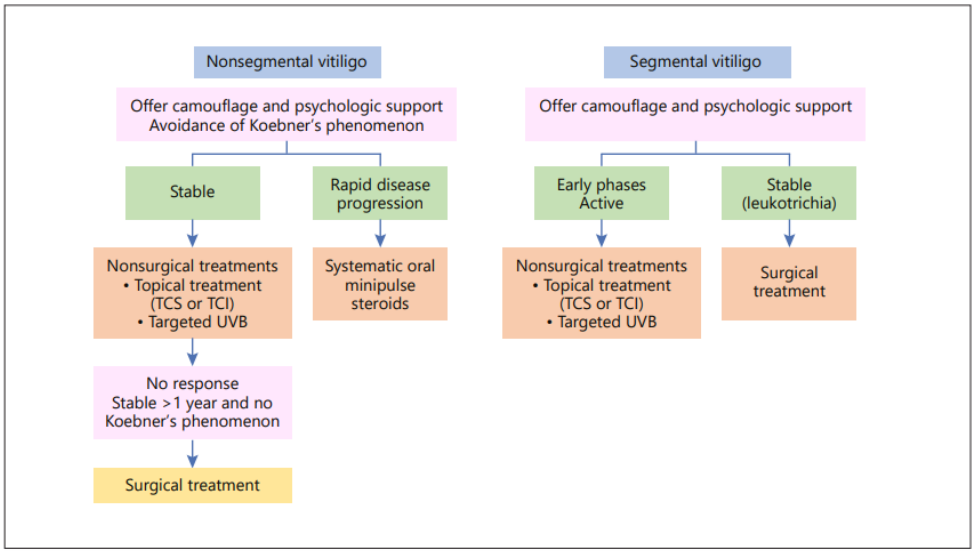
KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	
Source citation (APA Format)	
Original URL	
Source type	
Keywords	
#Tags	
Summary of key points + notes (include methodology)	
Research Question/Problem/ Need	
Important Figures	
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	

Article #1 Notes: Vitiligo: A Review

Article notes should be on separate sheets

Source Title	Vitiligo: A Review
Source citation (APA Format)	Bergqvist, C., & Ezzedine, K. (2020). Vitiligo: A Review. *Dermatology, 236*(6), 1–22. https://doi.org/10.1159/000506103
Original URL	https://karger.com/drm/article-pdf/236/6/571/2664336/000506103.pdf
Source type	Review Article (pdf)
Keywords	Vitiligo, non-segmental · Vitiligo, segmental · Pathogenesis · Epidemiology · Management
#Tags	#introduction #background
Summary of key points + notes (include methodology)	Vitiligo is an autoimmune disease caused by the destruction of melanocytes in the skin. The percentage of people, as well as the regions they are from vary widely, with most patients being diagnosed under 40 years of age. Although scientists have identified various possible explanations for the risk factors of vitiligo, it is still unclear whether the condition is caused by one or a combination of these factors, and it remains one of the greatest mysteries in dermatology. Clinical trials of vitiligo patients and survey data were utilized in the paper. However, research of different treatments and types of the disease taken from other sources were mostly used.
Research Question/Problem/ Need	What is vitiligo? / What treatments are there for vitiligo?
Important Figures	 This figure shows the process of the expression of depigmentation in the skin. It includes the main processes and genes involved in the reactions.

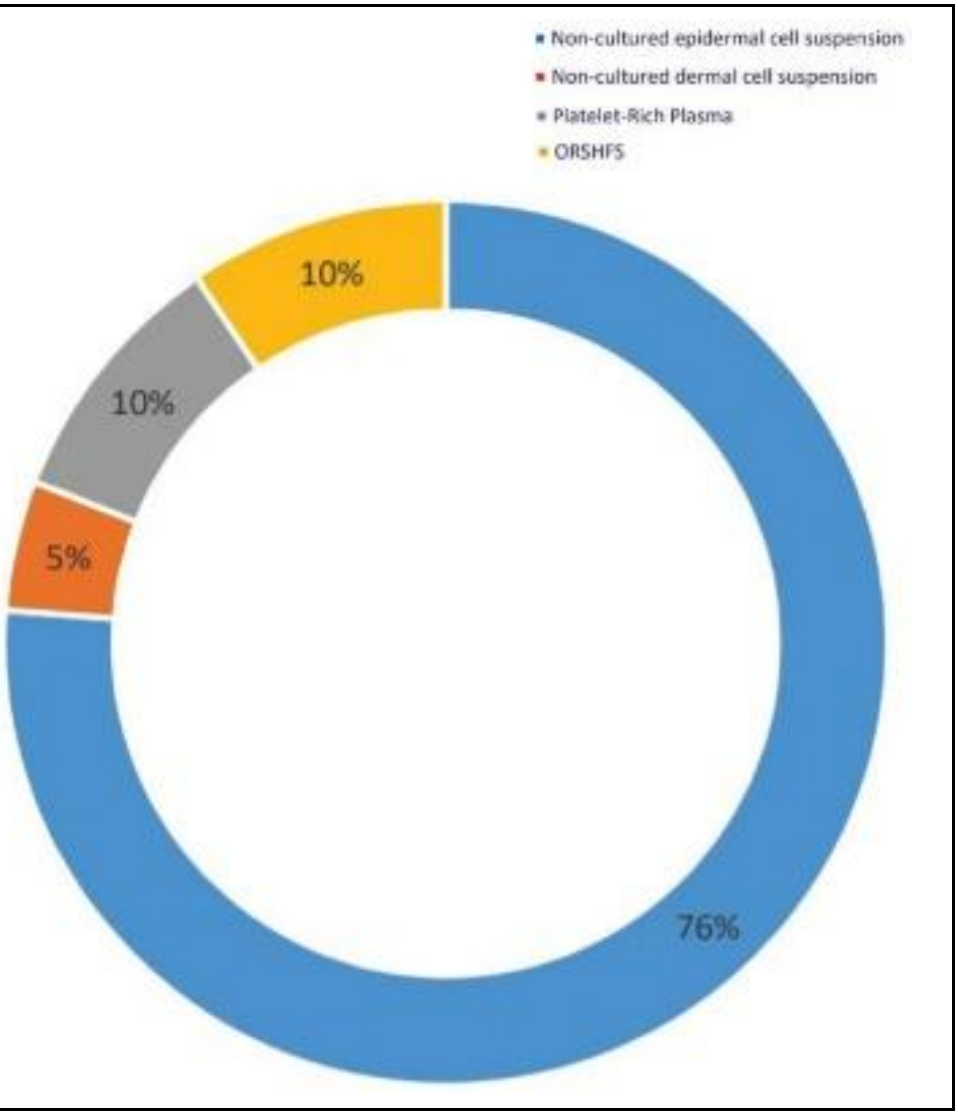
	This figure shows the difference between nonsegmental and segmental vitiligo, and how there are differences in phrases and disease progression. 
VOCAB: (w/definition)	Pathogenesis: the manner of development of a disease.
Cited references to follow up on	Zhang Y, Cai Y, Shi M, Jiang S, Cui S, Wu Y, et al. The Prevalence of Vitiligo: A Meta-Analysis. PLoS One. 2016 Sep;11(9):e0163806.
Follow up Questions	What other vaccines are currently in development? Why do people from certain continents have a higher risk of getting it than others? What treatments are available today to the public?

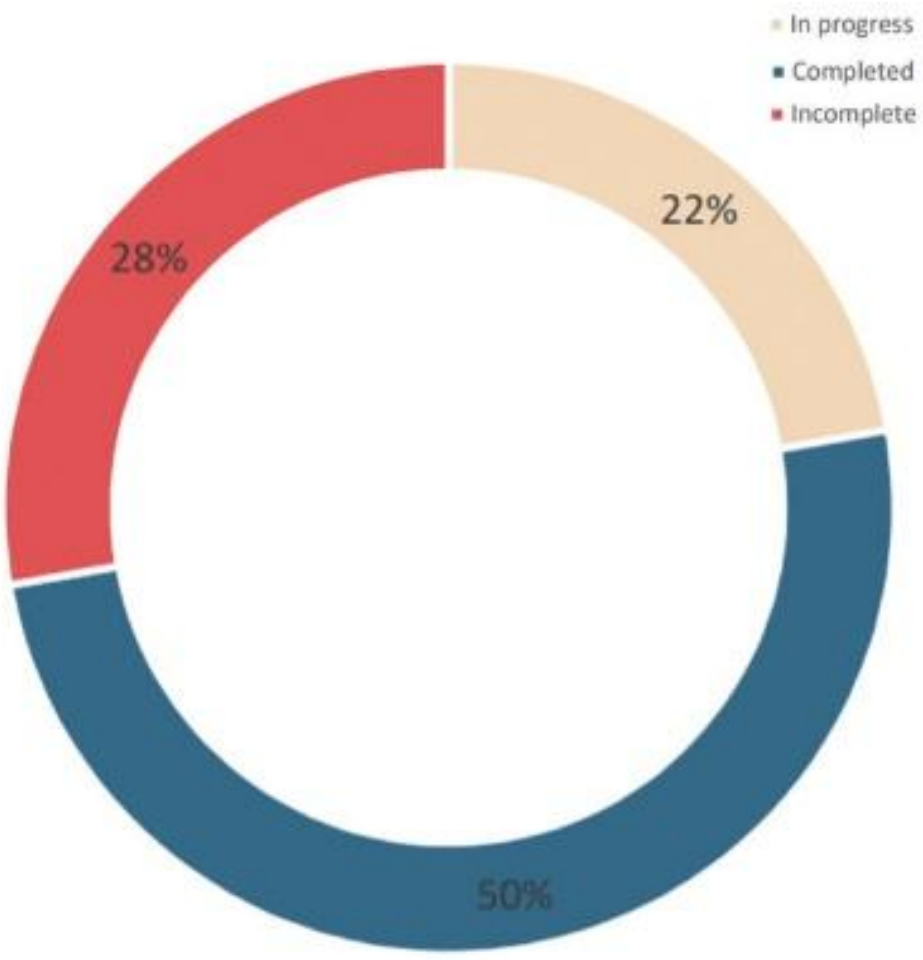
Article #2 Notes: Advanced Therapy Medicinal Products in Vitiligo; Current Status, Future Prospect, and Approved Treatments.

Article notes should be on separate sheets

Source Title	Advanced Therapy Medicinal Products in Vitiligo; Current Status, Future Prospect, and Approved Treatments.
Source citation (APA Format)	Ghashghaei, S., Abbaszadeh, M., Karimi, S., Ataie-Fashtami, L., Bajouri, A., & Vosough, M. (2023). Advanced Therapy Medicinal Products in Vitiligo; Current Status, Future Prospect, and Approved Treatments. *Cell Journal*, *25*(3), 143–157.

	https://doi.org/10.22074/cellj.2023.557550.1067
Original URL	https://www.celljournal.org/article_703078.html
Source type	Journal Article
Keywords	Cell Therapy, Immune System Diseases, Keratinocytes, Melanocytes, Vitiligo, Cell Suspension
#Tags	#genetherapy #introduction #vitiligo
Summary of key points + notes (include methodology)	The research question is important as vitiligo impacts the quality of life for people that have it. By minimizing side effects, treatment would become much more efficient for patients and could help more people. To answer this, the researchers collected data about the effectiveness of ATMPs on different types of cells, such as non-cultured epidermal cells, melanocytes, and hair follicle melanocytes. These treatments sometimes work in patients that don't respond to other types of treatment, making ATMPs more important. The existing vitiligo treatments include medications, physical therapies, and depigmentation treatments. The article focused more on currently implemented ATMPs and brought up data from several sources about effectiveness in different types of cells. Overall, the non-cultured epidermal cells were most tested on and found to be most effective.
Research Question/Problem/ Need	Could advanced therapy medicinal products minimize side effects while maximizing effectiveness to treat vitiligo?

Important Figures	

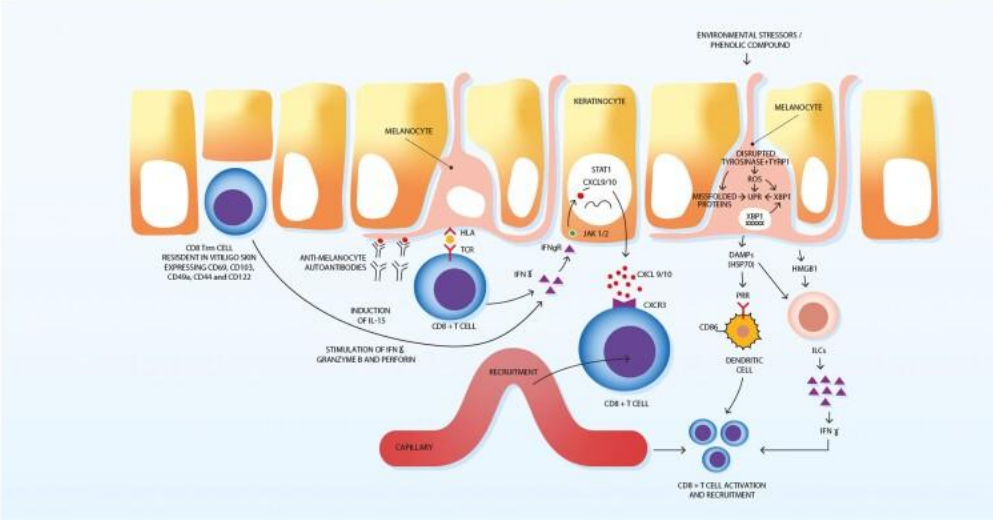
	 The figure on the left shows the percentage of trials run for different types of cells. The figure on the right shows the different percentages of ongoing, completed, and incomplete trials related to ATMPs.
VOCAB: (w/definition)	Segmental vitiligo: also known as bilateral vitiligo, affects both sides of the body Non-segmental vitiligo: also known as unilateral vitiligo, affects only one side of the body Narrow-band UVB phototherapy: UV light therapy that uses a specific range of UV to treat skin conditions. This reduces inflammation in the skin. PUVA: Another type of UV therapy that takes psoralen under UV light, which activates it, and interferes with DNA causing harmful cells to die.
Cited references to follow up on	Oral JAK inhibitors** Van TN, Minh TT, Huu DL, Huu SN, Thanh TV, Huu ND, et al. Successful treatment of vitiligo vietnamese patients with Vitilinex® herbal bio-actives in combination with phototherapy. *Open Access Maced J Med Sci.* 2019;7(2):283–286. [PMC free article] [PubMed] [Google Scholar]
Follow up Questions	How do we increase the affordability of ATMPs? Would therapies directed at other layers of the skin help if melanocytes are

	mostly located in the epidermis? What types of ATMPs are available for use?

Article #3 Notes: Patho-immunological mechanisms of vitiligo: the role of the innate and adaptive immunities and environmental stress factors

Article notes should be on separate sheets

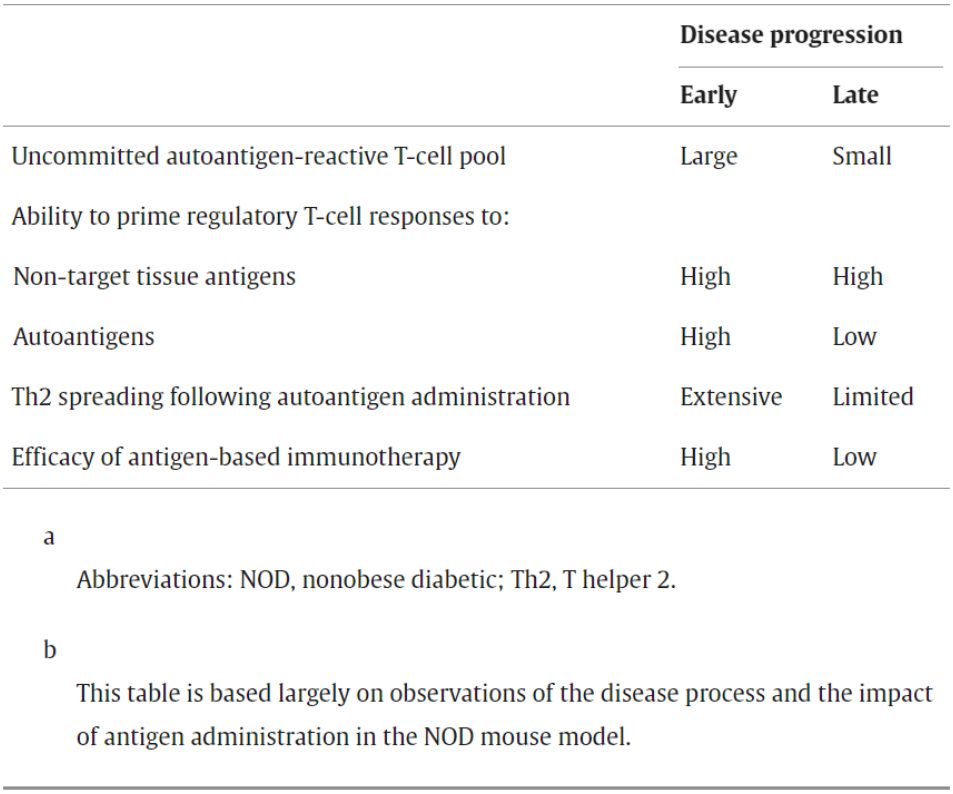
Source Title	Patho-immunological mechanisms of vitiligo: the role of the innate and adaptive immunities and environmental stress factors
Source citation (APA Format)	Faraj, S., Kemp, E. H., & Gawkrodger, D. J. (2021). Patho-immunological mechanisms of vitiligo: the role of the innate and adaptive immunities and environmental stress factors. *Clinical and Experimental Immunology*, *207*(1), 27–43. https://doi.org/10.1093/cei/uxab002
Original URL	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8802175/
Source type	Journal Article
Keywords	antibodies, autoimmunity, cytokines, cytotoxic T cells, Th1/Th2 cells
#Tags	#vitiligo #medical
Summary of key points + notes (include methodology)	This article discusses the causes of vitiligo, and reviews innate vs adaptive immunity. It talks about different stress factors that trigger the progression of vitiligo, and how different cells contribute to this chain of reactions – the cells in the IFN-y signaling pathway. The article also discusses regulatory t cells, t helper cells, resident memory t cells, and cytokine imbalance. They also include a chart of all relevant genes associated with vitiligo. The data was obtained from clinical trials of patients with vitiligo.
Research Question/Problem/ Need	What factors contribute to the initial causation and progression of vitiligo?

