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Viscoelastic and Viscoplastic Glucose Theory (VGT #132): A Longevity Study in Gerontology and Geriatrics Using Two Different Energy Methods, Time Domain Analysis and Space Domain Analysis, to Calculate Various Energies or Degrees of Influence on Health Age and Age Difference versus Body Weight (m1), Glucose (m2), Blood Pressure (m3), and Blood Lipids (m4) Over 9+ Years from 1/1/2013 to 8/18/2022 Based on Math-Physical Medicine Method (No. 723)

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Keywords: Viscoelastic; Viscoplastic; Body weight; Glucose; Blood pressure; Blood lipid; Postprandial plasma glucose; Fasting plasma glucose; Type 2 diabetes; Fast Fourier transform

Abbreviations: FFT: fast Fourier transform; T2D: type 2 diabetes; PPG: postprandial plasma glucose; FPG: fasting plasma glucose; FD: frequency domain; SD: space domain; TD: time domain; MPM: math-physical medicine

1. INTRODUCTION

The author recently read a report titled, “Biological age, not birthdate may reveal healthy longevity” regarding gerontology and geriatrics from MDLinx written by the University of California - San Diego. The findings in the report have matched many of his published research papers on the subject of longevity. Therefore, for his future reference, he will keep the following short excerpt in his article:

「A first-of-its-kind study of 1,813 older women suggests that the accelerated biological aging of the body—epigenetic age acceleration specifically—is associated with lower odds of living to be 90 years old and also being physically mobile and having intact mental function.

In the July 27, 2022 online edition of JAMA Network Open, a multi-institutional team of researchers led by the Herbert Wertheim School of Public Health and Human Longevity Science at University of California San Diego reported that epigenetic age acceleration could be used as a biomarker for healthy longevity and to estimate functional and cognitive aging.

"Older people know well that age is just a number that may not be indicative of their health status. What if we had a way to measure how fast we were aging that could predict our odds of living a long and healthy life? In aging research, we call this an individual's healthspan," said principal investigator Andrea LaCroix, Ph.D., M.P.H., Distinguished Professor at the Herbert Wertheim School of Public Health and Human Longevity Science.

Chronological age is based on a person's birthdate. Epigenetic age refers to the biological age of a person's cells, tissues and organ systems.

If an individual's epigenetic age is greater than their chronological age, the person is undergoing epigenetic age acceleration,

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which is associated with higher risk of cancer, cardiovascular disease, Parkinson's disease and other diseases.

Based on four different epigenetic "clocks" that measure biological aging, every five to eight years of epigenetic age acceleration was associated with 20% to 32% lower odds of living to age 90 with intact mobility and cognitive function.

"Healthspan is important because the number of individuals who will live to be 90 years and older will quadruple from 1.9 million in 2016 to 7.6 million in 2050 in the United States alone," said LaCroix.

As part of the prospective study, the team analyzed data on physical and cognitive status from 1,813 women who participated in the Women's Health Initiative, a long-term national health study funded by the National Heart, Lung, and Blood Institute that began in 1993. The median age of death among Women's Health Initiative participants was 90 years.

Among this cohort, 464 (26%) women survived to the age of 90 with intact mobility and cognitive functioning, 420 (23%) lived to 90 but without intact mobility and cognitive functioning, and 929 (51%) women who died before reaching 90.

Study participants were 70 to 72 years old at baseline and were followed until at least age 90 or the time of their deaths. The associations of the epigenetic age acceleration clocks with healthy longevity were found to be independent of other characteristics more common among the long-lived women with intact mobility and memory compared to those who did not survive to age 90 including being white, having no or fewer chronic conditions at baseline, having higher education, not smoking and walking multiple times per week.

"Prior studies have shown that epigenetic age acceleration is associated with increased risk of death, and a few studies observed that slower age acceleration occurs among long-lived individuals. But this is the first study to prospectively examine the relationship between slower age acceleration and living to age 90 with preserved mobility and memory," said first author Purva Jain, Ph.D., who completed this work as part of her doctoral dissertation at UC San Diego.

