Special Issue 5
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The GH-Method

Viscoelastic and Viscoplastic Glucose Theory (VGT #133): 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 Physical Exercise (m5), Food & Meals (m9), Sleep (m7), and Stress (m8) Over 8+ Years from 1/1/2014 to 8/18/2022 Based on Math-Physical Medicine Method (No. 724)

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Keywords: Viscoelastic; Viscoplastic; Health; Physical exercise; Food; Sleep; Stress; 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 regarding gerontology and geriatrics titled, "Reversing Your Epigenetic Age, Is That Possible?" written by Lewis Chang, Ph.D., a Scientific Editorial Manager of R&D at Metagenics. The findings in the report have matched many of his published research papers on the subject of longevity. Therefore, as a future reference, he will keep the following short excerpt in his paper:

「A century ago, the global average life expectancy of humans was around 32 years. Today, it is 73. Because we live much longer, aging is now a major risk factor for a myriad of modern-day chronic illnesses. For scientists to study aging-related health issues, one must find a scientific way to measure aging, a quantifiable biochemical marker that reflects our biological age, so to speak. Having the ability to detect changes in such a biomarker will allow researchers to study whether certain factors cause acceleration in aging and, as important, whether specific interventions can slow it and by how much.

Enter epigenetic age, a futuristic-sounding biomarker whose concept was elegantly described in a journal editorial by Dr. Michael M. Mendelson (of Department of Cardiology from Boston Children's Hospital) as "where a drop of blood is fed into a machine, in which an algorithm churns through an accumulation of chemical groups coating a strand of DNA and spits out an individual's true age reflecting a lifetime of experiences and exposure." (Author's personal note: this statement is quite similar to his developed MI model with the health age equation, at least in concept).

Encouragingly, human studies are finding that this aging biomarker—based on DNA methylation patterns—correlates well with our chronological age.

For example, in a large cohort study called Atherosclerosis Risk in Communities (ARIC

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study), the investigators reported that classic cardiovascular disease risk factors such as smoking or type 2 diabetes were associated with acceleration of epigenetic age. Even after statistically adjusting for chronological age, sex, education, health behaviors, body weight, diabetes status, blood lipid panels, and more, epigenetic age acceleration remained associated with increased carotid intima-media thickness.

Which brings us to the subject of this write-up: the first exploratory clinical trial to investigate whether nutrition and lifestyle intervention might affect epigenetic age. Forty-three healthy adult males between the ages of 50 and 72 were randomized to control group (receiving no intervention) or treatment group. The treatment comprised an 8-week multimodal intervention:

- Diet: plant-centered diet (e.g. 2 cups of dark leafy greens, 2 cups of cruciferous vegetables, and 3 cups of colorful vegetables per day), with limited nutrient-dense animal protein (e.g. up to 10 eggs per week), excluding sugar, candy, dairy, grains, and legumes. Eating window was set between 7 AM and 7 PM each day
- Sleep: a minimum of 7 hours per night
- Exercise: a minimum of 30 minutes per day for at least 5 days per week at an intensity of 60-80% of maximum perceived exertion
- Stress management: via breathing exercise twice daily

And the results? The investigators found the intervention was associated with 3.23 years' decrease in the biomarker of epigenetic age compared with control. Meaning: Reengaging in healthy nutrition and lifestyle for 8 weeks may improve your epigenetic age by roughly 3 years. (The author's personal opinion: it may not be as effective for 8 weeks of work to extend 3 years of life since lifestyle improvement takes a longer period of persistent effort to have good outcomes.)

We all know good nutrition and lifestyle can promote health. Data from this study help us see the effect in a quantifiable manner. However, there is still much for scientists to learn. First, although there is scientific rationale behind the mathematical algorithm with which the epigenetic age is calculated, it is still a biomarker in development. What age-related biological processes have been captured by the algorithm are yet to be fully explained. Second, the clinical trial described here is limited to a small group of middle-aged men who were relatively healthy. Larger scale trials with robust statistical power and diverse participant characteristics are definitely needed. Last, but certainly not least, it is still yet to be determined whether reversing or slowing epigenetic age translates to reductions in age-related chronic illnesses and improvements in life expectancy and quality of life. Nevertheless, the research is heading toward a promising direction.

Why is this clinically relevant?