Important Figures	 This diagram shows the process of how environmental stress leads to the production and triggering of depigmentation in the skin.
VOCAB: (w/definition)	Cytotoxic: toxic to living cells Pathogenic: causing disease Aetiological: causing or contributing to the development of a disease/condition
Cited references to follow up on	3. Al Abadie MS, Gawkrodger DJ. Integrating neuronal involvement into the immune and genetic paradigm of vitiligo. *Clin Exp Dermatol* 2021, 46, 646–50. Google Scholar Crossref PubMed WorldCat
Follow up Questions	Could vitiligo be related to the brain? Which type of cell/genome contributes the most to the development of vitiligo? Could antibodies play no part in the pathogenesis of vitiligo?

Article #4 Notes: Antigen-based immunotherapy for autoimmune disease: from animal models to humans?

Article notes should be on separate sheets

Source Title	Antigen-based immunotherapy for autoimmune disease: from animal models to humans?
Source citation (APA Format)	Tian, J., Olcott, A., Hanssen, L., Zekzer, D., & Kaufman, D. L. (1999). Antigen-based immunotherapy for autoimmune disease: from animal models to humans? *Immunology Today*, *20*(4), 190–195. https://doi.org/10.1016/s0167-5699(99)01445-0
Original URL	https://www.sciencedirect.com/science/article/pii/S0167569999014450?via%3Dihub
Source type	Journal Article
Keywords	Autoimmunity, Tolerance, Immunoregulation, Th2 response, Delayed-type hypersensitivity, Antigen-immunotherapy, Immunology, Biotechnology, and Endocrinology
#Tags	#introduction #antigen #methods
Summary of key points + notes (include methodology)	Autoimmune diseases impact a huge part of our population, and encompass several diseases, from arthritis to multiple sclerosis. A general treatment for autoimmune disease, where the immune system attacks itself, could improve the quality of life for people with this disease. The article reviews several instances of animal models and analyze the efficiency and plausibility of antigen-based immunotherapy. Analysis of human trials is also included, and the responses to treatment are recorded. In conclusion, the authors write that more research must be done to conclude if human treatment is viable, but at the moment, antigen-based immunotherapy has a high potential for success.
Research Question/Problem/ Need	Could treatment for autoimmune disease be administered in humans instead of just in model organisms?

Important Figures	

	Disease progression	
	Early	**Late**
Uncommitted autoantigen-reactive T-cell pool	Large	Small
Ability to prime regulatory T-cell responses to:		
Non-target tissue antigens	High	High
Autoantigens	High	Low
Th2 spreading following autoantigen administration	Extensive	Limited
Efficacy of antigen-based immunotherapy	High	Low

a Abbreviations: NOD, nonobese diabetic; Th2, T helper 2.

b This table is based largely on observations of the disease process and the impact of antigen administration in the NOD mouse model.

This data table shows the different characteristics of T-cell responses over the progression of autoimmune disease.

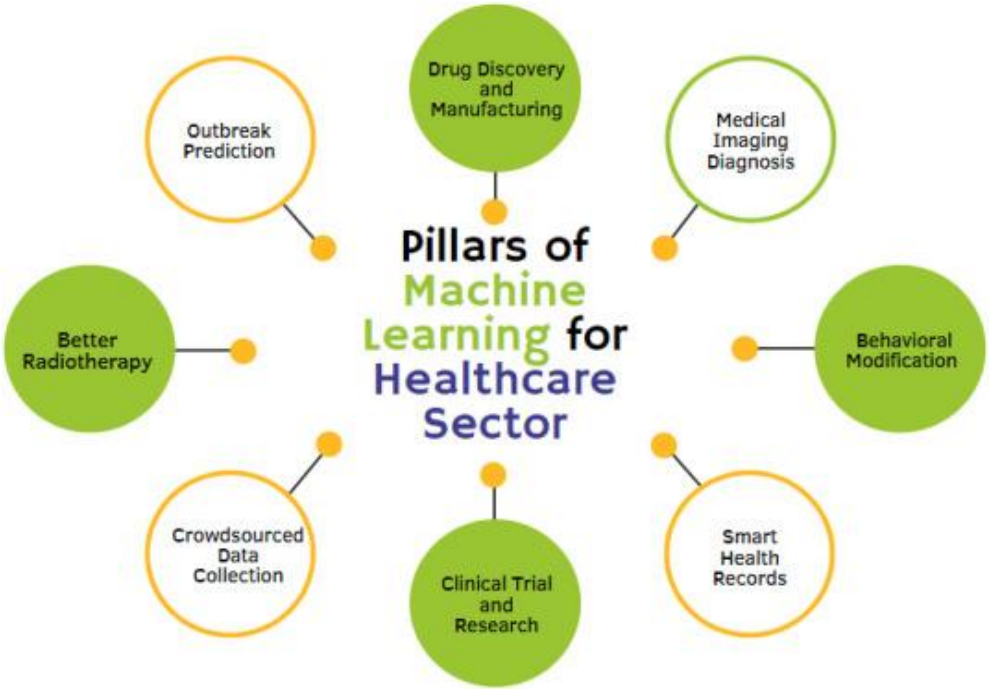
VOCAB: (w/definition)	Antigen: a molecule that binds to a specific antibody/T-cell receptor which triggers an immune response.
Cited references to follow up on	https://www.pnas.org/doi/abs/10.1073/pnas.88.24.11465
Follow up Questions	Are genes associated with autoimmune disease homologous between model organisms and humans? Could this also be modeled in C. Elegans? What are some side effects of antigen-based immunotherapy?

Article #5 Notes: Significance of machine learning in healthcare: Features, pillars and applications

Article notes should be on separate sheets

Source Title	Significance of machine learning in healthcare: Features, pillars and applications
Source citation (APA Format)	Javaid, M., Haleem, A., Ravi P. S., Suman, R., & Rab, S. (2022). Significance of machine learning in healthcare: Features, pillars and applications. *International Journal of Intelligent Networks*, *3*, 58–73.

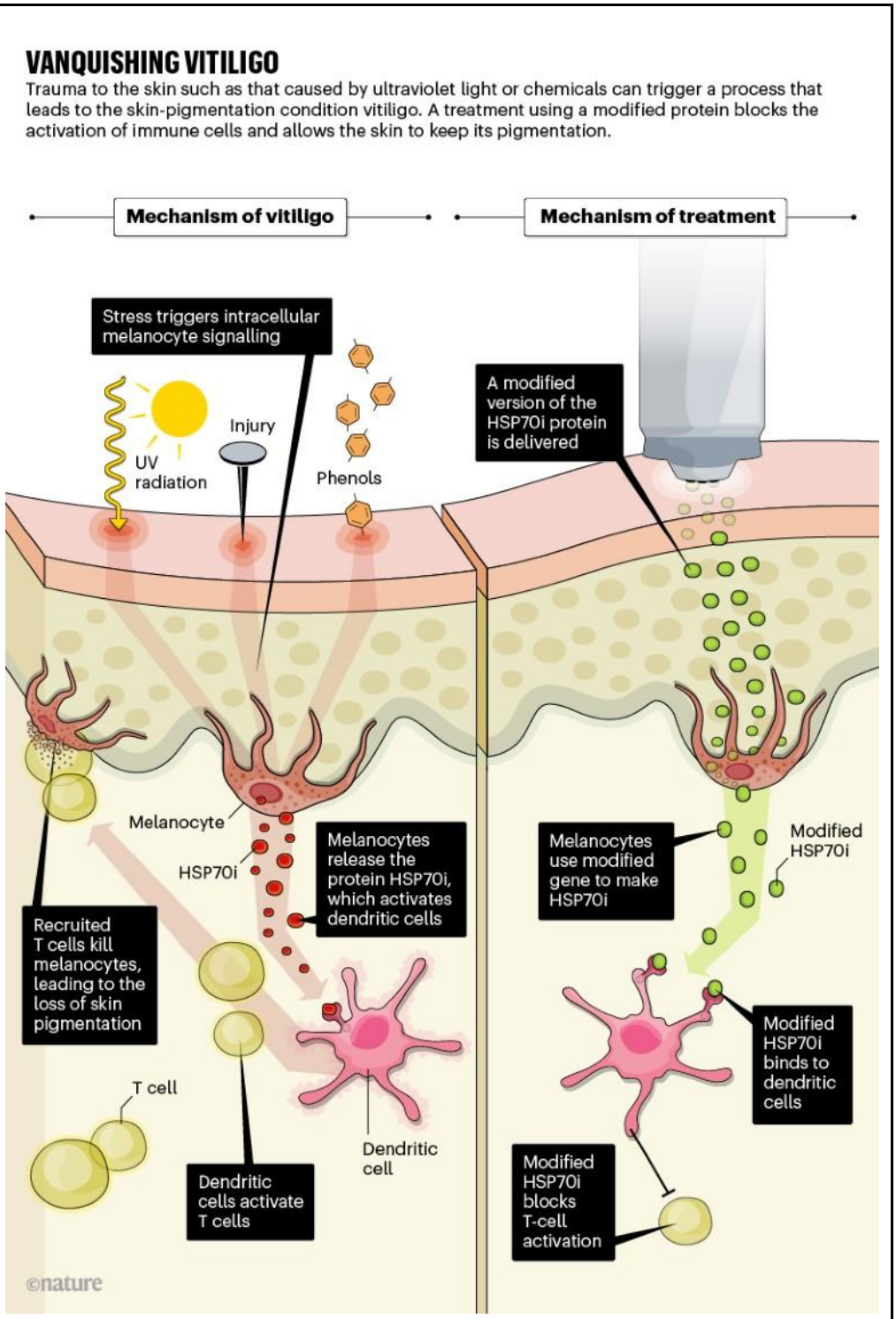
	https://doi.org/10.1016/j.ijin.2022.05.002
Original URL	https://www.sciencedirect.com/science/article/pii/S2666603022000069
Source type	Research Article
Keywords	Machine Learning, Artificial Intelligence, Healthcare
#Tags	#machinelearning #medical #AI
Summary of key points + notes (include methodology)	This article discusses the potential of AI and machine learning in healthcare. AI helps with the understaffing of healthcare professionals in areas with a high population, and can be used to reliably diagnose people and make recommendations. ML can also predict disease based on early symptoms quicker than clinical trials, which saves money and resources. Machine learning surpasses humans in things like disease and epidemic prediction. This was backed up with data from several different models observed from machine learning algorithms.
Research Question/Problem/ Need	Could machine learning be used as an alternative to traditional medical interactions?
Important Figures	 This figure shows different types of machine learning features that could be

	implemented in healthcare, as well as some of their advantages. This figure shows the different possible applications of machine learning in healthcare. 
VOCAB: (w/definition)	Machine Learning: a computer system/algorithm that can learn and grow without explicit instructions
Cited references to follow up on	https://www.sciencedirect.com/science/article/pii/S0263224118300228
Follow up Questions	How would a system with machine learning be effectively implemented in hospitals? Would this reduce the number of jobs available in hospitals? What disadvantages would this model have if it were to be implemented?

Article #6 Notes: Temprian Therapeutics: developing a gene-based treatment for vitiligo

Article notes should be on separate sheets

Source Title	Temprian Therapeutics: developing a gene-based treatment for vitiligo
Source citation (APA Format)	Schmidt, C. (2020). Temprian Therapeutics: developing a gene-based treatment for vitiligo. *Nature*. https://doi.org/10.1038/d41586-020-01808-5
Original URL	https://www.nature.com/articles/d41586-020-01808-5
Source type	News Article
Keywords	Modified proteins, gene therapy, melanocytes, T cells, inducible heat-shock protein 70 (HSP70i)
#Tags	#methods #vitiligo #medical
Summary of key points + notes (include methodology)	Temprian Therapeutics altered one amino acid in the protein HSP70i to produce a plasmid that was able to properly bind and simulate the reaction chain when administered to vitiligo patients. This was modeled with mice and pigs for over 6 months, and lesions shrank even in areas without the application of the therapy. This therapy has a lot of potential, as it was very effective and was able to successfully repigment skin.
Research Question/Problem/ Need	How can the intracellular signaling chain be interrupted to return pigmentation to skin cells?

Important Figures	 This diagram displays how the treatment developed by Temprian Therapeutics that the article talks about works.
VOCAB: (w/definition)	Dendritic Cells: a type of immune cell, presents antigens to other immune cells to boost immune response.

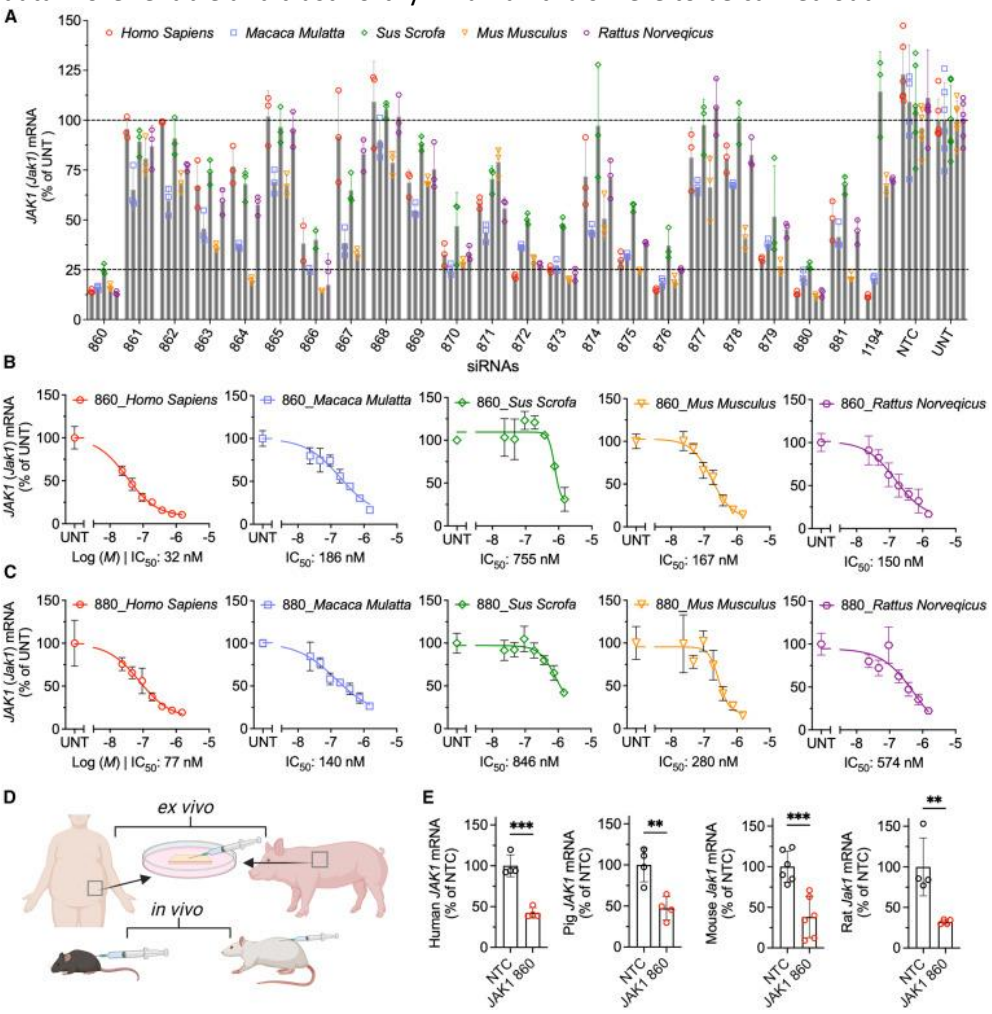
Cited references to follow up on	https://www.science.org/doi/10.1126/scitranslmed.3005127
Follow up Questions	Would this treatment have to be readministered multiple times for it to last? What is the impact of lymph nodes on vitiligo? What does the replaced amino acid do chemically to allow the protein to properly bind to dendritic cells?

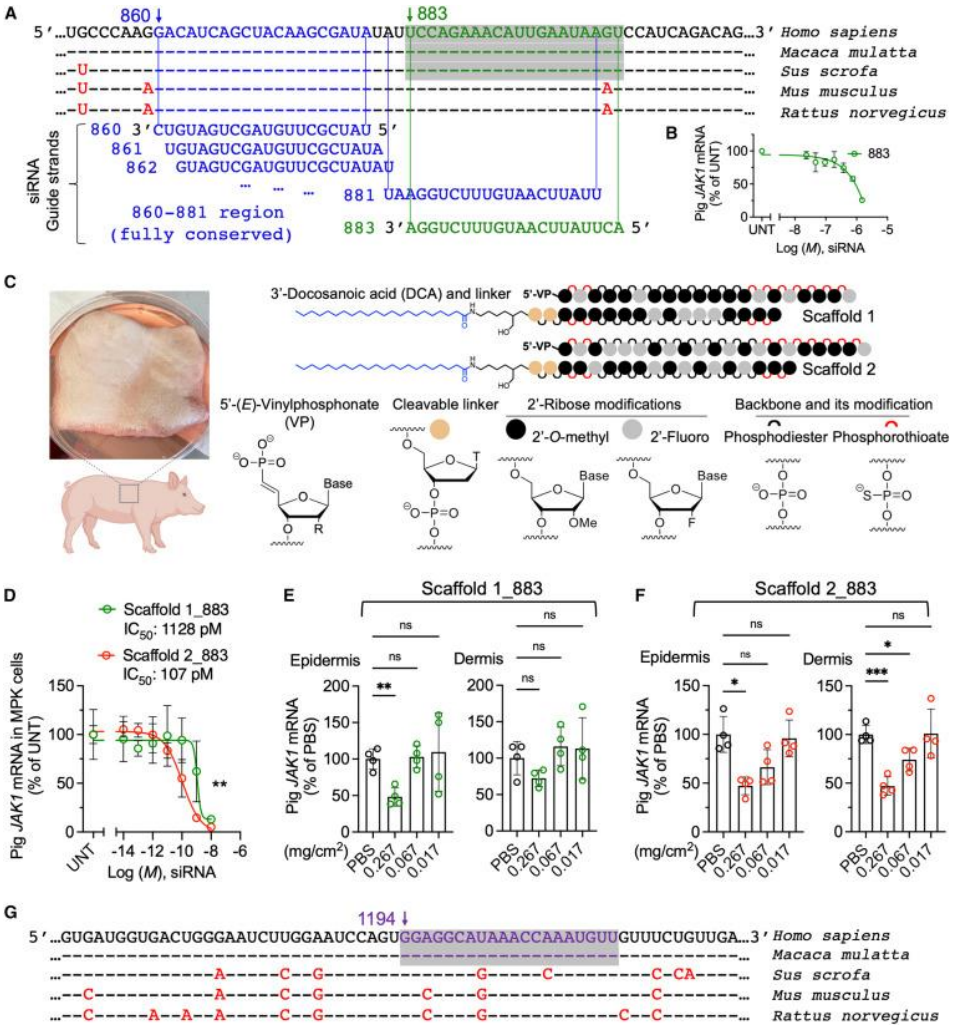
Article #7 Notes: Multispecies-targeting siRNAs for the modulation of JAK1 in the skin

Article notes should be on separate sheets

Source Title	Multispecies-targeting siRNAs for the modulation of JAK1 in the skin
Source citation (APA Format)	Tang, Q., Gross, K. Y., Fakih, H. H., Jackson, S. O., Zain, M., Monopoli, K. R., Blanchard, C., Bouix-Peter, C., Portal, T., Harris, J. E., Khvorova, A., & Alterman, J. F. (2024). Multispecies-targeting siRNAs for the modulation of JAK1 in the skin. *Molecular Therapy — Nucleic Acids*, *35*(1), 102117. https://doi.org/10.1016/j.omtn.2024.102117
Original URL	https://www.sciencedirect.com/science/article/pii/S2162253124000040?via%3Dihub
Source type	Journal Article
Keywords	RNA/DNA Editing, immunomodulation, RNAi therapeutics, JAK1 siRNA, multispecies targeting, inflammatory skin diseases, pig skin, human skin, *ex vivo* skin models
#Tags	#vitiligo #methods
Summary of key points + notes (include methodology)	siRNA was used to interfere with mRNA related to the JAK1 gene in pig, non-human primate, and rat skin. This was done by testing in vitro and ex vivo. The siRNA was made to be complimentary to the mRNA of the JAK1 gene mRNA, allowing it to bind and limit gene expression by cutting it through the AGO protein. To allow the siRNA to better penetrate the cell membrane, it was attached to docosonoic acid – a hydrophobic molecule. As a result, the JAK1 gene expression was limited by 60-70% in all species. This makes the data statistically significant.
Research Question/Problem/ Need	How can we ensure if siRNA can be reliably used to inhibit the expression of the JAK1 gene in the epidermal and dermal layers?
Important Figures	The first figure shows the data they got from the trials about the inhibition of the

JAK1 gene. It shows how all species follow a very similar trend in data, making the data more reliable and trustworthy if human trials were to be carried out.