"Furthermore, our study suggests we can use epigenetic age acceleration to estimate the risk of an individual not attaining healthy longevity, which could lead to future public health interventions to counteract poor health outcomes among older populations," said Jain.

More information: Purva Jain et al, Analysis of Epigenetic Age Acceleration and Healthy Longevity Among Older US Women, JAMA Network Open (2022). DOI: 10.1001/jamanetworkopen.2022.23285

Journal information: JAMA Network Open」

The author of this particular paper does not utilize statistics tools, other institutions, or patients collected data in his research work. Instead, he uses collected data from his own health conditions and applied his developed math-physical medicine (MPM) research methodology tools.

In 2014, the author applied the mathematical topology concept, nonlinear algebra and geometric algebra operations, and engineering finite-element technique, to develop a comprehensive mathematical algorithm for measuring human metabolism status, the metabolism index (MI) model.

This MI model contains ten specific categories, including four output categories of medical conditions (m1=body weight, m2=glucose, m3=blood pressure, and m4=lipids), and six input categories of lifestyle details (physical exercise=m5, water intake=m6, sleep=m7, stress=m8, food quantity and quality=m9, and daily life routines=m10). These 10 categories are comprised of approximately 500 detailed elements which include 4 basic chronic disease categories and 6 basic lifestyle categories. He has also defined two new resulting parameters: the metabolism index or MI, as the combined and normalized score of the above 10 metabolism categories and 500 elements using his developed algorithm, along with the general health status unit (GHSU), as the 90-day moving average value of MI.

A physical analogy of this mathematical metabolism model is similar to a model of "using multiple nails that are encircled by many rubber bands". For example, first, we hammer 10 nails into a piece of flat wood with an initial shape of a circle, then take 3,628,800 (=10!) rubber bands to encircle these 10 nails. The ~3.6 million rubber bands, indicating the big number of nails' inter-relationships, show the possible relationships existing among the 10 nails (10 original metabolism data). Some rubber bands encircle 2 or 3 nails and so on until the last rubber band encircles all of the 10 nails together (no rubber band to encircle a single nail is allowed since it does not create tension). Now, if we move any one of the nails outward (i.e., moving away from the center of the nail circle), then this moving action would create some internal tension inside the encircled rubber band. Moving one nail "outward" means one of the ten metabolism categories is becoming "unhealthy" which would cause some stress to our body. Of course, we can also move some or all of the 10 nails outward at the same time, but with different moving distances. If we can measure the summation of the internal tension created in the affected rubber bands, then this summarized tension force is equivalent to the total metabolism value or the overall health conditions. The higher tension means a higher metabolism value which develops into an unhealthy situation. The author uses the above-described scenario of moving nails and their encircled rubber bands to explain his developed mathematical metabolism index model of human health.

From 1/1/2012 to 8/16/2022, he collected more than 3 million data on his biomedical conditions and personal lifestyle details. Due to concerns of sufficient data collection and data integrity, he has selected a specific long period of 9+ years from 1/1/2013 through 8/16/2022 which has contained much more reliable and completed data for this particular longevity concern versus 4 chronic diseases (m1 = weight/obesity, m2 = glucose/diabetes, m3 = blood pressure/hypertension, and m4 = blood lipids/hyperlipidemia).

Here is his developed mathematical equation for estimated health age as follows:

Mathematical Health Age
= Real Biological Age * (1+((MI-0.735)/0.735)/2)

Age difference
= mathematical health age - biological real age

Where MI is a daily "metabolism index" value which is a combined score of 4 biomarkers of weight, glucose, blood pressure, and blood lipids along with 6 lifestyle details of food, water intake, exercise, sleep, stress, and daily life routines. Furthermore, a positive age difference number means a shorter expected lifespan and a negative age difference number indicates a longer expected lifespan.

