The chapter represents a vision about how DNA might act as a topological
quantum computer). TQC means that the braidings of braid strands define TQC
programs and M-matrix (generalization of S-matrix in zero energy ontology)
defining the entanglement between states assignable to the end points of
strands define the TQC usually coded as unitary time evolution for Schr\"odinger equation.

Before a representation of the model of TQC general vision about what
happens in quantum jump, which at least in formal sense can be regarded as
quantum computation (TQC), is represented. Included is also a section about
possible modification of thermodynamics required by the possibility of
negentropic entanglement. The modification corresponds simply to the replacement $S\rightarrow S-N$ for the entropy in standard thermodynamics.
The implications of this replacement are however highly non-trivial. The
\blockquote{pessimistic} generalization of the second law allows to understand the
thermodynamical aspect of TQC. One can understand why living matter is
so effective entropy producer as compared to inanimate matter and also the
characteristic decomposition of living systems to highly negentropic and
entropic parts as a consequence of generalized second law. ADP-ATP process
of metabolism provides a concrete application for the generalized
thermodynamics and allows to see this process as a transfer of negentropic
entanglement. Also DNA double strand for which sugar-phosphate backbone
consists of XMPs, X= A,T,C,G containing negentropy carrying phosphate bonds
can be seen as analogous to conscious brain with DNA strands representing
right and left hemispheres.

One can end up to the model of TQC in the following manner.

\begin{enumerate}

\item Darwinian selection for which the standard theory of
self-organization provides a model, should apply also to TQC

programs. Tqc
programs should correspond to asymptotic self-organization patterns
selected by dissipation in the presence of metabolic energy feed.
The
spatial and temporal pattern of the metabolic energy feed
characterizes
the TQC program - or equivalently - sub-program call.

\item Since braiding characterizes the TQC program, the self-
organization
pattern should correspond to a hydrodynamical flow or a pattern of
magnetic
field inducing the braiding. Braid strands must correspond to
magnetic flux
tubes of the magnetic body of DNA. If each nucleotide is transversal
magnetic dipole it gives rise to transversal flux tubes, which can
also
connect to the genome of another cell. As a matter fact, the flux
tubes
would correspond to what I call wormhole magnetic fields having
pairs of
space-time sheets carrying opposite magnetic fluxes.

\item The output of TQC sub-program is probability distribution for
the
outcomes of state function reduction so that the sub-program must
be
repeated very many times. It is represented as four-dimensional
patterns
for various rates (chemical rates, nerve pulse patterns, EEG power
distributions,...) having also identification as temporal densities
of zero
energy states in various scales. By the fractality of TGD Universe
there is
a hierarchy of TQCs corresponding to p-adic and dark matter
hierarchies.
Programs (space-time sheets defining coherence regions) call
programs in
shorter scale. If the self-organizing system has a periodic behavior
each
TQC module defines a large number of almost copies of itself
asymptotically. Generalized EEG could naturally define this periodic
pattern and each period of EEG would correspond to an initiation and
halting of TQC. This brings in mind the periodically occurring sol-
gel
phase transition inside cell near the cell membrane. There is also a
connection with hologram idea: EEG rhythm corresponds to reference
wave and
nerve pulse patters to the wave carrying the information and
interfering
with the reference wave.

\item Fluid flow must induce the braiding which requires that the ends of
braid strands must be anchored to the fluid flow. Recalling that lipid
mono-layers of the cell membrane are liquid crystals and lipids of
interior mono-layer have hydrophilic ends pointing towards cell interior,
it is easy to guess that DNA nucleotides are connected to lipids by
magnetic flux tubes and hydrophilic lipid ends are stuck to the flow.

\item The topology of the braid traversing cell membrane cannot be affected
by the hydrodynamical flow. Hence braid strands must be split during TQC.
This also induces the desired magnetic isolation from the environment.
Halting of TQC reconnects them and make possible the communication of the
outcome of TQC.

\end{enumerate}

There are several problems related to the details of the realization.

\begin{enumerate}

\item How nucleotides A,T,C,G are coded to the strand
color and what this color corresponds to physically? There are two options
which could be characterized as fermionic and bosonic.

\begin{enumerate}
\item Magnetic flux tubes having quark and anti-quark at their ends with
u,d and u_c, d_c coding for A,G and T,C. CP conjugation would
correspond to conjugation for DNA nucleotides.

\item Wormhole magnetic flux tubes having wormhole contact and its CP
conjugate at its ends with wormhole contact carrying quark and anti-quark
at its throats. The latter are predicted to appear in all length scales in
TGD Universe.

\end{enumerate}

\item How to split the braid strands in a controlled manner? High T_c

super conductivity suggests a possible mechanism: braid strand can be split only if the supra current flowing through it vanishes. A suitable voltage pulse induces the supra-current and its negative cancels it. The conformation of the lipid could control whether it it can follow the flow or not. The absence of both genuine magnetic monopoles and boundaries however demands that the monopole flux tubes must be closed. One manner to achieve this is to assume that the magnetic flux returns back along second space-time sheet.

A more realistic variant of this model is based on pairs of flux tubes going through the membrane and carrying opposite currents and parallel (opposite) magnetic fields. Reconnection for the members of the pair occurring the cell membrane effectively cuts both. This conforms with the identification of Cooper pairs as $S=0$ or $S=1$ states of electrons at the two flux tubes. The reconnection occurs naturally at the limit when the velocity of electrons and thus current goes to zero.