	 The second figure shows how the scaffolding for the siRNA was made and carried out. It shows the different components of the siRNA, and how it was optimized for durability by bonding of different chemicals.
VOCAB: (w/definition)	siRNA: short, double stranded RNA used for targeted gene therapy of mRNA
Cited references to follow up on	https://www.scopus.com/record/display.uri?eid=2-s2.0-0032545933&origin=inward&txGid=30b4370bde06a54516856bfe4567c3da https://www.sciencedirect.com/science/article/pii/S1525001622002490
Follow up Questions	Could this same process be implemented to edit different genes contributing to vitiligo or autoimmune response? Could efficiency be increased further? How would this process be repeated for human clinical trials? What changes would have to be made? Why did scaffolding 2 work better than scaffolding 1? What kinds of side effects would there be?

Article #8 Notes: Telemedicine: Current Impact on the Future

Article notes should be on separate sheets

Source Title	Telemedicine: Current Impact on the Future
Source citation (APA Format)	Jin, M. X., Kim, S. Y., Miller, L. J., Behari, G., & Correa, R. (2020). Telemedicine: Current Impact on the Future. *Cureus*. https://doi.org/10.7759/cureus.9891
Original URL	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7502422/
Source type	Review Article
Keywords	tele health, tech, public health and social work, internal medicine (general medicine), family medicine
#Tags	#telemedicine
Summary of key points + notes (include methodology)	Due to the COVID-19 pandemic, many treatments and medical appointments have been shifted to zoom or other telecommunication technologies. The article discusses the advantages of this shift – people can access healthcare professionals from anywhere in the world, immunocompromised individuals can access treatment from the safety of their own home, and treatment is more accessible for those that may be too weak to leave their houses, such as the elderly or injured. The article analyzes data from different sources, including that the relationship between the patient and the professional was found to remain the same even through virtual sessions. In addition to the advantages, however, there also exist several limitations. More advanced treatment would still require patients to come to the hospital. Other devices may have to be used to measure vitals or other factors, which would have to be sent to the individual. Virtual meetings still cannot fully replace in person direct contact. In conclusion, telemedicine serves as a viable replacement and alternative form of diagnosis, and does not have as many limitations as thought of before.
Research Question/Problem/ Need	How can telemedicine be used as an alternative to traditional medicine?
Important Figures	N/A
VOCAB: (w/definition)	Telemedicine: remote diagnosis and treatment of patients through telecommunication
Cited references to follow up on	1. Barney A, Buckelew S, Mesheriakova V, Raymond-Flesch M: The COVID-19

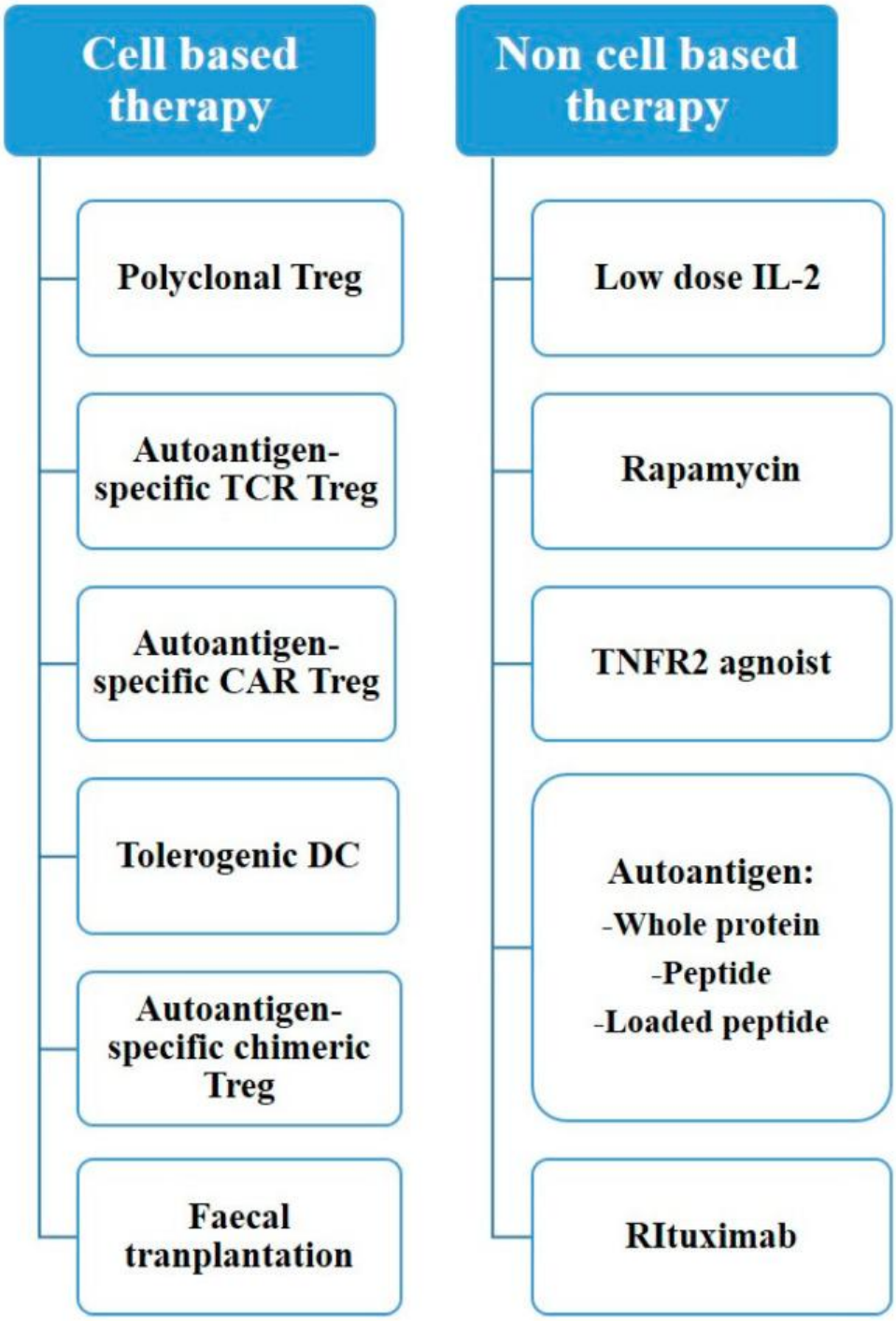
	pandemic and rapid implementation of adolescent and young adult telemedicine: challenges and opportunities for innovation [published online ahead of print, 2020 May 14]. J Adolesc Health. 2020, 10.1016/j.jadohealth.2020.05.006
Follow up Questions	What devices would have to be available to individuals for them to have effective treatment at home? Would the cost of treatment be more or less? Could other services be transitioned to virtual appointments?

Article #9 Notes: Genome Editing Using CRISPR-Cas9 and Autoimmune Diseases: A Comprehensive Review

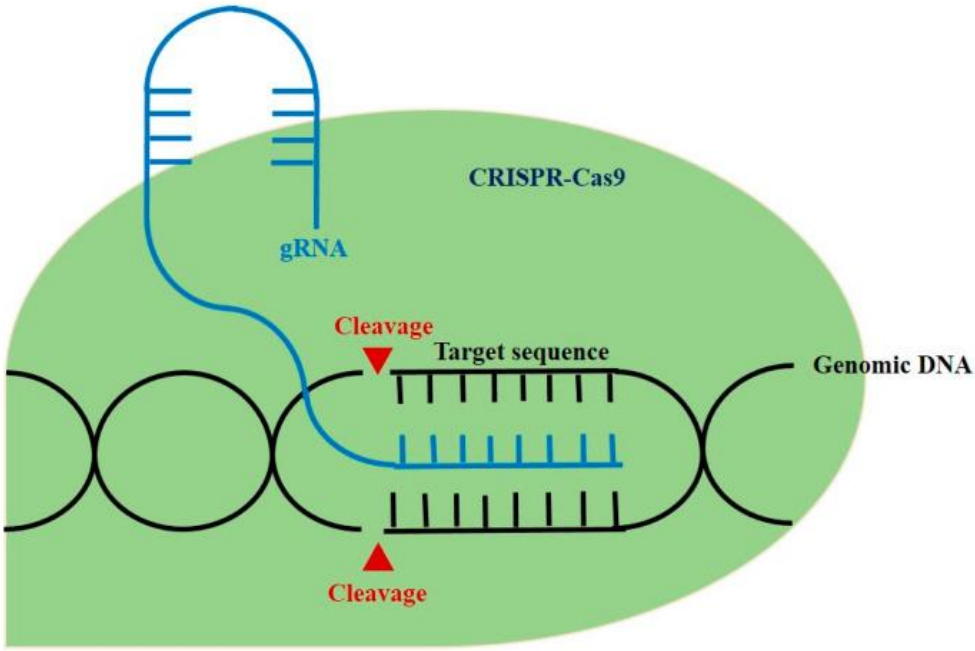
Article notes should be on separate sheets

Source Title	Genome Editing Using CRISPR-Cas9 and Autoimmune Diseases: A Comprehensive Review
Source citation (APA Format)	Lee, M., Shin, J.I., Yang, J.W., Lee, K.H., Cha, D., Hong, J.B., Park, Y., Choi, E., Tizaoui, K., Koyanagi, A., Jacob, L., Park, S., Kim, J., & Smith, L. (2022). Genome Editing Using CRISPR-Cas9 and Autoimmune Diseases: A Comprehensive Review. *International Journal of Molecular Sciences*, *23*(3), 1337. https://doi.org/10.3390/ijms23031337
Original URL	https://www.mdpi.com/1422-0067/23/3/1337
Source type	Review Article
Keywords	CRISPR-Cas9, genome editing, autoimmune diseases
#Tags	#vitiligo #methods
Summary of key points + notes (include methodology)	The article discusses and summarizes the research done on the Cas9 gene using CRISPR for different autoimmune diseases. These include rheumatoid arthritis, inflammatory bowel disease, systemic lupus, multiple sclerosis, diabetes type 1, psoriasis, and type 1 coeliac disease. The researchers also identify different genes associated with these autoimmune diseases based on studies done in the past, such as Pai et al 2020, Friedrich et al 2017, and so on. They conclude by stating that current evidence implies a promising role, but further studies to human treatment would need to happen.
Research Question/Problem/ Need	How can CRISPR-Cas9 be used to treat different autoimmune diseases?
Important Figures	

This diagram shows the currently available treatments, split into cell-based and non-cell-based therapies.



This diagram demonstrates how CRISPR-Cas9 works to edit DNA.

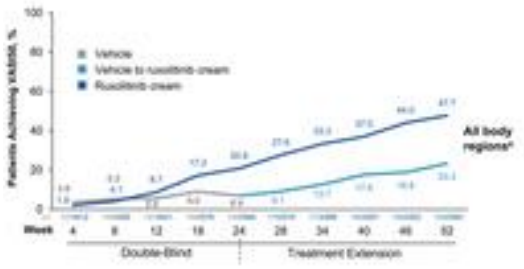
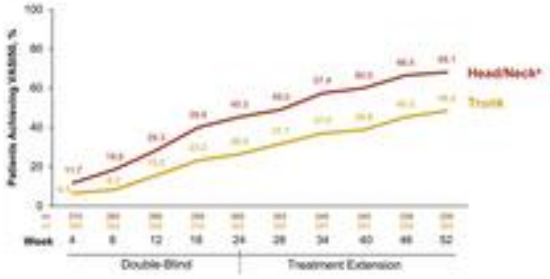
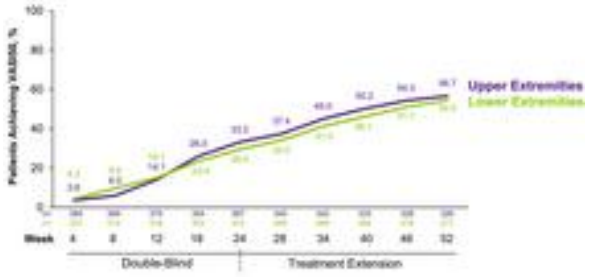
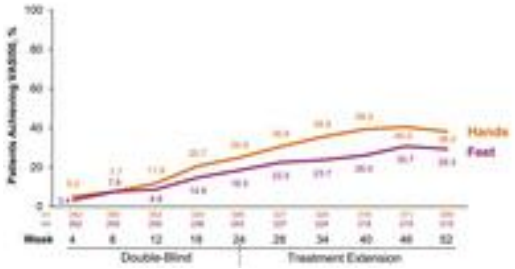
	
VOCAB: (w/definition)	Proprotein: inactive protein, can be activated through post-translational modifications
Cited references to follow up on	3. Cooper G.S., Miller F.W., Pandey J.P. The role of genetic factors in autoimmune disease: Implications for environmental research. *Environ. Health Perspect.* 1999;107((Suppl. S5)):693–700. doi: 10.1289/ehp.99107s5693. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
Follow up Questions	Could this treatment work for vitiligo? Would this be able to be modeled across different species? Are there any side effects of this treatment?

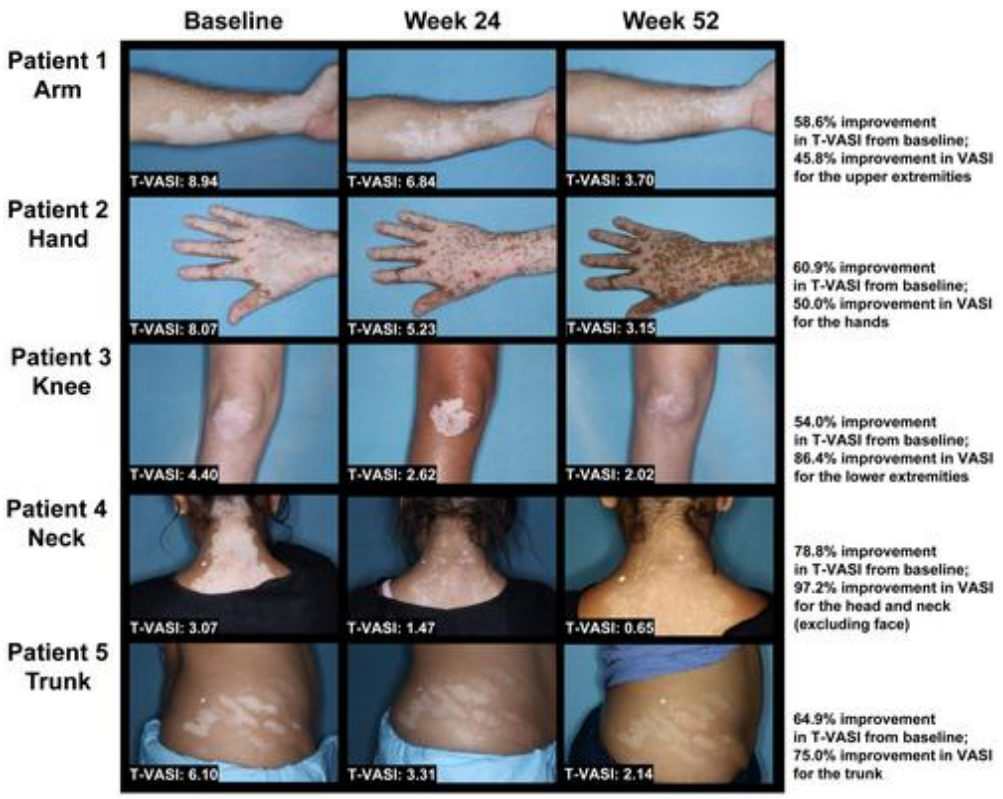
Article #10 Notes: Repigmentation by body region in patients with vitiligo treated with ruxolitinib cream over 52 weeks

Article notes should be on separate sheets

Source Title	Repigmentation by body region in patients with vitiligo treated with ruxolitinib cream over 52 weeks
Source citation (APA Format)	Passeron, T., Harris, J. E., Pandya, A. G., Seneschal, J., Grimes, P., Kornacki, D., Wang, M., Ezzedine, K., & Rosmarin, D. (2024). Repigmentation by body region in patients with vitiligo treated with ruxolitinib cream over 52 weeks. *Journal of the European Academy of Dermatology and Venereology*.