- Epigenetic age is a promising biomarker that correlates well with chronological age
- The clinical study demonstrates in a quantifiable way how healthy nutrition and lifestyle can potentially slow aging by improving epigenetic age」

The author of this 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 lifestyle details and applied his developed math-physical medicine (MPM) research methodology and tools.

In 2014, the author applied the mathematical topology concept, nonlinear algebra, and geometric algebra operations along with the 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, drinking water=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 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 pieces of 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 8+ years from 1/1/2014 through 8/18/2022 which contained much more reliable and completed data for this particular longevity versus 4 chronic diseases (m5 = exercise, m9 = food & meals, m7 = sleep, m8 = stress).

Furthermore, he has developed a mathematical equation for estimated health age as listed below:

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 are quite close to the concept of epigenetic age (which can be in a reversed order) and lifestyle details as described in the cited excerpt.

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 131 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 methods section, he provides a brief description regarding this 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 program, for example, the space-domain (SD) analysis has a limitation for one output symptom and up to 4 input causes, and 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, the longevity (health age and age difference, respectively) versus the same four input causes which are m5, m9, m7, and m8; therefore, he chose to omit the FD study in this article.

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 the frequency domain, 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 TD and then perform the fast Fourier transformation (FFT) operation to convert them into 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, it 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 (health age and age difference).

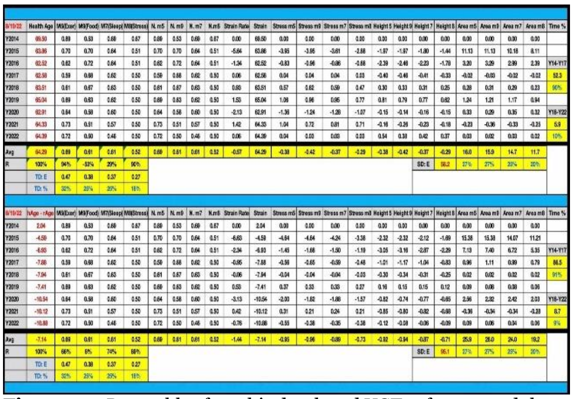

Figure 1: 2 Data tables from his developed VGT software module.

Figure 2 displays 3 TD analysis results.

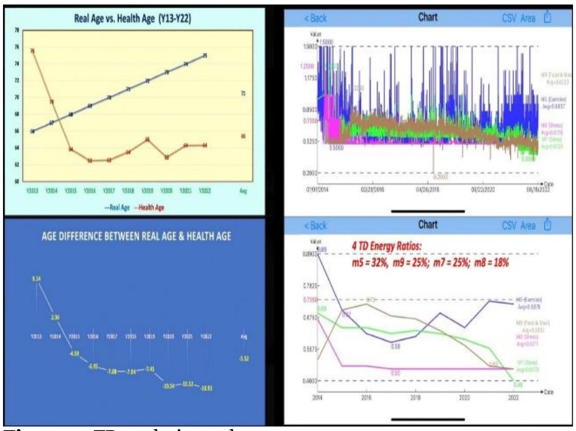

Figure 2: TD analysis results.

Figure 3 depicts 2 SD-VGT analysis results.

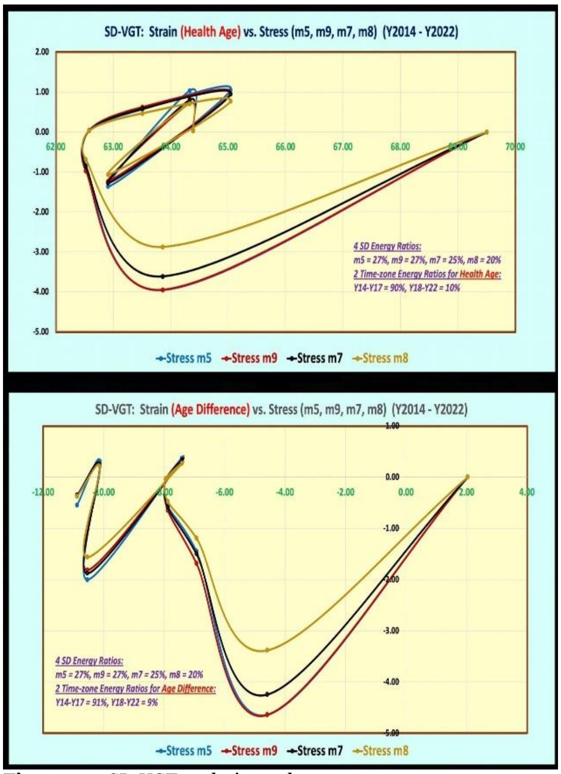

Figure 3: 2 SD-VGT analysis results.