\item How magnetic flux tubes can be cut without breaking the conservation of the magnetic flux? The notion of wormhole magnetic field could save the situation now: after the splitting the flux returns back along the second space-time sheet of wormhole magnetic field. An alternative solution is based on reconnection of flux tubes. Since only flux tubes of same color can reconnect this process can induce transfer of color: \blockquote{color inheritance}: when applied at the level of amino-acids this leads to a successful model of protein folding. Reconnection makes possible breaking of flux tube connection for both the ordinary magnetic flux tubes and wormhole magnetic flux tubes.

\item How magnetic flux tubes are realized? The interpretation of flux tubes as correlates of directed attention at molecular level leads to concrete picture. Hydrogen bonds are by their asymmetry natural

correlates
for a directed attention at molecular level. Also flux tubes between
acceptors of hydrogen bonds must be allowed and acceptors can be seen as
the subjects of directed attention and donors as objects. Examples of
acceptors are aromatic rings of nucleotides, $O=$ atoms of phosphates,
etc.. A connection with metabolism is obtained if it is assumed that
various phosphates XMP,XDP,XTP, $X=A,T,G,C$ act as fundamental acceptors
and plugs in the connection lines. The basic metabolic process
$ATP\rightarrow ADP+P_i$ allows an interpretation as a reconnection
splitting flux tube connection, and the basic function of phosphorylating
enzymes would be to build flux tube connections as also of breathing and
photosynthesis. \end{enumerate}

The rest of the article represents a more concrete vision about how
DNA might act as a topological quantum computer (TQC). The topics
discussed are following.

\begin{enumerate}

\item How the basic gates are realized concretely? Gates can be identified
as basic braid operations so that the question reduces to how braidings of
magnetic flux tubes represent gates and what kind of particles represent
the quantum states. The identification of the particles is in terms of
quarks: TGD indeed predicts a hierarchy of scaled variants of hadron physics.

\item How the braiding is realized? What do braid strands
identified as magnetic flux tubes look like? How the braiding operation is
induced? The tentative answer is that color magnetic flux tubes connecting
DNA nucleotides to the lipids of nuclear and cell membrane define braid
strands and that braiding operations are induced by hydrodynamic flow
around membrane generating 2-D flow of liquid crystal defined by the
lipids. Also nerve pulse propagation can induced this kind of 2-D flow.

\item How magnetic flux tubes are realized? The interpretation of

flux
tubes as correlates of directed attention at molecular level leads to
concrete picture. Hydrogen bonds are by their asymmetry natural correlates
for a directed attention at molecular level. Also flux tubes between
acceptors of hydrogen bonds must be allowed and acceptors can be seen as
the subjects of directed attention and donors as objects. Examples of
acceptors are aromatic rings of nucleotides, $O=$ atoms of phosphates,
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$ATP\rightarrow ADP+P_i$ allows an interpretation as a reconnection
splitting flux tube connection, and the basic function of phosphorylating
enzymes would be to build flux tube connections as also of breathing and
photosynthesis.

\end{enumerate}

The model is certainly very speculative and heavily relies on the new
physics predicted by TGD. One can also imagine   alternative scenarios.
The model makes however strong predictions and is therefore testable.

\begin{enumerate}

\item The model makes several testable predictions about
DNA itself. In particular, matter-antimatter asymmetry and slightly broken
isospin symmetry have counterparts at DNA level induced from the breaking
of these symmetries for quarks and antiquarks associated with the flux
tubes. DNA cell membrane system is not the only possible system that could
perform TQC like activities and store memories in braidings: flux tubes
could connect biomolecules and the braiding could provide an almost
definition for what it is to be living. Even water memory might reduce to
braidings.

\item The model leads also to an improved understanding of other roles of

the magnetic flux tubes containing dark matter. Phase transitions changing
the value of Planck constant for the magnetic flux tubes could be key
element of bio-catalysis and electromagnetic long distance communications
in living matter. For instance, one ends up to what might be called code
for protein folding and bio-catalysis. There is also a fascinating
connection with Peter Gariaev's work suggesting that the phase transitions
changing Planck constant have been observed and wormhole magnetic flux
tubes containing dark matter have been photographed in his experiments.

\item   In the proposed vision genes define the hardware and TQC programs
the software responsible for what becomes cultural evolution at the higher
levels of evolutionary hierarchy. This vision explains also the mystery of
introns. The quite recent findings challenging genetic determinism
expressed using the term \blockquote{genetic dark matter} provide support for an
existence of new information carrying level at the level of genome
identifiable in terms of TQC programs.

\end{enumerate}

It must be emphasized that this model of DNA as TQC is only one
option among many. There is large flexibility concerning the identification of
fermions involved. For instance A,T,C,G could be represented also in terms
of 4 states assignable to two spin half fermions at parallel flux tubes.
This would give rise to high T_c superconductor with both $S=0$ ($S=1$)
Cooper pairs assignet to flux tubes with opposite (parallel) magnetic
fields. The spin-spin interaction energy for the Cooper pair would be
negative and proportional to h_{eff} and same for all fermion pairs if
$h_{eff}=h_{gr}$ hypothesis holds true at microscopic level.

%\end{abstract}