Based on the above descriptions, his combined MI model and related mathematical health age equation is quite close to the concept of epigenetic age (which can be in a reversed order) as described in the UC San Diego article that refers to the biological age of a person's cells, tissues, and organ systems.

Regarding his medical research tools, the author has conducted medical research work using viscoelastic or viscoplastic glucose theory (VGT) starting on 1/8/2022 with Paper No. 578. During this past 8-month research period, he has written 130 papers where he has learned in depth the subtlety and things to watch out for by applying this specific VGT research tool in his biomedical research work.

In the following section of methods, he provides a brief description of the SD-VGT tool using English words instead of physics or engineering theories with complex mathematical equations. The data processing work is conducted using his developed VGT software module. Unfortunately, he has implemented some restrictions in his software program, for example, the space-domain (SD) analysis has a limitation for one output symptom and up to 4 input causes; the frequency-domain (FD) analysis has a limitation of up to 3 defined variables for fast Fourier transformation (FFT) operation. In this study, his chosen single output symptom for longevity (health age and age difference, respectively) versus the same four input causes which are m1, m2, m3, and m4; therefore, he chose to omit the FD study in this paper.

2. METHODS

2.1 Brief introduction of math-physical medicine (MPM) research

The author has collected 3+ million data regarding his health condition and lifestyle details over the past 13 years. He spent the entire year of 2014 developing a metabolism index (MI) model using a topology concept, nonlinear algebra, algebraic geometry, and finite element method. This MI model contains various measured biomarkers and recorded lifestyle details along with their induced new biomedical variables for an additional ~1.5 million data. Detailed data of his body weight, glucose, blood pressure, heart rate, blood lipids, body temperature, and blood oxygen level, along with important lifestyle details, including diet, exercise, sleep, stress, water intake, and daily life routines are included in the MI database. In addition, these lifestyle details also include some lifetime bad habits and certain environmental exposures. Fortunately, the author has none of these lifetime bad habits and an extremely low degree of exposure to environmental factors. The developed MI model has a total of 10 categories covering approximately 500 detailed elements that constitute his defined "metabolism index model" which are the building blocks or root causes for diabetes and other chronic disease-induced complications, including but not limited to cardiovascular disease (CVD), chronic heart disease (CHD), stroke, chronic kidney disease (CKD), diabetic retinopathy (DR), neuropathy, foot ulcer, hypothyroidism, dementia, and various cancers. The end result of the MI development work is a combined MI value within any selected period with 73.5% as its dividing line between a healthy and unhealthy state. The MI serves as the foundation for many of his follow-up medical research work.

During the period from 2015 to 2017, he focused his research on type 2 diabetes (T2D), especially glucose, including fasting plasma glucose (FPG), PPG, estimated average glucose (eAG), and hemoglobin A1C (HbA1C). During the following period from 2018 to 2022, he concentrated on researching medical complications resulting from diabetes, chronic diseases, and metabolic disorders which include heart problems, stroke, kidney problems, retinopathy, neuropathy, foot ulcer, diabetic skin fungal infection, hypothyroidism, diabetic constipation, dementia, and various cancers. He also developed a few mathematical risk models to calculate the probability percentages of developing various diabetic complications based on this MI model. From his previous medical research work with 700+ published papers, he has identified and learned that the associated energy of hyperglycemic conditions is the primary source of causing many diabetic complications which lead to death. Therefore, a thorough knowledge of these energies is important for achieving a better understanding of the dangerous complications.

2.2 TD, SD, and FD analysis tools

This section has brief descriptions of TD correlation analysis with other observational results, SD VGT analysis with hysteresis loop area's energy results, and FD analysis with frequency curve area's energy results.

First of all, by using a TD analysis tool, we can examine the curves' moving trend and pattern visually along with their correlation numerically. We can also study the extremely high or low data values in the dataset. The visual observation or calculation-derived interpretations are a part of statistical analysis results which can indeed provide some useful hints or even derive some accurate conclusions. However, we must be aware of the limitations of the selected data size and time window and also be cautious of the appropriate statistics tool we choose.