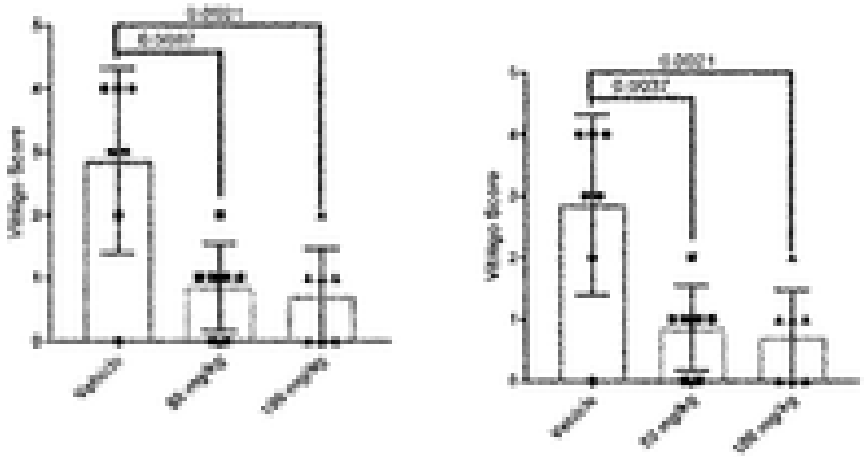
	https://doi.org/10.1111/jdv.20236
Original URL	https://onlinelibrary.wiley.com/doi/10.1111/jdv.20236
Source type	Journal Article
Keywords	Ruxolitinib, JAK1/2, repigmentation, Vitiligo Area Scoring Index
#Tags	#vitiligo #methods
Summary of key points + notes (include methodology)	Phase 3 studies were run over the course of 52 weeks with patients with nonsegmental vitiligo. They were given a ruxolitinib, or JAK1/JAK2 inhibitor topical treatment, and it was found that repigmentation was successful. These trials were run on different parts of the body: arm, hand, knee, neck, and trunk/torso. They found that head and neck regions repigmented the best, and bony areas like fingers or feet the least. The sample size was 661, and there was a negative control/vehicle group of around 218 patients.
Research Question/Problem/ Need	How reliable and effective is ruxolitinib cream for repigmenting vitiligo affected patches of skin?

Important Figures	(a)  (b)  (c)  (d)  Both figures display data collected from using the cream over 52 weeks in different regions of the body. The chart shows the data, while the picture grid provides progress pictures.

	
VOCAB: (w/definition)	Vehicle group: a type of negative control, an item where the test system should not respond.
Cited references to follow up on	6 Hamzavi I, Rosmarin D, Harris JE, Pandya AG, Lebwohl M, Gottlieb AB, et al. Efficacy of ruxolitinib cream in vitiligo by patient characteristics and affected body areas: descriptive subgroup analyses from a phase 2, randomized, double-blind trial. *J Am Acad Dermatol*. 2022; **86**: 1398–1401. View | CAS | PubMed | Web of Science® | Google Scholar
Follow up Questions	How would the results change if patients with segmental vitiligo were used? How much longer could the trial time go on for the treatment to reach its plateau? Why did the treatment not work as well near bony areas, like fingers and feet?

Patent #1 Notes: Compositions and methods for treatment of vitiligo

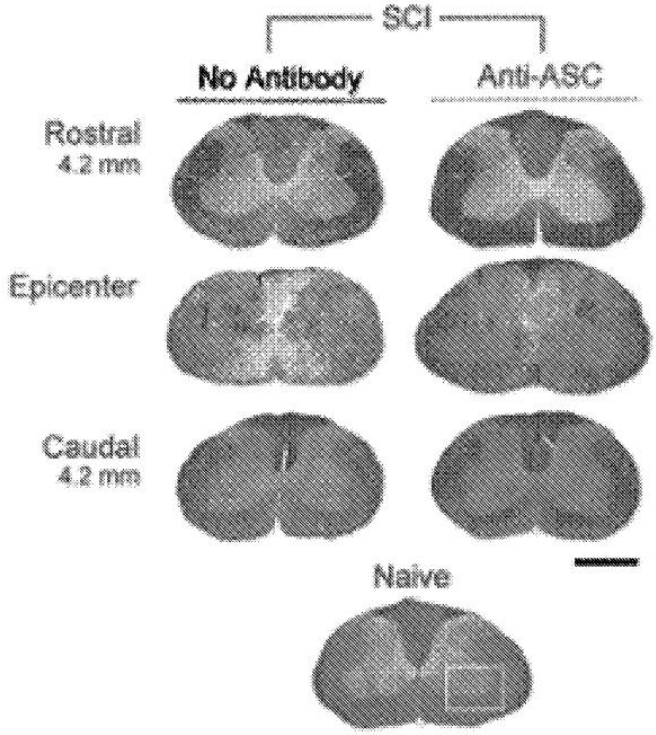
Source Title	Compositions and methods for treatment of vitiligo

Source citation (APA Format)	Shanler, S. D., Dick, E., Walker, N. S., Powala, C. (2019). *Compositions and methods for treatment of vitiligo* (U.S. Patent No. US20190060311A1). U.S. Patent and Trademark Office. https://patentimages.storage.googleapis.com/21/bd/96/028a6a1674245e/US20190060311A1.pdf
Original URL	https://patentimages.storage.googleapis.com/21/bd/96/028a6a1674245e/US20190060311A1.pdf
Source type	Patent
Keywords	JAK, STAT, gene therapy, vitiligo
#Tags	#introduction, #vitiligo
Summary of key points + notes (include methodology)	The patent is for JAK/STAT modulating compounds, which can be used for topical or oral treatment. The types of treatment for the different types of vitiligo – segmental, non-segmental, mixed, focal, and mucosal vitiligo are included in the treatment. The exact chemical formula for the compounds is also included. The data was obtained from clinical trials of non-segmental vitiligo.
Research Question/Problem/ Need	How can different treatments effectively treat vitiligo?
Important Figures	 These graphs show data from the researchers' trials about the effectiveness of their treatments based on a VASI, or vitiligo area scoring index.
VOCAB: (w/definition)	Heterocyclic: a compound that has a molecule containing a ring of atoms of at least two elements
Cited references to follow up on	ES2880622T3 * 2010-07-28 2021-11-25 Rigel Pharmaceuticals Inc Compositions and procedures for inhibition of the JAK pathway WO2014043257A1 * 2012-09-12 2014-03-20 Rigel Pharmaceuticals, Inc. Treatment for vitiligo
Follow up Questions	How can this treatment be made more effective?

	Would a new patent have to be filed if the treatment was able to be improved? Are there other patents on JAK1/2 inhibitors?

Patent 2 Notes: Methods of modulating inflammasome activity to treat inflammatory conditions

Source Title	Methods of modulating inflammasome activity to treat inflammatory conditions
Source citation (APA Format)	Keane, R. W., Dietrich, W. D., Vaccari, J. P., Bramlett, H. M. (2020). *Methods of modulating inflammasome activity to treat inflammatory conditions* (U.S. Patent No. US20200354442A1). U.S. Patent and Trademark Office. https://patentimages.storage.googleapis.com/69/8d/02/0fcdaeb1a0adc5/US20200354442A1.pdf
Original URL	https://patentimages.storage.googleapis.com/69/8d/02/0fcdaeb1a0adc5/US20200354442A1.pdf
Source type	Patent
Keywords	Inflammation, Central Nervous System, Stroke, Spinal Injury, Antibodies, neuroscience
#Tags	#methods #introduction #genetherapy
Summary of key points + notes (include methodology)	ASC and NALP1 are components of inflammasomes in the central nervous system, which can cause inflammation in mammals. The researchers developed specific antibodies targeting these components to reduce inflammation and tissue damage for inflammatory disease. This was tested with rodents as a model organism, which were injected with the antibody to see if inflammatory response increased or decreased. Overall, this experiment highlighted the therapeutic potential of targeting the central nervous system to reduce inflammation.
Research Question/Problem/ Need	Can inflammasome activity be altered to reduce inflammation and treat inflammatory diseases?

Important Figures	 **FIG. 2A** These images show cross sections of spinal cords of animals treated by the antibody and non-treated. The animals with the anti-ASC had significantly reduced lesion volume (43%), which was determined by diminished white matter degeneration.
VOCAB: (w/definition)	Inflammasome: a complex that detects threats and initiates inflammation as a response. They are located in the cytoplasm of cells.
Cited references to follow up on	US8685400B2 2007-07-30 2014-04-01 University Of Miami Modulating inflammasome activity and inflammation in the central nervous system
Follow up Questions	What pathways are involved with the antibody targeting of ASC and NALP1? Is this homologous to humans? What are some potential side effects of this treatment?

Article #11 Notes: A deep learning-based hybrid artificial intelligence model for the detection and severity assessment of vitiligo lesions

Source Title	A deep learning-based hybrid artificial intelligence model for the detection and severity assessment of vitiligo lesions
Source citation (APA Format)	Guo, L., Yang, Y., Ding, H., Zheng, H., Yang, H., Xie, J., Li, Y., Lin, T., & Ge, Y. (2022). A deep learning-based hybrid artificial intelligence model for the detection and severity assessment of vitiligo lesions. *Annals of Translational Medicine*, *10*(10), 590–590. https://doi.org/10.21037/atm-22-1738
Original URL	https://pmc.ncbi.nlm.nih.gov/articles/PMC9201159/
Source type	Journal Article
Keywords	Colorimetric, convolutional neural network, deep learning, morphometric, objective
#Tags	#machinelearning #vitiligo
Summary of key points + notes (include methodology)	Researchers used two DCNNs to analyze around 4,000 images from Chinese patients (Fitzgerald skin types III or IV). This was done using the softwares YOLOv3 and Unet++. They compared the three DCNNs, then the results were analyzed using the Jaccardi Index. They concluded that their model, specifically the YOLOv3 one, had an accuracy rate of around 93%. This would be useful in quickly diagnosing and identifying vitiligo, as well as determining severity without extensive laboratory procedures.
Research Question/Problem/ Need	What is a facile, quick, and cost-effective way to objectively diagnose vitiligo?
Important Figures	Figure 1: An overview of the development of the authors' DCNN machine learning model.

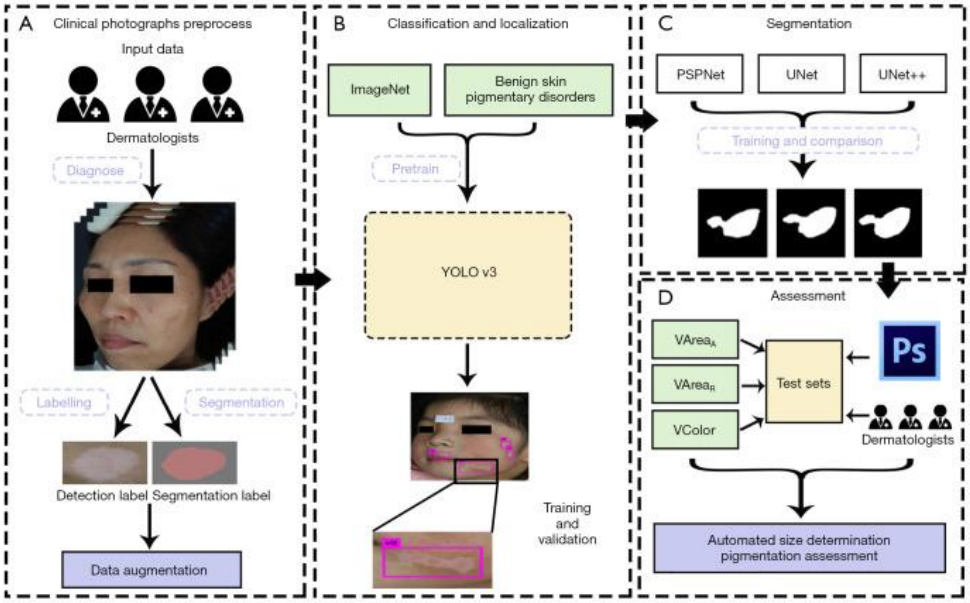
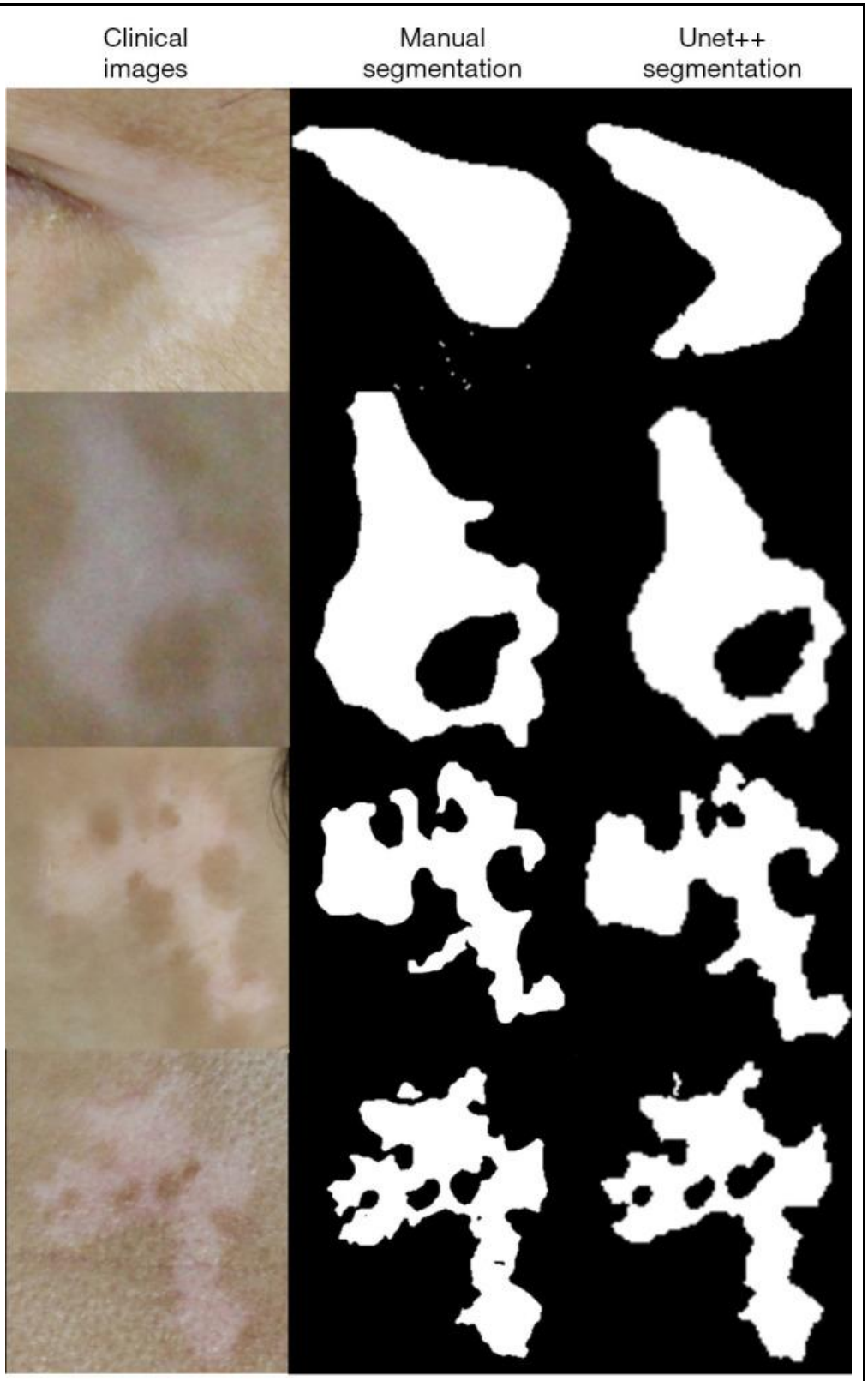


Figure 2: Datasets used in the training and development of the model.

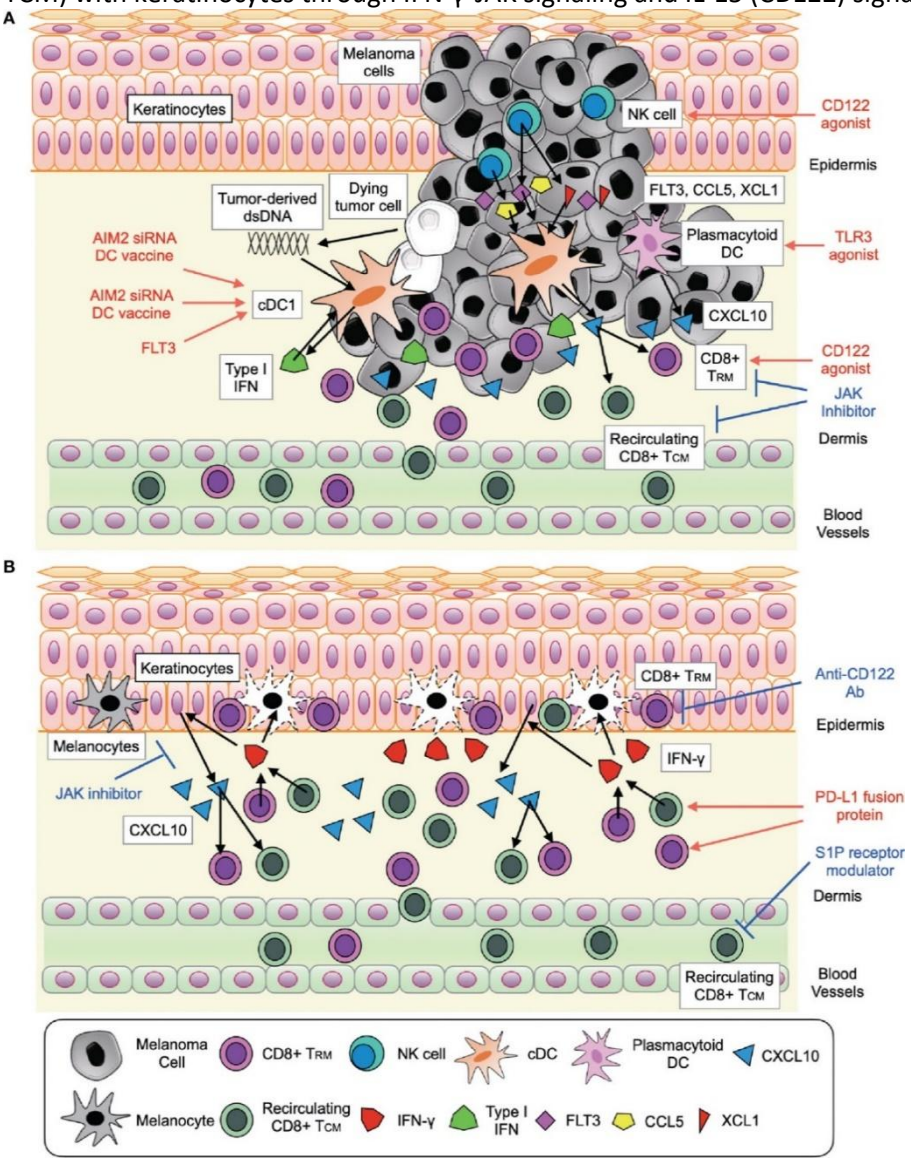
Figure 3. Sample comparisons of lesion segmentation between UNet++ architecture and dermatologists.