Figure 4 reflects the author's checklist of his food & meal quality rules.

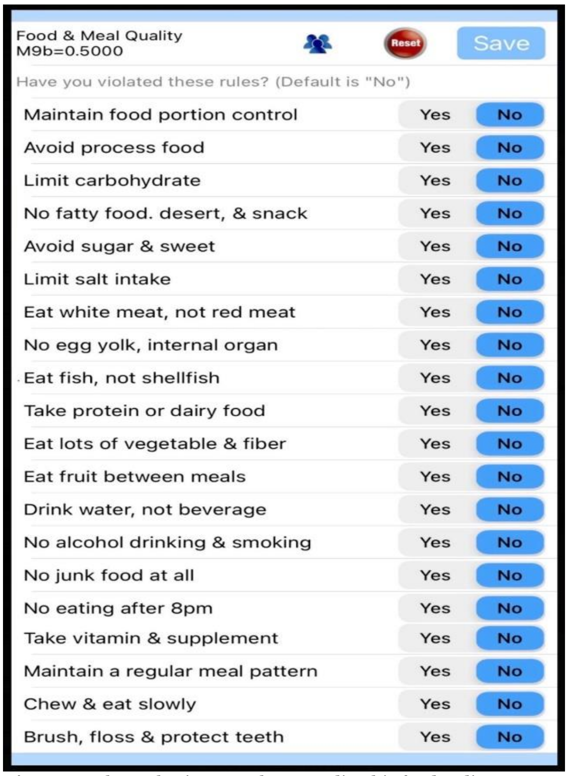

Figure 4: The author's own rules regarding his food & diet.

4. CONCLUSION

In summary, there are 5 key findings from this study of longevity versus 4 basic lifestyle details (m5, m9, m7, and m8) using two biomedical energy analysis methods:

(1) From the TD diagram, his health age has been continuously improved 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: m5 exercise = 32%; m9 food = 25%; m7 sleep = 25%; and m8 stress = 18%. This observation simply indicates that his lifestyle control efforts and performance levels are ranked in the following order: "stress is better than sleep, sleep is the same as food, and food is better than exercise." During the past ~9 years, he

has focused on conducting medical research work and is not involved with any personal conflicts or financial issues. Therefore, his stress level is extremely low. His sleep conditions have been quite good (~6-7 hours sleep with ~2 wake-ups at night) and becomes even better recently (7-8 hours sleep with <1 wake-up at night). In addition, he follows the Mediterranean diet style (see Figure 4) and walks 6-7 miles (10-11 km) each day.

(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: m5 exercise = 27%; m9 food = 27%; m7 sleep = 25%; and m8 stress = 20%. The SD energy ratios are quite close to the TD energy ratios. It is clear that both exercise and food have a higher degree of influence on his longevity (both health age and age difference). Sleep sits behind exercise and food. Stress has the least amount of influence on his longevity since its performance level has been excellent. Therefore, he should continuously watch out for his physical exercise and food/diet which have a direct link with his body weight and glucose level.

(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 4 years of 2014 to 2017 versus energy within recent 5 years of 2018 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: Y14-Y17 = 90%; Y18-Y22 = 10%. For "age difference" case: The SD-VGT energy ratios are: Y14-Y17 = 91%; Y18-Y22 = 9%. The two sets of energy ratios are almost identical. From the conclusion of the two time-zone energy analyses, we can see that most influences (90% to 91%) on his health age and age difference happened during the first 4 years, Y14-Y17. After that period, his health ages fluctuated around 64 years, which is healthy, despite his linearly increased biological real age each year.

In summary, he should continuously focus on his physical exercise and food/diet which are extremely important to weight control and glucose control. Both obesity and diabetes are the primary sources of most of the consequent serious health issues. Overall, his continuous improvements over the past ~9 years on the 4 lifestyle details, i.e. exercise, food, sleep, and stress, have already decreased his probabilities of developing heart problems, 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 also served as a useful tool to prolong his lifespan in a healthy state. Other patients can observe the findings from this article and follow the author's example to improve their own prospects of longevity.