The author would like to describe the essence of his developed "hybrid model" that combines both the SD viscoelastic/plastic VGT analysis method and FD fast Fourier transform (FFT) analysis method together with a comparison against the traditional time-domain statistical correlation analysis.

It is described in 10 steps in the English language instead of using mathematical equations to explain it. In this article, he has applied both the SD-VGT operations (steps 1-7) and the FD-FFT operations (steps 8-10). As a result, it is aimed at readers who do not have an extensive background in those academic subjects of engineering, physics & mathematics.

The first step is to collect the output data or symptom (strain or ε) on a time scale. The

second step is to calculate the output change rate with time (dε/dt), i.e. the change rate of strain or symptom over each period. The third step is to gather the input data or cause (viscosity or η) on a time scale. The fourth step is to calculate the time-dependent input or cause (time-dependent stress or σ) by multiplying dε/dt and η together. The "time-dependent input or cause equation" of "stress σ = strain change rate of dε/dt * viscosity η" is the essential part of this "time dependency". The fifth step is to plot the input-output (i.e. stress-strain or cause-symptom) curve in a two-dimensional space-domain or SD (x-axis versus y-axis) with strain (output or symptom) on the x-axis and stresses (time-dependent inputs, causes, or stresses) on the y-axis.

The sixth step is to calculate the total enclosed area within these stress-strain curves or input-output curves (i.e. the hysteresis loops), which is also an indicator of associated energies (either created energy or dissipated energy) of this input and output dataset. These energy values can also be considered as the degrees of influence on output by inputs. The seventh step is the assembly of the area values of the selected periods to compare the "historical progression and contribution of medical condition" over certain periods. For FD, the eighth step is to define a "hybrid input variable" by using "strain*stress" which yields another accurate estimation of energy ratio similar to the SD-VGT energy ratio associated with the hysteresis loop. The ninth step is to present these hybrid models' results of (strain*stress) in a time domain and then perform the fast Fourier transformation (FFT) operation to convert them into an FD. The enclosed area of the frequency curve (where the x-axis is the frequency and the y-axis is the amplitude of energy) can be used to estimate the total FD-FFT energy. The tenth step is to compare these FD energy results against the SD-VGT energy results, or even TD energy results.

After providing the above 10-step description, the author would still like to use the following set of VGT stress-strain mathematical equations in a two-dimensional SD to address the selected medical variables:

Strain
= ε (time-dependency characteristics of individual strain value at the present time duration)

Stress
= σ (based on the change rate of strain multiplying with a chosen viscosity factor η)
= η * (dε/dt)
= η * (d-strain/d-time)
= (viscosity factor η using individual viscosity factor at present time duration) * (strain at present quarter - strain at previous time duration)

Some of these inputs (causes or viscosity factors) are further normalized by dividing them or being divided by a normalization factor using certain established health standards or medical pieces of knowledge. Some examples of normalization factors are 6.0 for HbA1C, 120 mg/dL for glucose, 25 for body mass index (BMI), 4,000 steps after each meal, 10,000 or 12,000 steps for daily walking exercise depending on time-period selection, 13 grams to 20 grams of carbs/sugar intake amount per meal depends on time-period selection. If using the originally collected data, i.e. the non-normalized data would distort the numerical comparison of the hysteresis loop areas. Using this "normalization process", we can remove the dependency of the individual unit or certain unique characteristics associated with each viscosity factor. This process allows us to convert the originally collected variables into a set of "dimensionless variables" for easier numerical comparison and result interpretation.

In this particular study, he has used two sets of "normalization factors": (1) 120 mg/dL; (2) (specific meal number / total meal number) * 120 mg/dL.

Note: For a more detailed description, please refer to the "consolidated method" section which is given at the beginning of the special issue.