	
VOCAB: (w/definition)	

Cited references to follow up on	2. Zhang JZ, Luo D, An CX, et al. Clinical and epidemiological characteristics of vitiligo at different ages: An analysis of 571 patients in Northwest China. International Journal of Dermatology and Venereology 2019;2:165-8. 10.1097/JD9.0000000000000028 [DOI] [Google Scholar] 3. Linthorst Homan MW, Spuls PI, de Korte J, et al. The burden of vitiligo: patient characteristics associated with quality of life. J Am Acad Dermatol 2009;61:411-20. 10.1016/j.jaad.2009.03.022 [DOI] [PubMed] [Google Scholar]
Follow up Questions	How can this code be adapted to fit an antigen study? Were other skin pigmentation conditions, such as melasma or hyperpigmentation considered when they made this model? Could this model be scaled for other diseases, such as melanoma or melasma?

Article #12 Notes: Networks of CD8+ T Cell Response Activation in Melanoma and Vitiligo

Source Title	Networks of CD8+ T Cell Response Activation in Melanoma and Vitiligo
Source citation (APA Format)	Fukuda, K. (2022). Networks of CD8+ T Cell Response Activation in Melanoma and Vitiligo. *Frontiers in Immunology*, *13*. https://doi.org/10.3389/fimmu.2022.866703
Original URL	https://www.frontiersin.org/journals/immunology/articles/10.3389/fimmu.2022.866703/full
Source type	Review Article
Keywords	CD8+ T Cells, Melanoma, Cancer, Vitiligo
#Tags	#vitiligo #background
Summary of key points + notes (include methodology)	This article reviews recent advancements in understanding the immune signaling pathways and cell types that regulate the migration, proliferation, and function of MSA-specific CD8+ T cells in melanoma and vitiligo. It discusses how cellular communications within the skin and tumor microenvironments influence these processes, and provides insights into potential therapeutic strategies for both conditions. The article reviews previous studies done clinically and in mouse models for both melanoma and vitiligo to compare their findings.
Research Question/Problem/ Need	How could immune responses in melanoma be connected to immune responses in vitiligo?
Important Figures	**Figure 1**: Signaling pathways involved in CD8+ T cell response activation and future therapeutic approaches in melanoma (A) and vitiligo (B). (A) The interaction of (i) CD8+ T cell (CD8+ TRM and recirculating CD8+ TCM) with cDC1 and plasmacytoid DC through type I IFN-CXCL10 signaling (ii) NK cell with cDC1 through FLT3, CCL5,

	and XCL1. (B) The interaction of CD8+ T cell (CD8+ TRM and recirculating CD8+ TCM) with keratinocytes through IFN-γ-JAK signaling and IL-15 (CD122) signaling. 
VOCAB: (w/definition)	
Cited references to follow up on	2. Teulings HE, Limpens J, Jansen SN, Zwinderman AH, Reitsma JB, Spuls PI, et al. Vitiligo-Like Depigmentation in Patients With Stage III-IV Melanoma Receiving Immunotherapy and its Association With Survival: A Systematic Review and Meta-Analysis. *J Clin Oncol* (2015) 33(7):773–81. doi: 10.1200/jco.2014.57.4756 PubMed Abstract | CrossRef Full Text | Google Scholar
Follow up Questions	Could vitiligo treatment potentially affect the expression of melanoma in patients? What are the specific melanocyte/melanoma-shared antigens most commonly targeted in vitiligo?

	Can antigen-prediction models for cancer (melanoma) be adapted for use in autoimmune diseases like vitiligo?

Article #13 Notes: Artificial intelligence applied in neoantigen identification facilitates personalized cancer immunotherapy

Source Title	Artificial intelligence applied in neoantigen identification facilitates personalized cancer immunotherapy
Source citation (APA Format)	Cai, Y., Chen, R., Gao, S., Li, W., Liu, Y., Su, G., Song, M., Jiang, M., Jiang, C., & Zhang, X. (2023). Artificial intelligence applied in neoantigen identification facilitates personalized cancer immunotherapy. *Frontiers in Oncology*, *12*. https://doi.org/10.3389/fonc.2022.1054231
Original URL	https://www.frontiersin.org/journals/oncology/articles/10.3389/fonc.2022.1054231/full
Source type	Review Article
Keywords	Cancer, Immunotherapy, Machine Learning, Neoantigen identification
#Tags	#methods #antigen #machinelearning
Summary of key points + notes (include methodology)	This article reviews currently existing prediction models, discusses limitations, and predicts development trends of ML and DL in this field. It analyzes the benefits of using deep learning in comparison to traditional cDNA library screening. The article goes in depth on how these models are able to predict mutated MHCs and TCRs, and how often hybrid models can be more beneficial than single types. Finally, they discuss the feature extraction tools and multi-layer neural network architectures in typical ML models used for neoantigen identification.
Research Question/Problem/ Need	There is a need for machine learning models that can predict immunogenic neoantigens.
Important Figures	Figure 1. Neural network architecture for this article. **Created with BioRender.com**.

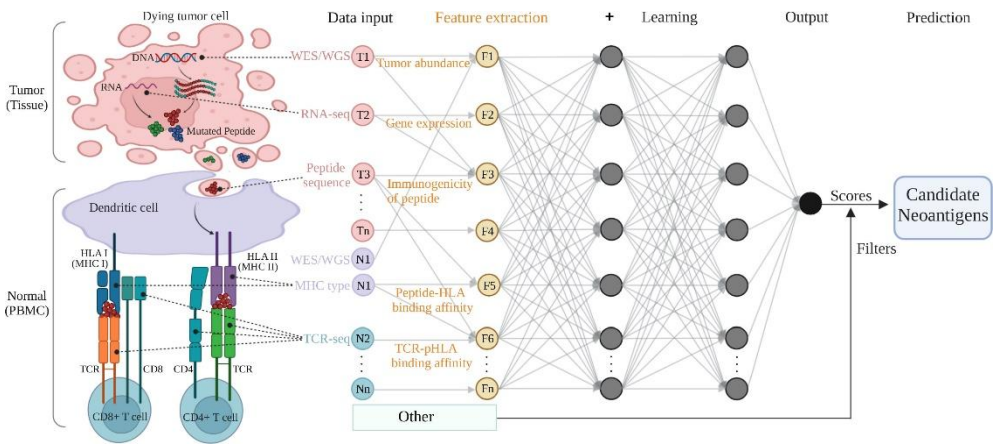
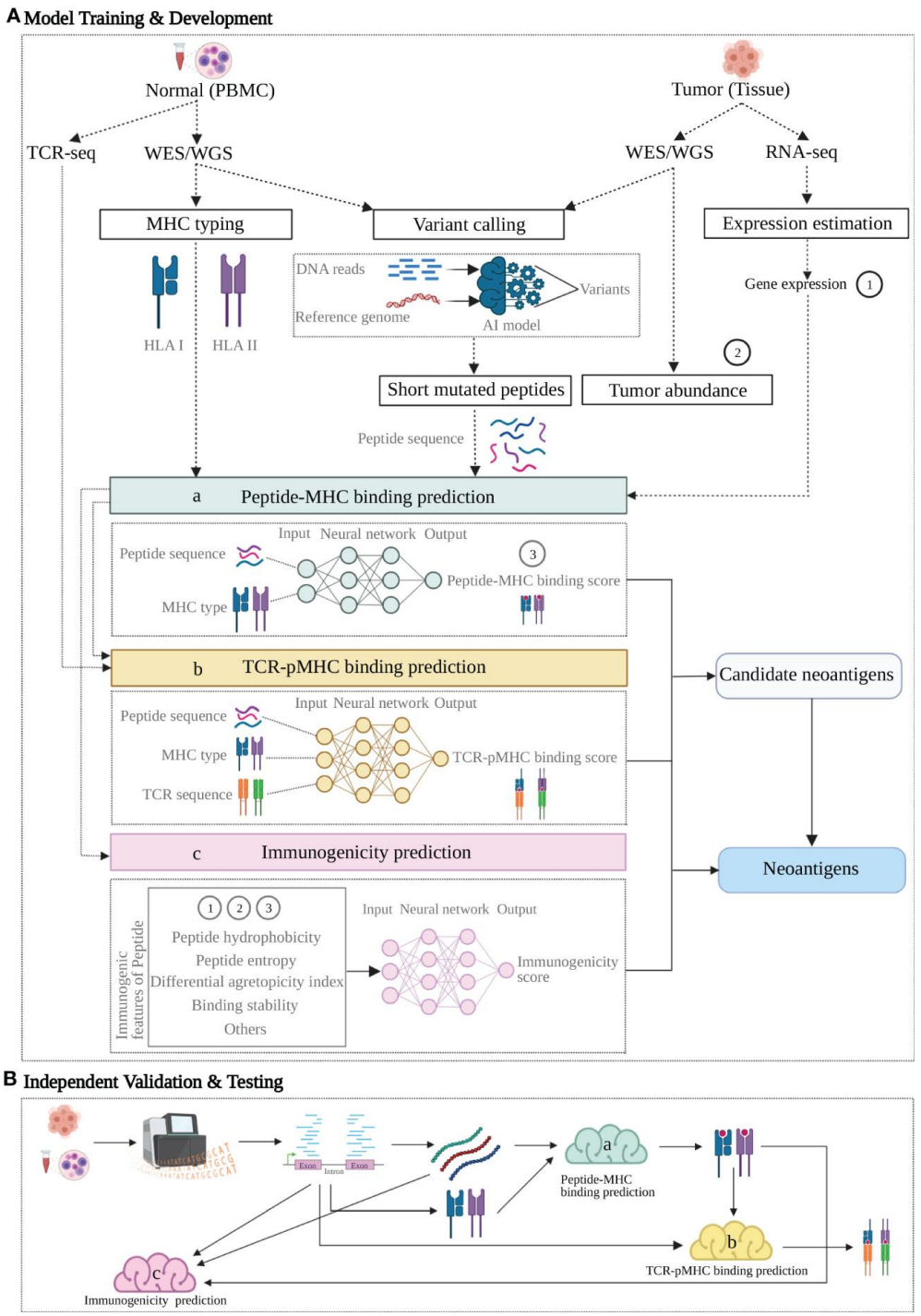


Figure 2. A proposed neoantigen-predicting workflow implemented with machine learning (ML) models targeting individual characteristics.



VOCAB: (w/definition)

Cited references to follow up on

6. Zheng A, Lamkin M, Zhao H, Wu C, Su H, Gymrek M. Deep neural networks identify sequence context features predictive of transcription factor binding. *Nat Mach Intell* (2021) 3(2):172–80. doi: 10.1038/s42256-020-00282-y

PubMed Abstract | CrossRef Full Text | Google Scholar

Follow up Questions	Which machine learning or deep learning models are most used in neoantigen prediction? Are there successful clinical trials/therapies utilizing machine learning models currently in cancer research? What are the ethical challenges of relying on AI for developing personalized immunotherapies?

Article #14 Notes: Vitiligo Antibodies Are Not Directed to Tyrosinase

Source Title	Vitiligo Antibodies Are Not Directed to Tyrosinase
Source citation (APA Format)	Xie, Z., Chen, D., Jiao, D., & Bystryn, J. C. (1999). Vitiligo Antibodies Are Not Directed to Tyrosinase. *JAMA Dermatology*, *135*(4). https://doi.org/10.1001/archderm.135.4.417
Original URL	https://jamanetwork.com/journals/jamadermatology/fullarticle/477805#:~:text=The%20melanocyte%20antibodies%20that%20occur,these%20in%2011%25%20of%20patients.
Source type	Journal Article
Keywords	Vitiligo, antigens, tyrosinase, antibodies, autoimmune disease
#Tags	#vitiligo #background
Summary of key points + notes (include methodology)	In this article, 54 vitiligo patients (40 with active, 14 with inactive) were gathered to detect antibodies present in their skin. Some patients exhibited antibodies that co-migrated with tyrosinase in immunoblot assays, more specific tests (immunoprecipitation DOPA stain and sandwich ELISA) did not detect anti tyrosinase antibodies in either vitiligo patients or controls. Their findings suggest that tyrosinase is not the antigen that triggers the depigmentation observed in vitiligo in patients.
Research Question/Problem/ Need	Are vitiligo antibodies directed to tyrosinase?
Important Figures	Figure 1: The identification of tyrosinase in extracts of melanocytes.

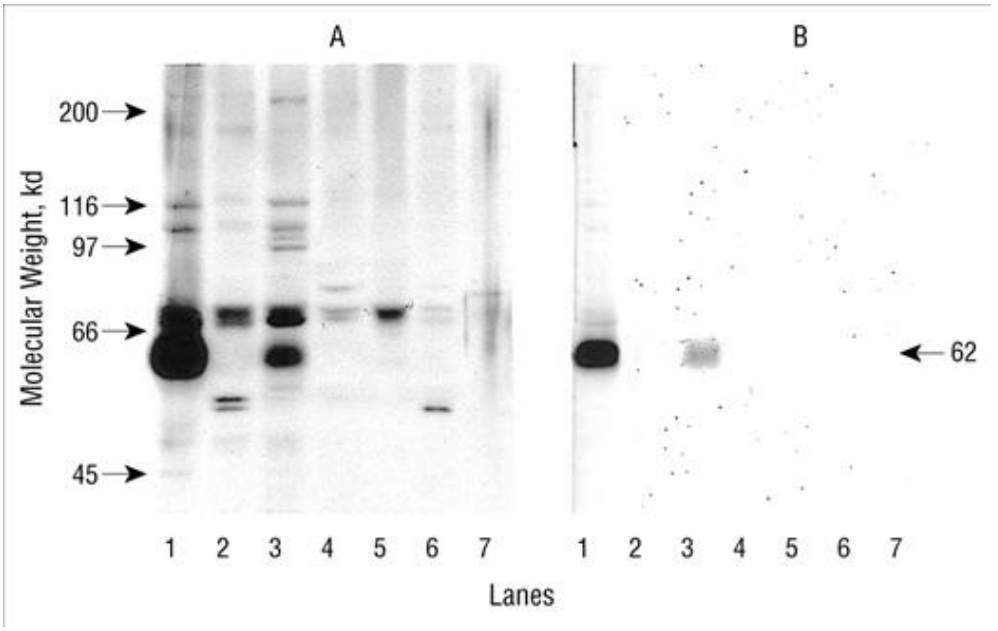


Figure 2: Immunoblotting assay of vitiligo and control serum for antibodies to human melanocytes.

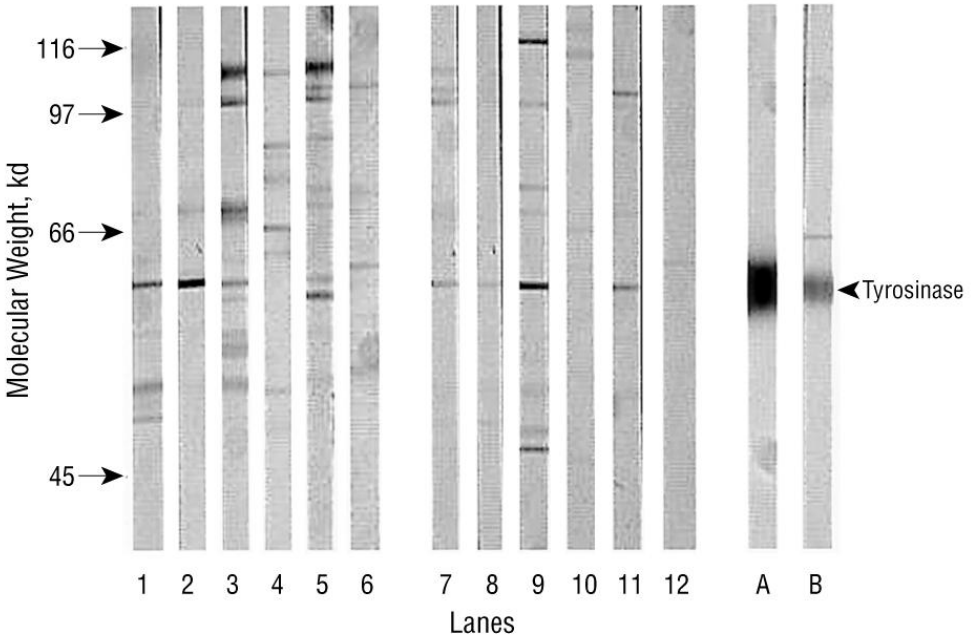


Figure 3: Immunoprecipitation DOPA stain assay for antibodies to tyrosinase in vitiligo and control serum samples.