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, are removed from 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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Special Issue | Issue No. 5 The GH-Method

Viscoelastic and Viscoplastic Glucose Theory Application in Medicine

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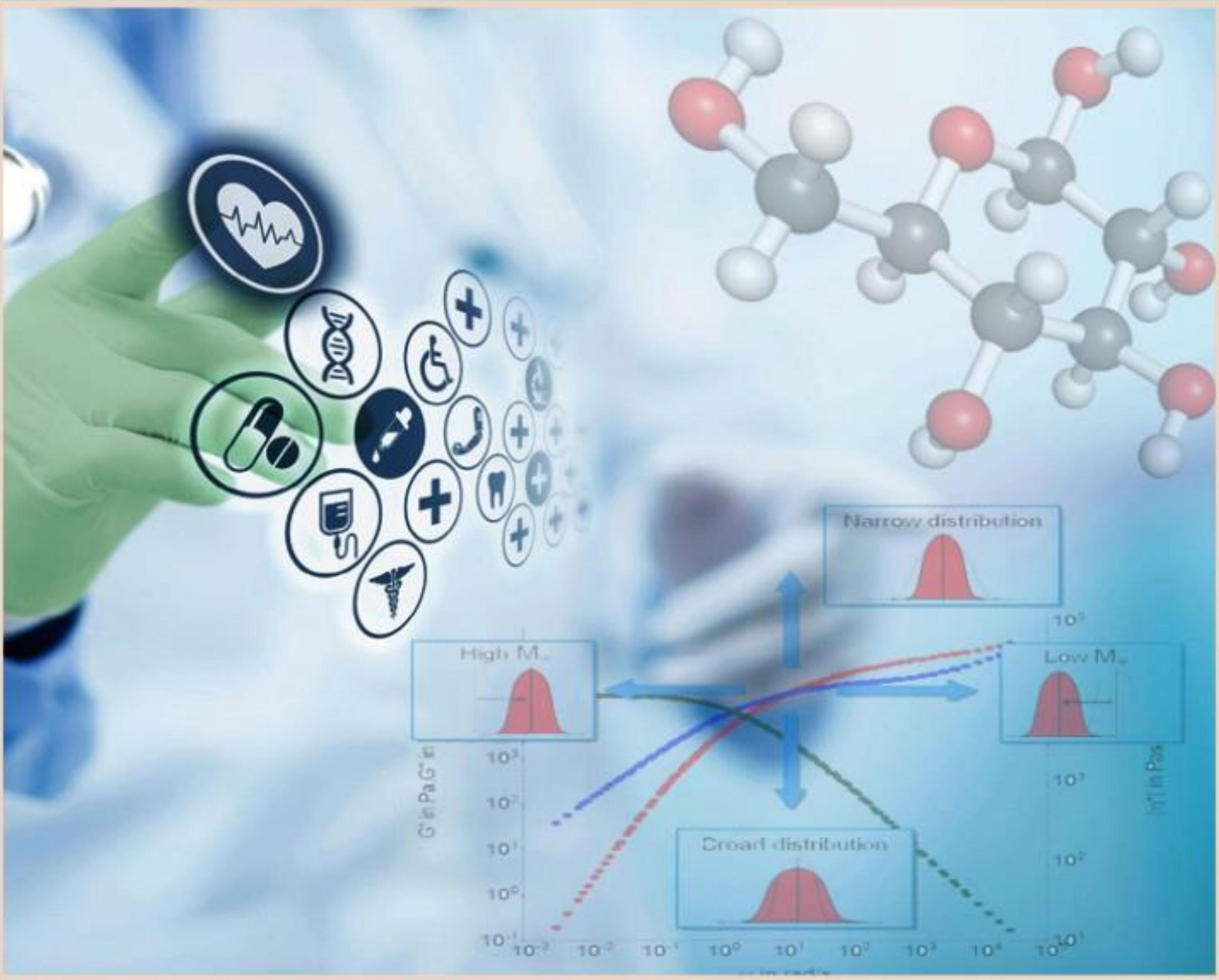

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