3. RESULTS

Figure 1 shows 2 data tables (heath age and age difference).

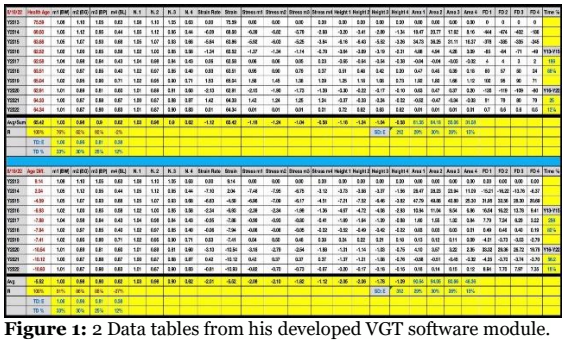

Figure 1: 2 Data tables from his developed VGT software module.

Figure 2 displays 3 TD analysis results.

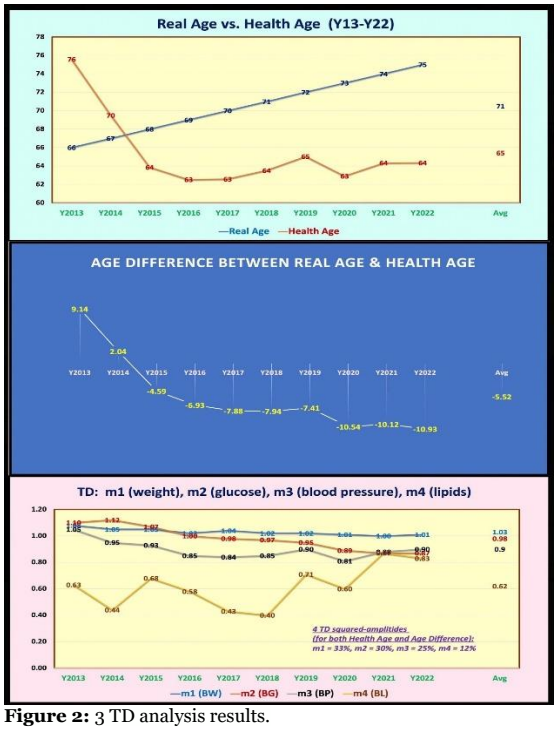

Figure 2: 3 TD analysis results.

Figure 3 depicts 2 SD-VGT analysis results.

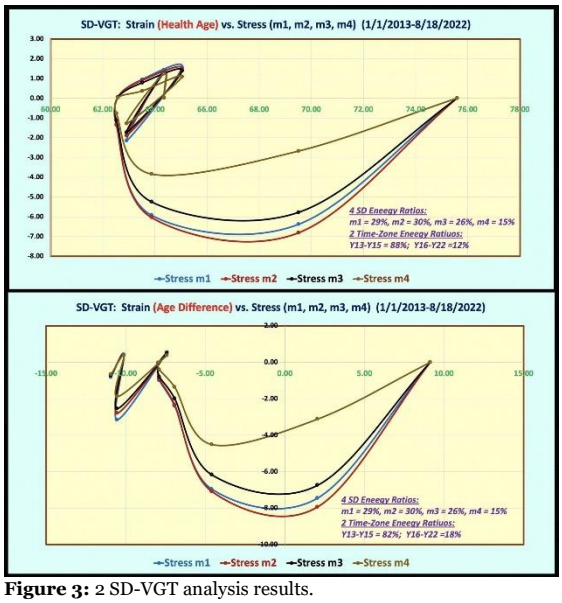

Figure 3: 2 SD-VGT analysis results.

4. CONCLUSION

In summary, there are 5 key findings from this study of longevity versus 4 basic chronic disease conditions (m1, m2, m3, and m4) using 2 biomedical energy analysis tools:

(1) From the TD diagram, his health age has continuously improving from 76 years in the beginning year of 2013, where his real age was 66 and the age difference was +9.14, through the health age of 64 in the turn-around year of 2015. His real age was 68 and the age difference was -4.59, and finally to the present year of health age of 64 in 2022. His real age is 75 and the age difference is -10.93.