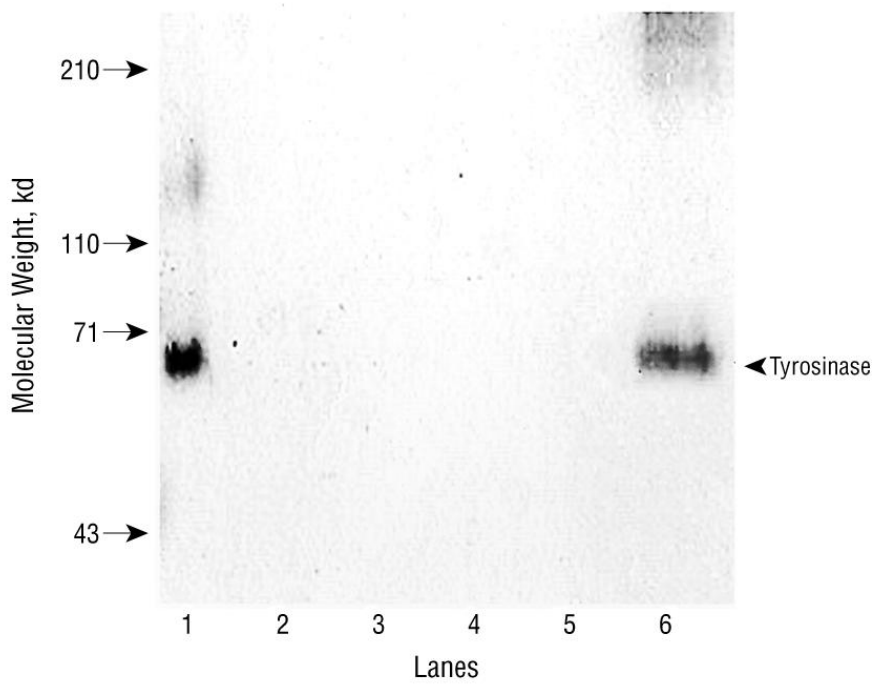
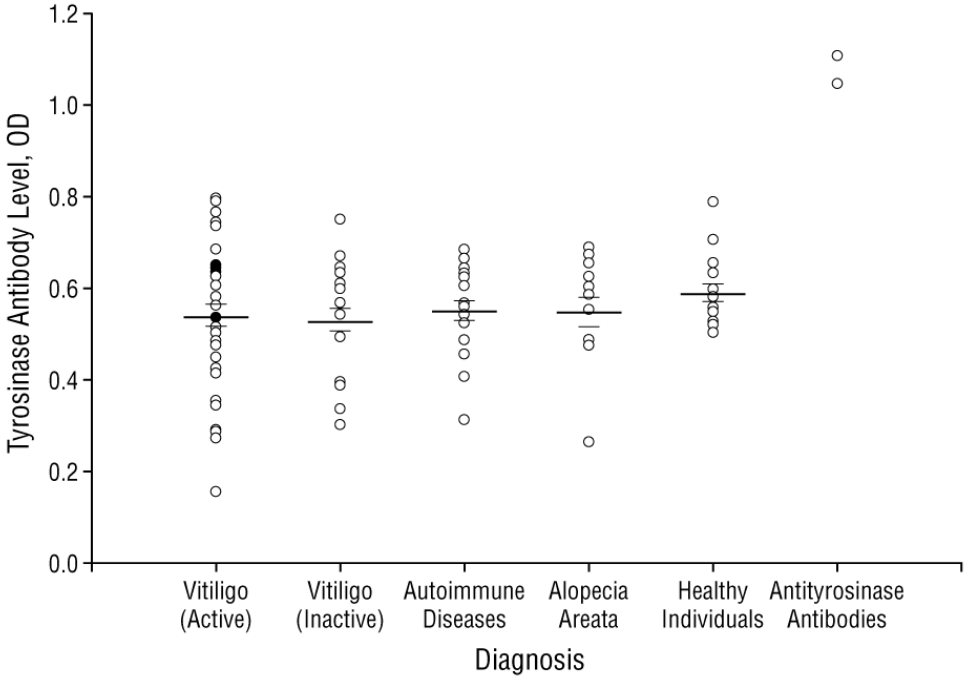


Figure 4: Double-sandwich enzyme-linked immunosorbent assay for antibodies to tyrosinase in vitiligo and control serum.

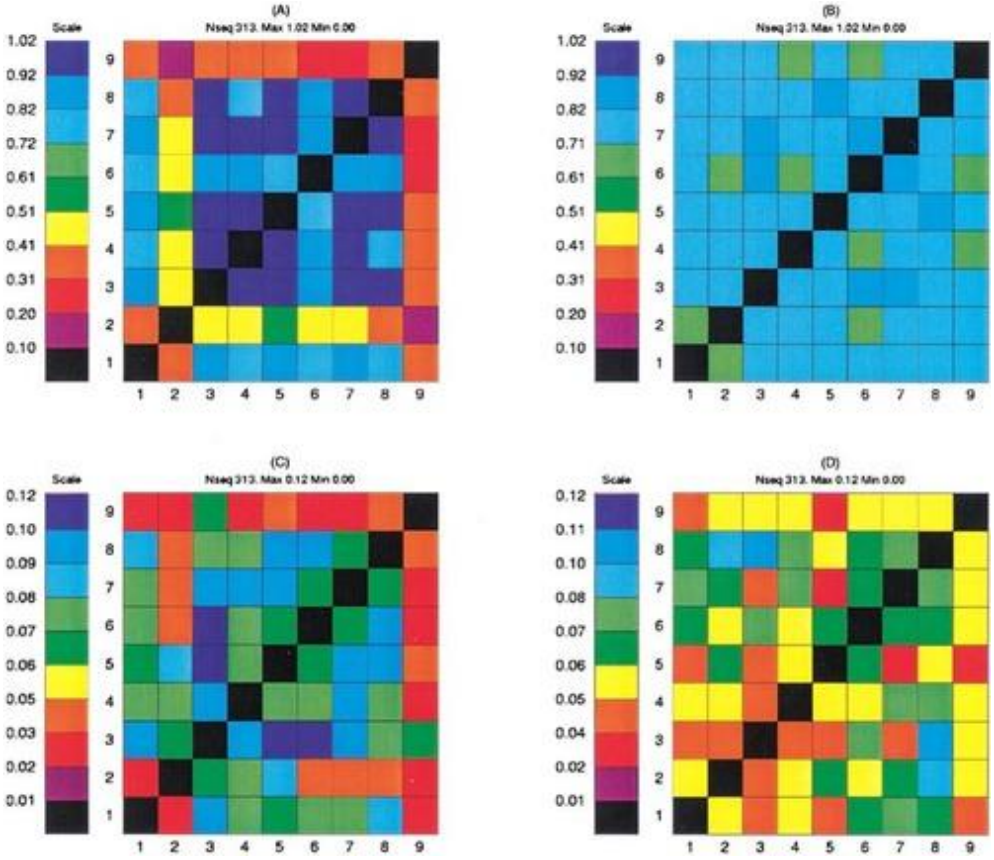


VOCAB: (w/definition)	ELISA: a type of test that detects and counts certain substances in bodily fluids

Cited references to follow up on	**5.** Naughton GKMahaffey MBystryn J-C Antibodies to surface antigens of pigment cells in animals with vitiligo. *Proc Soc Exp Biol Med.* 1986;181423- 426 Google Scholar | Crossref
Follow up Questions	What other antigens could be responsible for the trigger of depigmentation in patients? What experimental/clinical tests are best suited for a machine learning model? Are the types of antigens present different in active and stable vitiligo? What would this mean for the findings of this study?

Article #15 Notes: Reliable prediction of T-cell epitopes using neural networks with novel sequence representations

Source Title	Reliable prediction of T-cell epitopes using neural networks with novel sequence representations
Source citation (APA Format)	Nielsen, M., Lundegaard, C., Worning, P., Lauemøller, S. L., Lamberth, K., Buus, S., Brunak, S., & Lund, O. (2003). Reliable prediction of T-cell epitopes using neural networks with novel sequence representations. *Protein Science*, *12*(5), 1007–1017. https://doi.org/10.1110/ps.0239403
Original URL	https://onlinelibrary.wiley.com/doi/10.1110/ps.0239403
Source type	Journal Article
Keywords	T-cell class I epitope, HLA-A2, artificial neural network, hidden Markov model, sequence encoding, mutual information
#Tags	#machinelearning #background
Summary of key points + notes (include methodology)	The scientists combined different types of neural networks to create a more accurate model for the prediction of sequences in T-cell epitopes across the HCV genome. In addition, various inputs were used, such as sparse encoding, BLOSUM encoding, and features derived from hidden Markov models. Multiple neural networks were used for the outcome, making results more reliable on a variety of factors.
Research Question/Problem/ Need	How can we improve the accuracy and reliability of predicting T-cell epitopes and peptide-MHC binding to better support immunotherapy design?

Important Figures	Figure 1. Mutual information matrices calculated for two different data sets  Figure 2: Sensitivity/PPV plot calculated using a classification binding affinity of 500 nM for a series of linear combinations of the two neural network methods corresponding to Blosum50 and sparse sequence encoding, respectively. The curves were calculated by use of the Bootstrap method (Press et al. 1989) using 500 data set realizations.

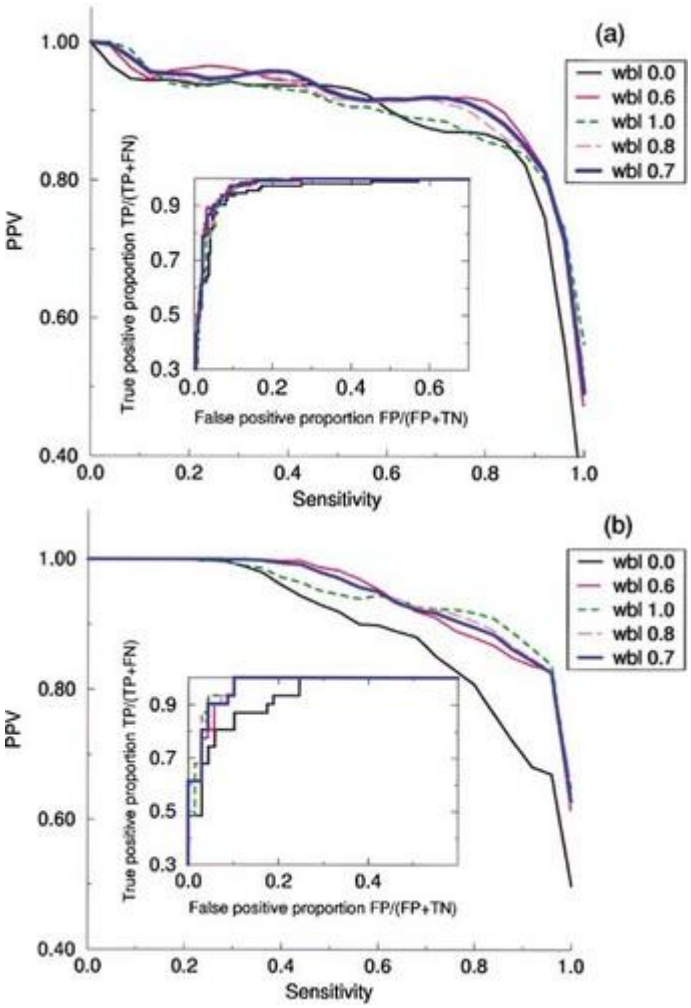


Figure 3: Scatter plot of the predicted score versus the measured binding affinity for the 528 peptides in the Buus data set.

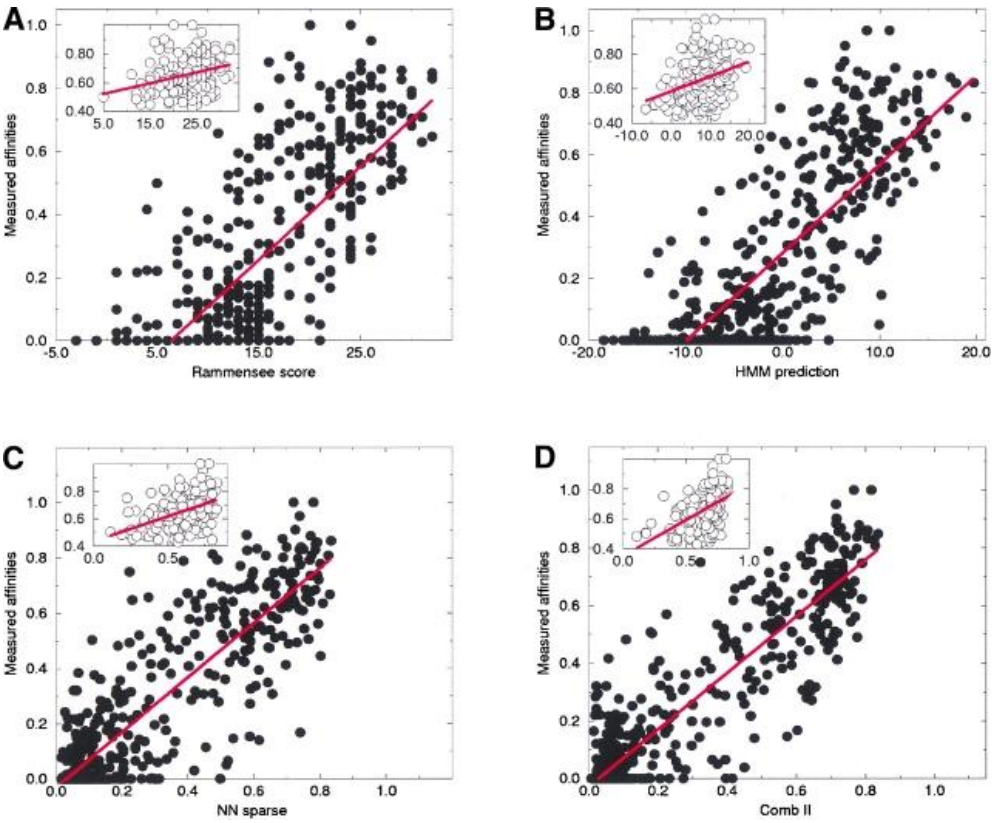
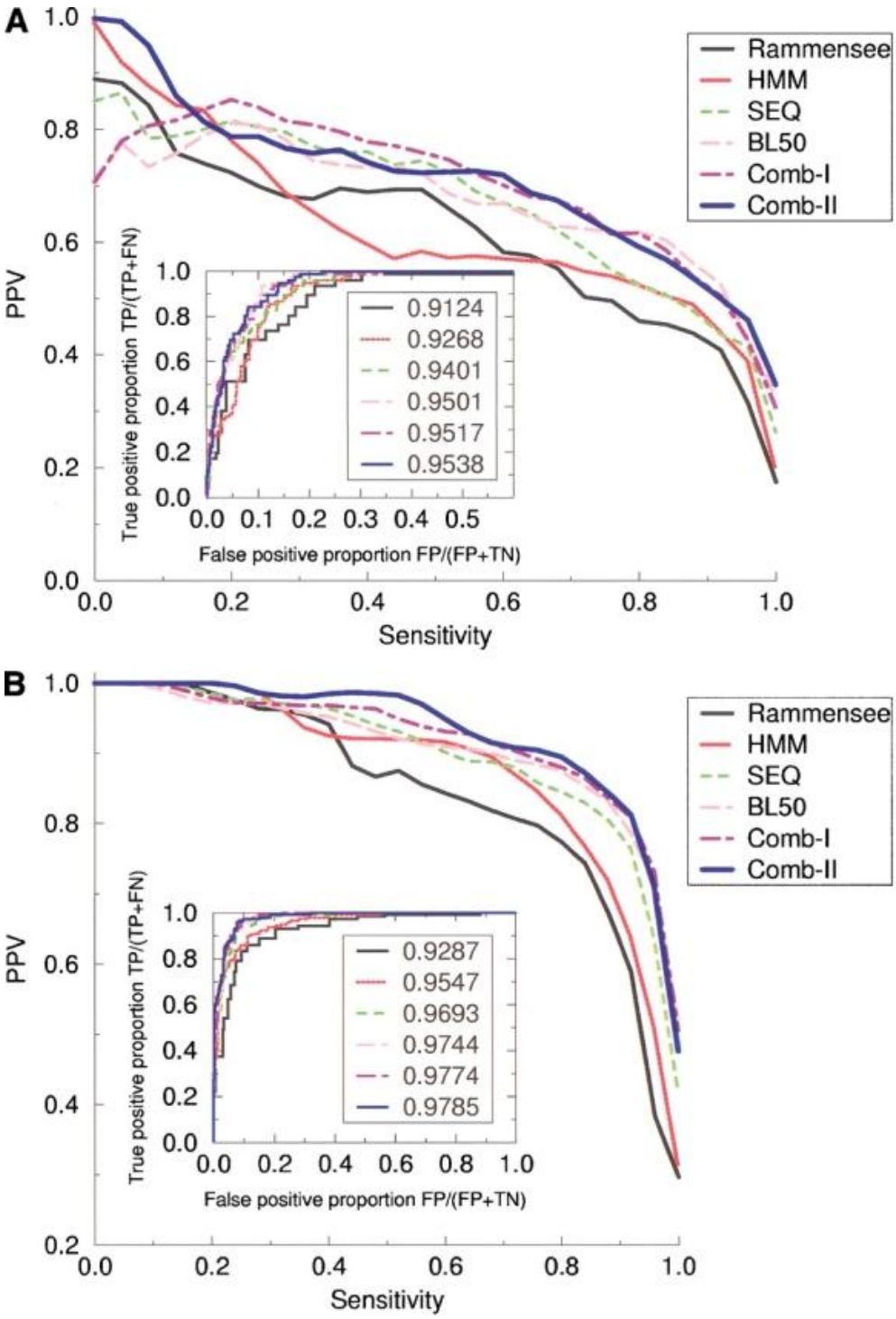


Figure 4: Sensitivity/PPV curves calculated from the 528-peptide data set.



VOCAB: (w/definition)	
Cited references to follow up on	3. Bairoch, A. and Apweiler, R. 2000. The SWISS-PROT protein sequence database and its supplement TrEMBL in 2000. Nucleic Acids Res. 28 45–48. [DOI] [PMC free article] [PubMed] [Google Scholar]

Follow up Questions	What specific sequence encoding methods (Sparse, BLOSUM, or hidden Markov models) are best suited for vitiligo? Could pre-trained models for T-cell epitope prediction be adapted to vitiligo? How can these findings be applied to other diseases?

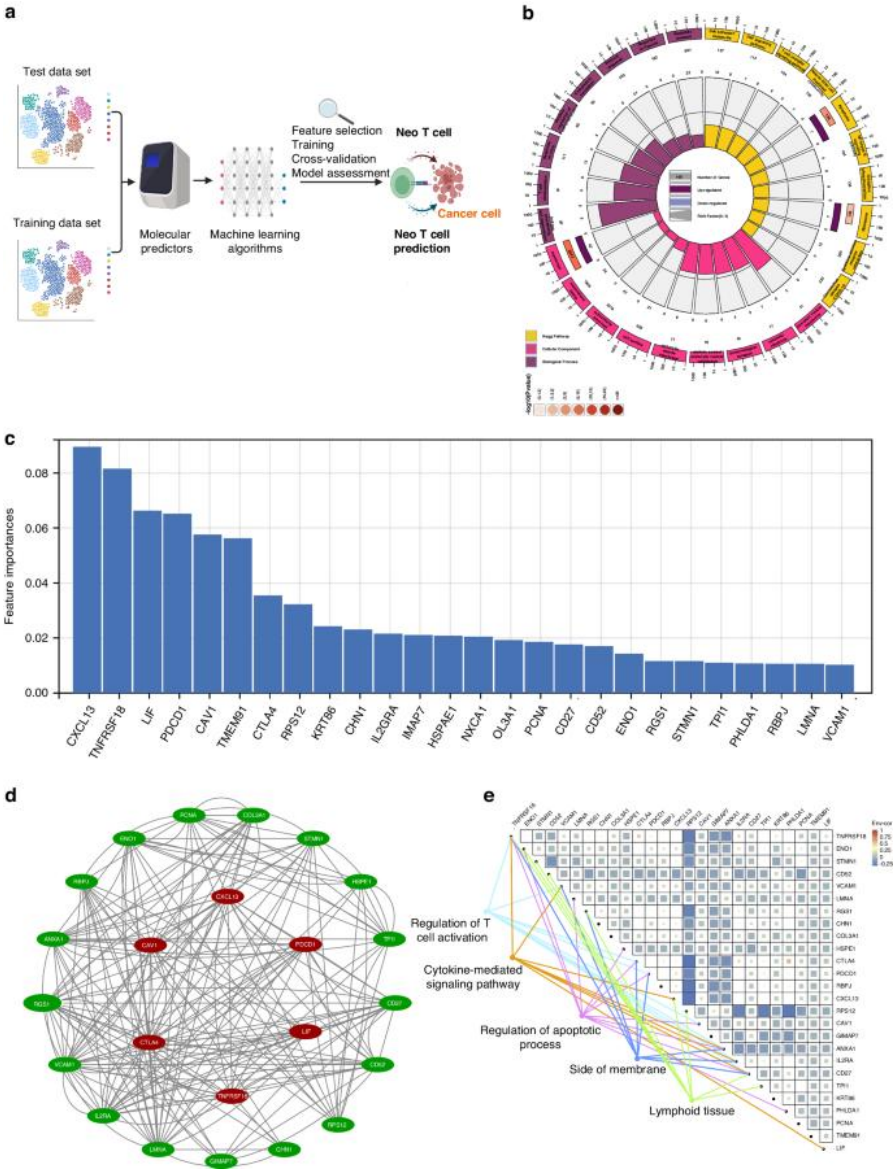
Article #16 Notes: Machine learning application in autoimmune diseases: State of art and future prospectives

Source Title	Machine learning application in autoimmune diseases: State of art and future prospectives	
Source citation (APA Format)	Danieli, M. G., Brunetto, S., Gammeri, L., Palmeri, D., Claudi, I., Shoenfeld, Y., & Gangemi, S. (2024). Machine learning application in autoimmune diseases: State of art and future prospectives. *Autoimmunity Reviews, 23*(2), 103496. https://doi.org/10.1016/j.autrev.2023.103496	
Original URL	https://www.sciencedirect.com/science/article/pii/S1568997223002306#:~:text=ML%20allows%20the%20creation%20of,patients%20with%20systemic%20autoimmune%20diseases.	
Source type	Review Article	
Keywords	Autoimmune diseases, Inflammatory bowel diseases, Machine learning, Rheumatoid arthritis, Systemic lupus erythematosus, Type 1 diabetes mellitus	
#Tags	#machinelearning #methods	
Summary of key points + notes (include methodology)	This article synthesizes and reviews several machine learning articles created to diagnose autoimmune diseases, such as CNNs, RNNs, and much more. They highlight the main benefits of machine learning, such as being able to predict organ damage before it happens and allowing for early identification of autoimmune diseases. The authors go in depth on existing models and possible future prospects for many different autoimmune diseases like alopecia, vitiligo, lupus, rheumatoid arthritis, and type 1 diabetes.	
Research Question/Problem/ Need	How can machine learning be used to better autoimmune disease treatment?	
Important Figures	No figures in article ☹️	
VOCAB: (w/definition)		

Cited references to follow up on	[3] G. Schett, A. Mackensen, D. Mougiakakos CAR T-cell therapy in autoimmune diseases Lancet, 0 (2023), 10.1016/S0140-6736(23)01126-1 ↗ View at publisher ↗ Google Scholar ↗ [4] A. Ghavidel, P. Pazos Machine learning (ML) techniques to predict breast cancer in imbalanced datasets: a systematic review J. Cancer Surviv. (2023), 10.1007/S11764-023-01465-3 ↗ View at publisher ↗ Google Scholar ↗
Follow up Questions	What types of omics data (e.g., genomic, proteomic, transcriptomic) are most relevant for identifying vitiligo-specific antigens? What challenges might arise in scaling ML-based prediction methods for broader use in autoimmune diseases? Which models most effectively synthesize different risk factors of autoimmune diseases – such as different existing conditions, environmental factors, or genetics?

Article #17 Notes: Machine learning for the identification of neoantigen-reactive CD8 + T cells in gastrointestinal cancer using single-cell sequencing

Source Title	Machine learning for the identification of neoantigen-reactive CD8 + T cells in gastrointestinal cancer using single-cell sequencing
Source citation (APA Format)	Sun, H., Han, X., Du, Z., Chen, G., Guo, T., Xie, F., Gu, W., & Shi, Z. (2024). Machine learning for the identification of neoantigen-reactive CD8 + T cells in gastrointestinal cancer using single-cell sequencing. *British Journal of Cancer, 131*(2), 387–402. https://doi.org/10.1038/s41416-024-02737-0
Original URL	https://www.nature.com/articles/s41416-024-02737-0#Sec12
Source type	Journal Article
Keywords	CD8+ T cells, cancer, machine learning, neoantigens
#Tags	#machinelearning #antigen #CD8+Tcells #background
Summary of key points + notes (include methodology)	By mapping neoantigen-reactive T cells from the single-cell transcriptomes of thousands of tumor-infiltrating lymphocytes, the authors developed a 26-gene

	machine learning model for the identification of neoantigen-reactive T cells. They used XGBoost, an ML Library, to train the model. The model was around 80% accurate for an independent single-cell dataset.
Research Question/Problem/ Need	Gastrointestinal cancer is primarily driven by CD8+ T cells; however, identification of Neo T cells and their receptors (TCRs) is time consuming. This identification would help with therapeutic solutions in the future.
Important Figures	Fig. 1: Feature importance analysis identified 26 genes robustly associated with Neo T cells.  Fig. 2: The 26-gene XGBoost-based model performed well on predicting Neo T cells.

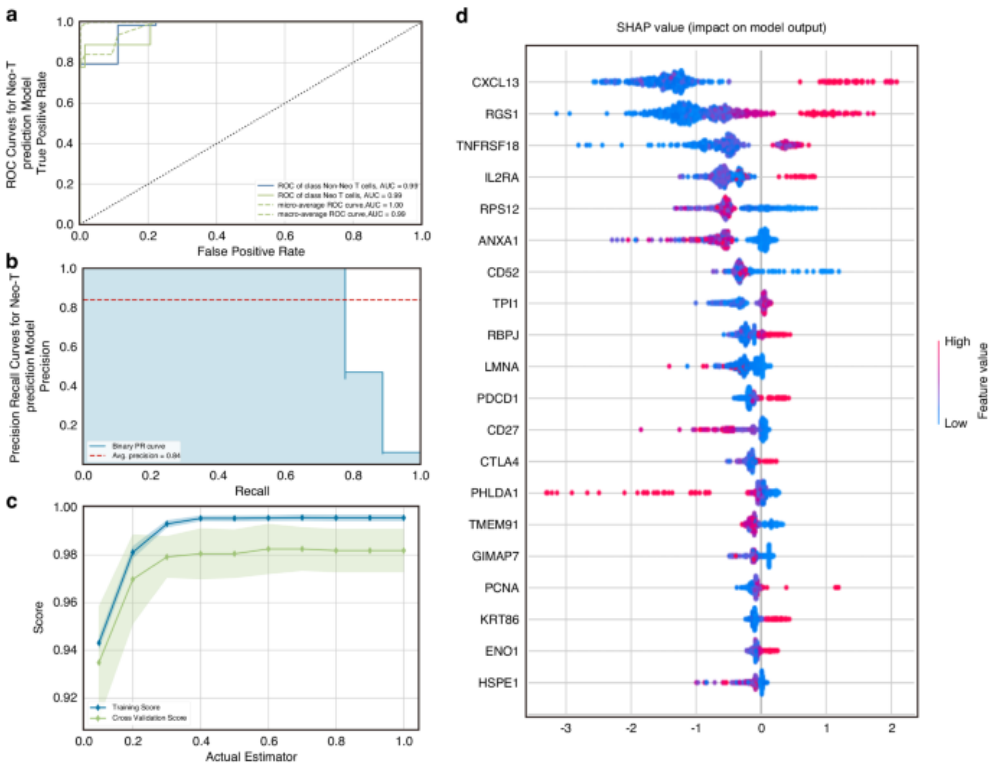


Fig. 3: Transcriptomic landscape of CD8+ TIL from human gastrointestinal cancer.

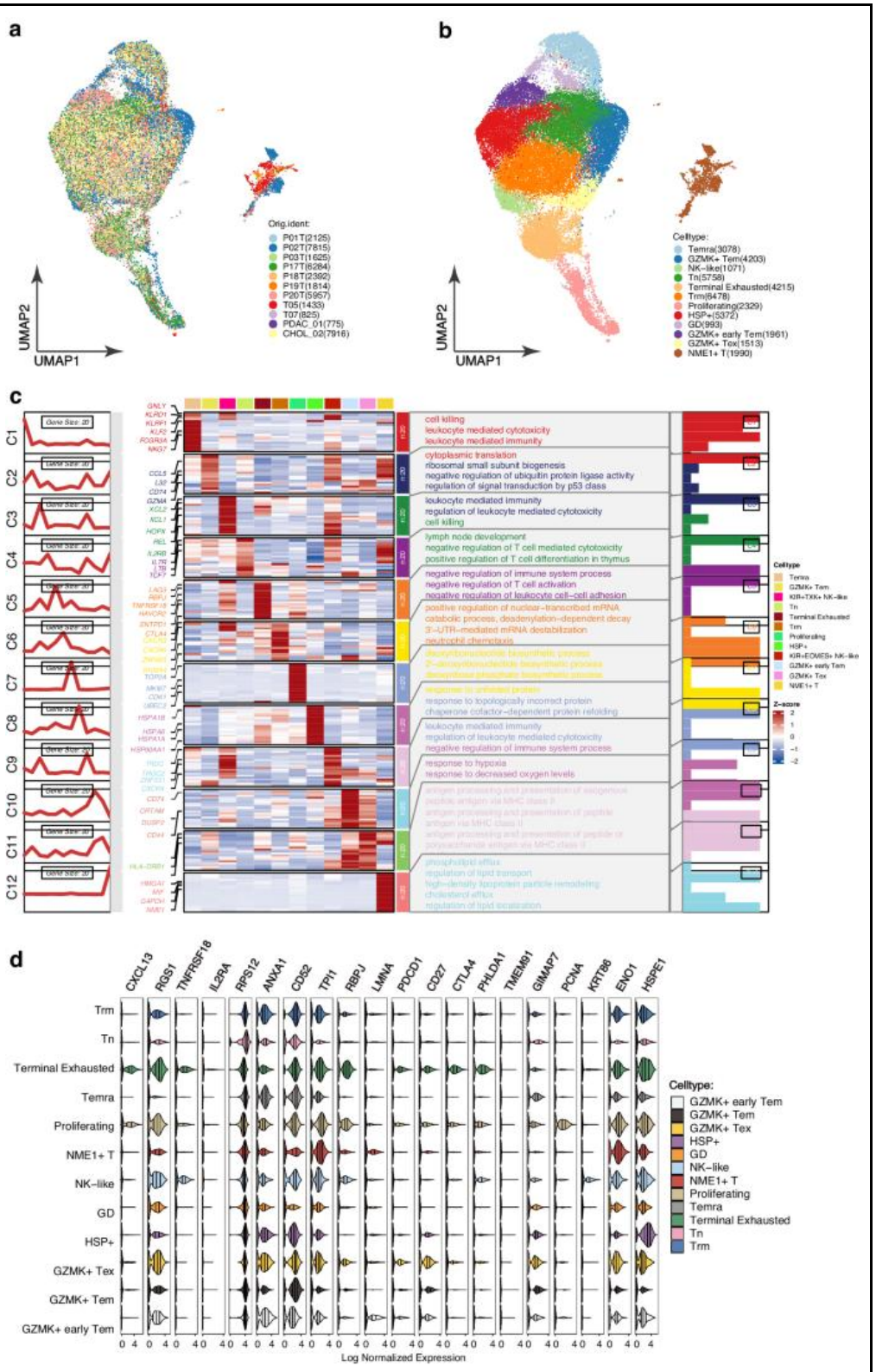
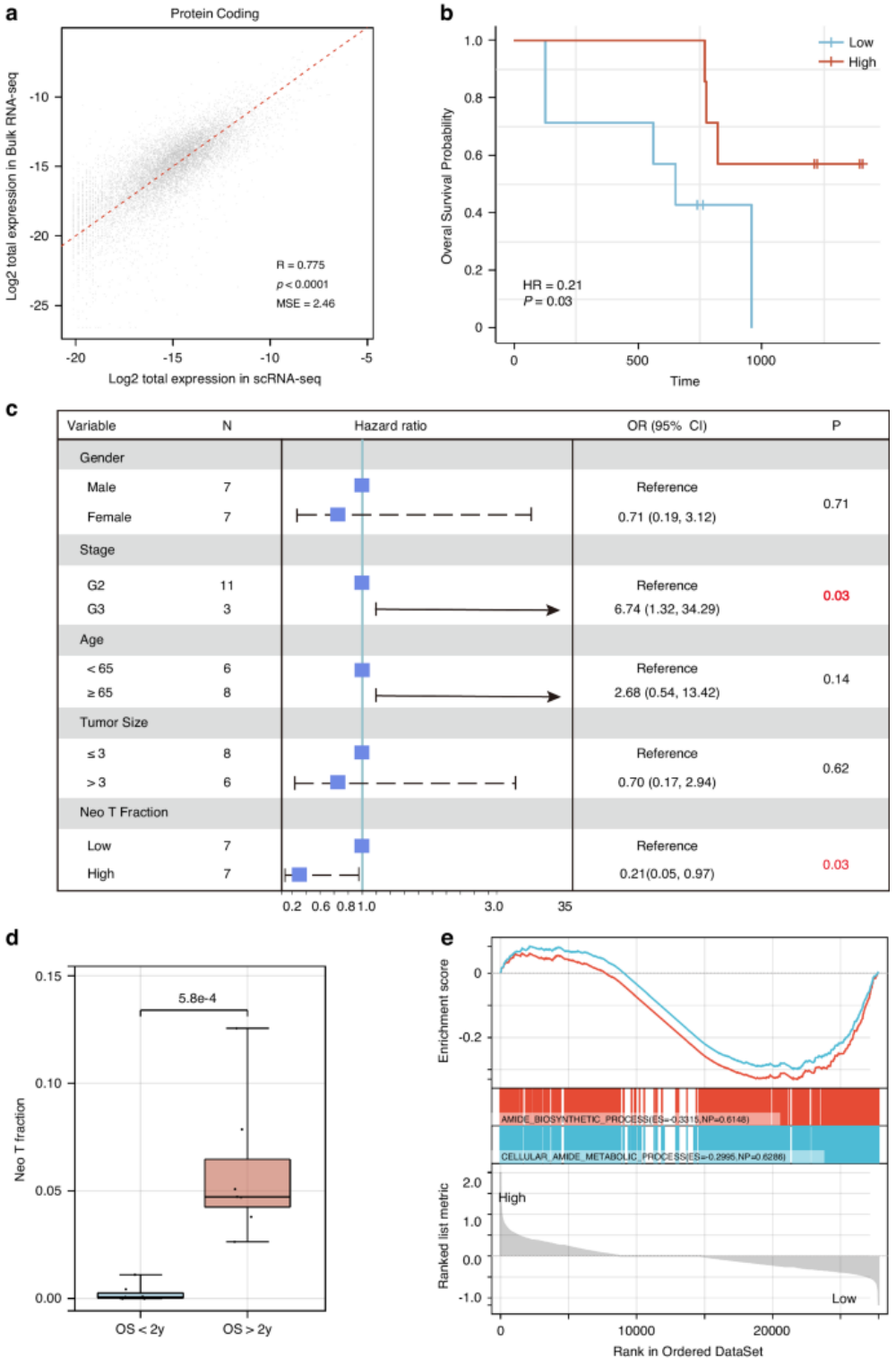


Fig. 8: The fraction of Neo T cells could be used as a potential biomarker for neoadjuvant treatment with anti-PD-1therapy.

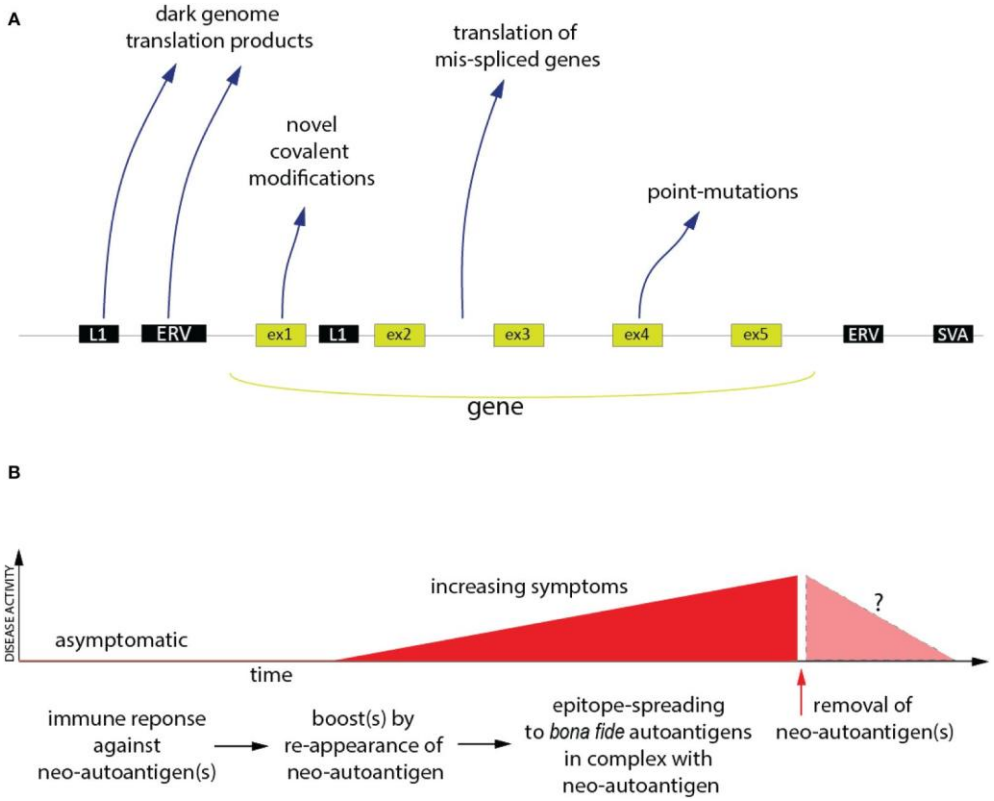


VOCAB: (w/definition)

Cited references to follow up on	2. Leidner R, Sanjuan Silva N, Huang H, Sprott D, Zheng C, Shih Y-P, et al. Neoantigen T-cell receptor gene therapy in pancreatic cancer. N Engl J Med. 2022;386:2112–9. Article CAS PubMed PubMed Central Google Scholar 12. Greener JG, Kandathil SM, Moffat L, Jones DT. A guide to machine learning for biologists. Nat Rev Mol Cell Biol. 2022;23:40–55. Article CAS PubMed Google Scholar
Follow up Questions	Could the same/a similar method work for vitiligo or autoimmune disease? Are there any side effects to neo-antigen treatment? Would non-T-cell related factors, such as genetics or existing conditions, need to be included in the model if they had an impact on the expression of this cancer?