(2) TD squared-amplitude energy analysis results are: For both the "health age" case and the "age difference" case: Their TD squared-amplitude energy ratios are identical to each other: m1 weight = 33%; m2 glucose = 30%; m3 blood pressure = 25%; and m4 lipids = 12%. This observation simply indicates that his control efforts and performance levels are ranked in the following order: "lipids are better than blood pressure, blood pressure is better than glucose, and glucose is better than body weight."

(3) From the SD-VGT analysis results, the SD energy ratios for both "health age" case and "age difference" case are identical to each other: m1 weight = 29%; m2 glucose = 30%; m3 blood pressure = 26%; and m4 lipids = 15%. The SD energy ratios are quite close to the TD energy ratios. It is clear that body weight and glucose have a higher degree of influence on his longevity (both health age and age difference) than blood pressure and lipids. Therefore, he should place more attention and better control in future years on his body weight and glucose.

(4) Since the hysteresis loop shape is determined by the strain rate values and the x-axis scale by the strain values, based on the observation of the overall stress-strain diagram, especially the "wide open hysteresis loop", his longevity diagram has revealed a viscoplastic behavior.

(5) From the SD-VGT analysis results, the author has further analyzed the energy's time-zone process of "energy within earlier 3 years of 2013 to 2015 versus energy within

the later 7 years of 2016 to 2022". The SD time-zone energy ratios for both "health age" and "age difference" are slightly different from each other: For the "health age" case: Y13-Y15 = 88%; Y16-Y22 = 12%. For the "age difference" case: The SD-VGT energy ratios are: Y13-Y15 = 82%; Y16-Y22 = 18%. From the conclusion of the two time-zone energy analyses, we can see that most influences on both health age and age difference happened during the first three years, Y13-Y15. After that period, his health ages fluctuated around 64 years despite his linearly increased biological real age each year.

In summary, his better-controlled blood pressure and lipids have greatly reduced the risk of developing various heart diseases and stroke. His lesser degree of control over his glucose would increase the odds of damaging the structural integrity of the artery and micro-blood vessels which are the source of heart attack, stroke, kidney failure, neuropathy, and retinopathy. However, his glucose control has been greatly improved to around 106 mg/dL of eAG, 93 mg/dL of FPG, and 6.0% of HbA1C over the past ~3 years of the Covid quarantined-life period. Therefore, this glucose improvement could definitely further improve his longevity perspectives. Regarding his body weight which was at 220 lbs. (BMI 32) in 2010 and dropped to ~170. lbs (BMI 25) in 2016. It has then been maintained at around 170 lbs. (BMI 25) throughout 2022 without any further reduction. Body weight is the primary source of most of his consequent health issues; therefore, he needs to continually improve his weight control issue. Overall, his past 10 years' continuous improvements on the 4 biomarkers of basic chronic diseases have already decreased his probability of developing heart issues, stroke, kidney failure, cancers, Parkinson's disease, and other dementia diseases.

Although this longevity study has used the author's own data, the concept behind is almost identical to the epigenetic age mentioned in other medical reports. His longevity studies have already served as a very useful tool for him to prolong his lifespan in a healthy state. His following study will focus on certain key lifestyle elements, including happiness a part of them which is related to both stress and psychology.

The research methodology behind this particular study has offered a subtle and deeper understanding of the complicated biophysical behaviors of longevity. In addition, it has further proven the usefulness of math-physical medicine research methodology in biomedical research.

5. REFERENCES

For editing purposes, the majority of the references in this paper, which are self-references, have been removed for this article. Only references from other authors' published sources remain. The bibliography of the author's original self-references can be viewed at www.eclairemd.com.

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Viscoelastic and Viscoplastic Glucose Theory Application in Medicine

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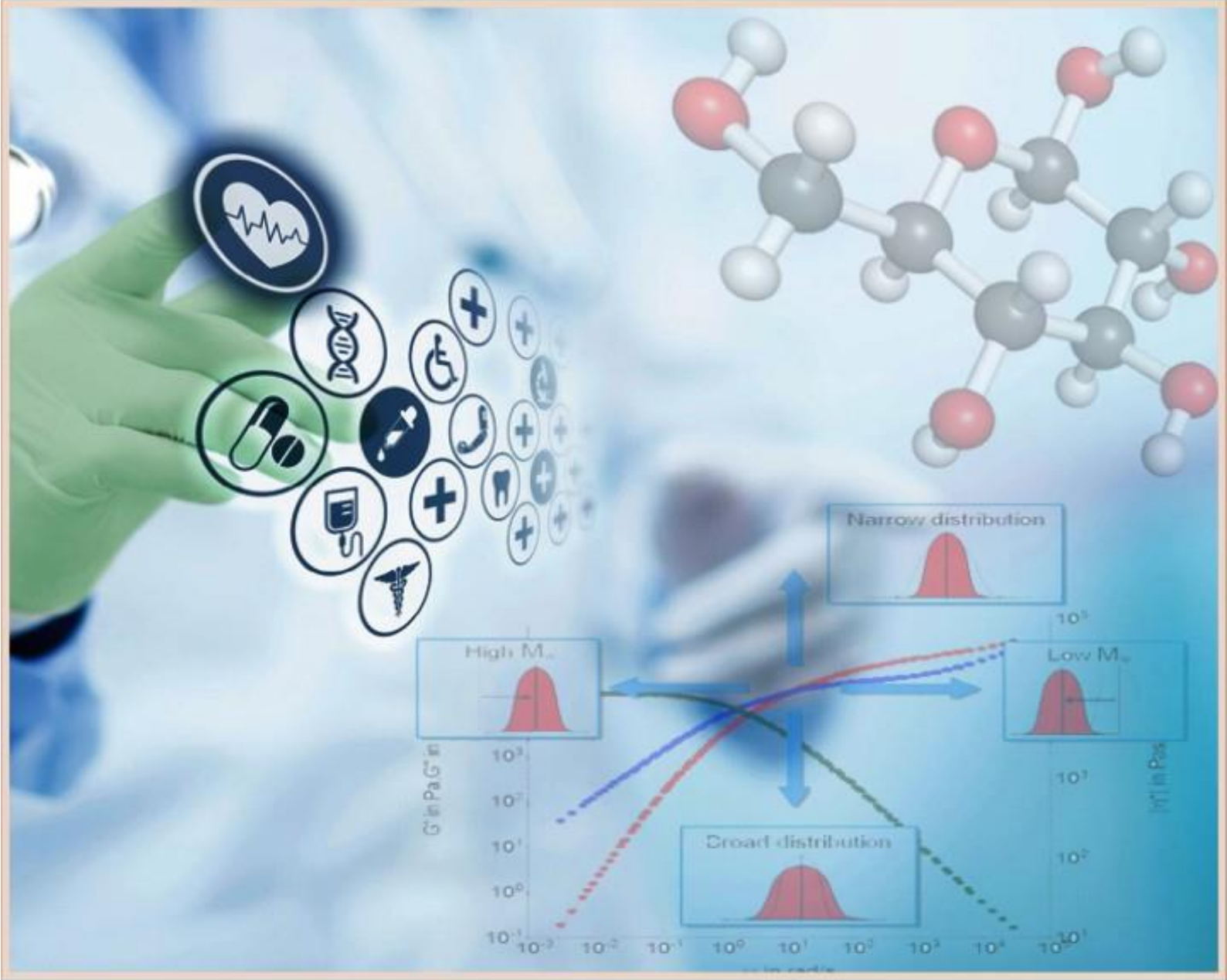

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