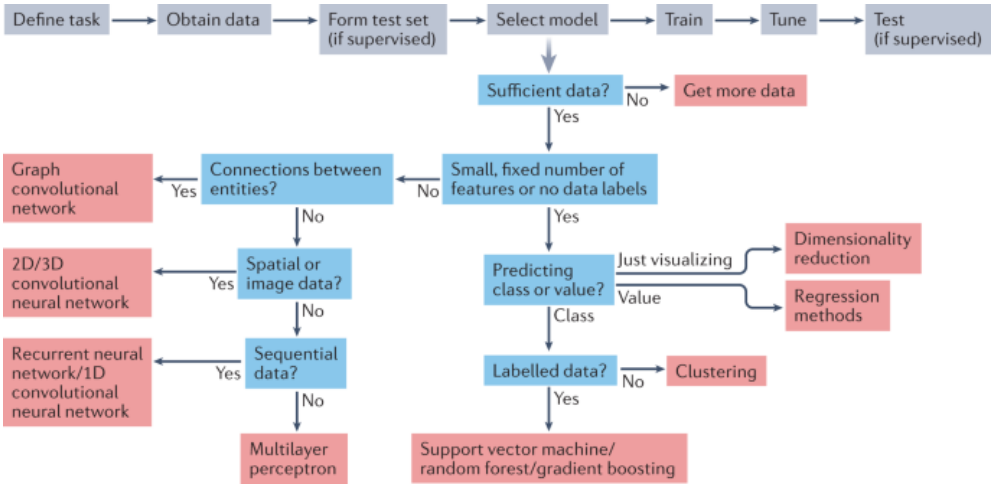
Article #18 Notes: Autoimmunity: the neoantigen hypothesis

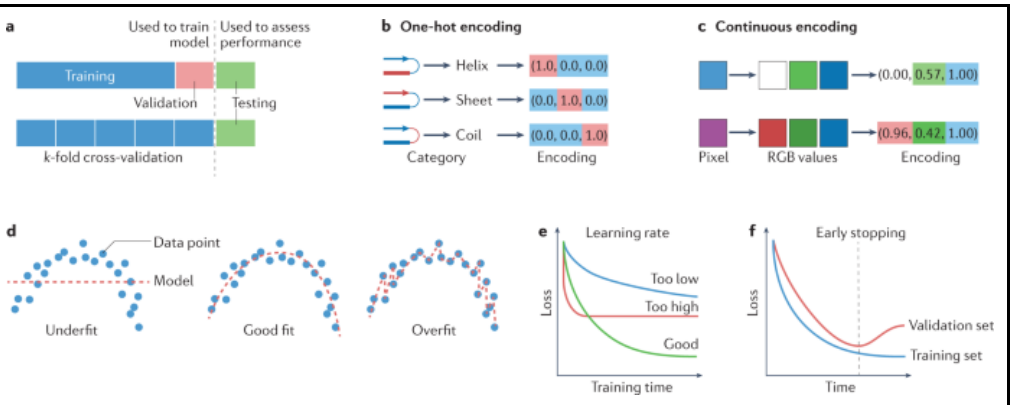
Source Title	Autoimmunity: the neoantigen hypothesis
Source citation (APA Format)	Mustelin, T., & Andrade, F. (2024). Autoimmunity: the neoantigen hypothesis. *Frontiers in Immunology*, *15*. https://doi.org/10.3389/fimmu.2024.1432985
Original URL	https://www.frontiersin.org/journals/immunology/articles/10.3389/fimmu.2024.1432985/full
Source type	Opinion Article
Keywords	Neoantigens, Autoimmune disease, T cells
#Tags	#CD8+Tcells #antigen
Summary of key points + notes (include methodology)	There are four dilemmas with the “loss of tolerance” concept in autoimmunity – the self does not change from before the patient is diagnosed with the disease, it is unable to explain many aspects of autoimmunity in patients, there are several genes involved in disease expression unrelated to the immune system, and the immune system of affected patients express very similar traits to normal individuals. The neo-antigen hypothesis, however, explains these fallacies, and would better fit the currently observed expression of autoimmune disease. Thus, the authors state that it is more likely for autoimmune disease to be caused by neo-antigens rather than the loss of tolerance of the immune system.
Research Question/Problem/	What causes autoimmune disease?

Need	
Important Figures	 **Figure 1** The Neoantigen Hypothesis. **(A)** The genomic and post-translational sources of the four principal categories of neo(auto)antigens. Novel covalent modifications are not restricted to exon-encoded proteins, but could, in principle, also affect the other classes of neoantigen polypeptides. **(B)** Proposed time-course of events in the pathogenesis of an autoimmune disease (red) driven by neo(auto)antigens and the hypothetical consequence of removal of the neoantigens (pink).
VOCAB: (w/definition)	Somatic (VEXAS) Syndrome: a rare genetic disease Proteolysis: breakdown of proteins into smaller polypeptides or amino acids - Wikipedia Loss of tolerance: The body's immune system is no longer tolerant of substances it should normally ignore, causing it to react and begin attacking itself. Stochastic: randomly determined; having a random probability distribution or pattern that may be analyzed statistically but may not be predicted precisely. – Oxford Dictionary
Cited references to follow up on	4. Moon JS, Younis S, Ramadoss NS, Iyer R, Sheth K, Sharpe O, et al. Cytotoxic CD8(+) T cells target citrullinated antigens in rheumatoid arthritis. *Nat Commun.* (2023) 14:319. doi: 10.1038/s41467-022-35264-8 PubMed Abstract | CrossRef Full Text | Google Scholar
Follow up Questions	Is it possible for both hypotheses to be true at once?

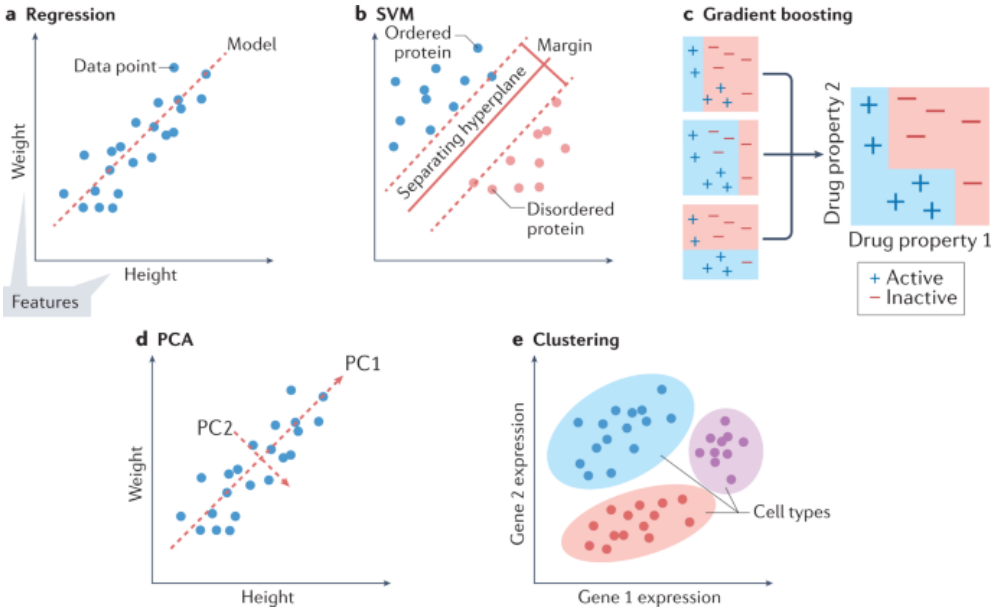
	Why hasn't this argument been made sooner? Are mutated genes or cells observed in all autoimmune disease after diagnosis?

Article #19 Notes: A guide to machine learning for biologists

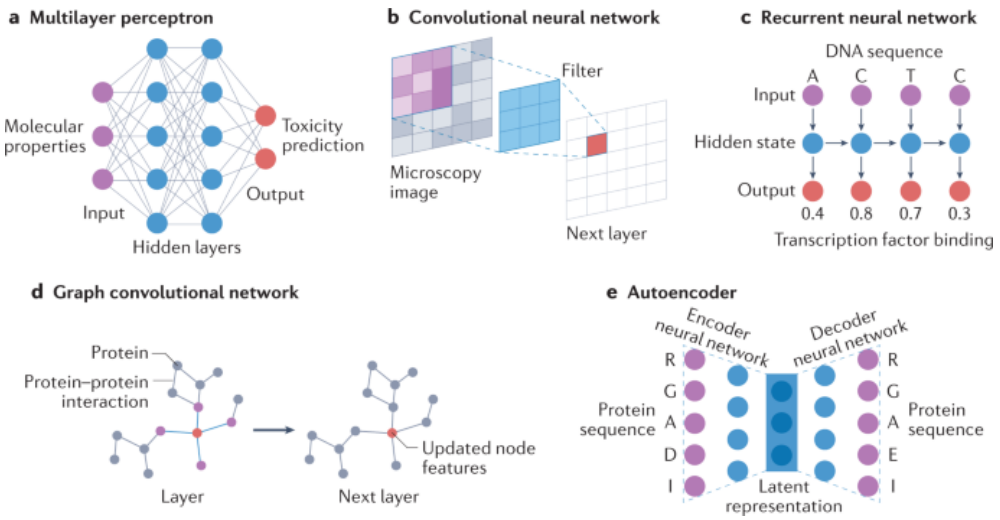
Source Title	A guide to machine learning for biologists
Source citation (APA Format)	Greener, J. G., Kandathil, S. M., Moffat, L., & Jones, D. T. (2021). A guide to machine learning for biologists. *Nature Reviews Molecular Cell Biology*, *23*(1), 40–55. https://doi.org/10.1038/s41580-021-00407-0
Original URL	https://www.nature.com/articles/s41580-021-00407-0
Source type	Review Article
Keywords	Machine learning, dataset, introduction
#Tags	#machinelearning
Summary of key points + notes (include methodology)	The authors review current ML techniques and provide examples of their applications in biology. They give advice on matching ML methods to specific data types and experimental goals. They discuss traditional ML models, as well as deep learning models like ANNs, CNNs, and RNNs.
Research Question/Problem/ Need	How can machine learning be utilized to improve concepts in biology?
Important Figures	 This figure shows how to choose a machine leaning method based on given data and objectives.



This figure shows how machine learning models are trained.

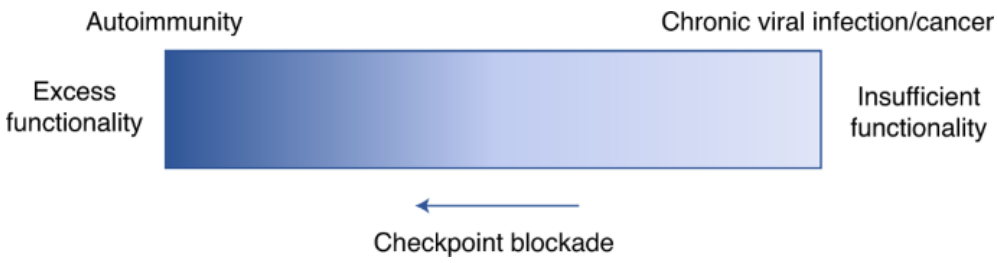


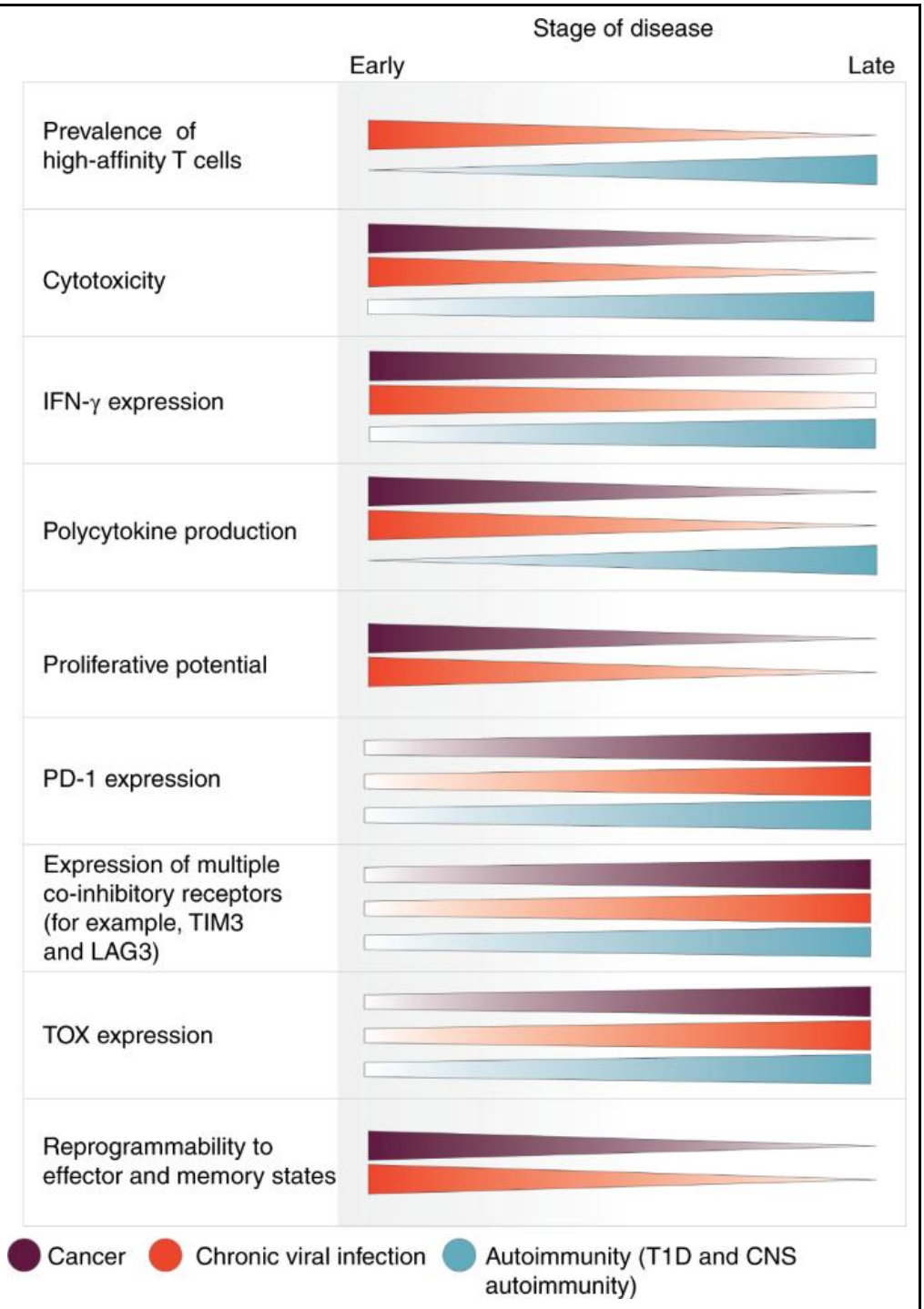
This figure shows traditional machine learning methods.

	 This figure illustrates different methods neural networks use to simulate the human brain.
VOCAB: (w/definition)	
Cited references to follow up on	1. Ching, T. et al. Opportunities and obstacles for deep learning in biology and medicine. *J. R. Soc. Interface* **15**, 20170387 (2018). **This is a thorough review of applications of deep learning to biology and medicine including many references to the literature.** PubMed PubMed Central Google Scholar
Follow up Questions	What machine learning model would be the best for my STEM project? Should I adjust my project to better fit a machine learning model? What platforms should I use to code for the models?

Article #20 Notes: Not-so-opposite ends of the spectrum: CD8+ T cell dysfunction across chronic infection, cancer and autoimmunity

Source Title	Not-so-opposite ends of the spectrum: CD8+ T cell dysfunction across chronic infection, cancer and autoimmunity
Source citation (APA Format)	Collier, J. L., Weiss, S. A., Pauken, K. E., Sen, D. R., & Sharpe, A. H. (2021). Not-so-opposite ends of the spectrum: CD8+ T cell dysfunction across chronic infection, cancer and autoimmunity. *Nature Immunology, 22*(7), 809–819. https://doi.org/10.1038/s41590-021-00949-7
Original URL	https://www.nature.com/articles/s41590-021-00949-7

Source type	Review Article
Keywords	CD8+ T cells, Cancer, Autoimmunity, cytotoxicity
#Tags	#melanoma #background #CD8+TCells
Summary of key points + notes (include methodology)	This article reviews previous studies done on CD8+ T cells in autoimmune disease, chronic infection, and cancer. They discuss how chronic infection and cancer are caused by T cell exhaustion, whist autoimmune disease is caused by dysregulation or overwork of T cells. By gaining a better insight into these mutations, we can improve current therapeutic strategies.
Research Question/Problem/ Need	Could treatment for cancer, autoimmune disease, and chronic infection be improved by gaining a better understanding of the connection between all three?
Important Figures	Figure 1: 'Opposite ends of the spectrum' framework of CD8+ T cells in autoimmunity versus chronic viral infection and cancer.  Figure 2: Temporal changes of CD8+ T cells in cancer, chronic viral infection and autoimmunity.

	
VOCAB: (w/definition)	Cytotoxicity: quality of being toxic to cells – News-Medical

Cited references to follow up on	3. Sinha, S., Boyden, A. W., Itani, F. R., Crawford, M. P. & Karandikar, N. J. $CD8^+$ T-cells as immune regulators of multiple sclerosis. *Front. Immunol.* **6**, 619 (2015). Article PubMed PubMed Central Google Scholar 4. Byrne, K. T. & Turk, M. J. New perspectives on the role of vitiligo in immune responses to melanoma. *Oncotarget* **2**, 684–694 (2011). Article PubMed PubMed Central Google Scholar
Follow up Questions	Could treatment for either disease increase risk for the other? Could treatment for either disease decrease risk for the other? How would both conditions be able to be accommodated in singular treatment? Are other immune cells, like B cells, also related in these conditions?