ePhood

Phenotypes & Omics On Diet

17/01/2017

where the idea of ePhood comes from...

ePhood™
electronic Phenotypes & Omics On Diet

- Kos Genetic is part of Sanipedia, a network of SMEs focused in health sciences.
- In early 2000 Kos Genetic was appointed in ATHENA (www.athena-flora.eu), an EC funded FP7 project aimed at exploring the basis for dietary improvements to protect societies against chronic disease.
- Kos Genetic's task, within the ATHENA project was to develop an informatics infrastructure for storage and integration of clinical, nutritional and genetics data. ATHENA project closed by mid 2015.
- By that time the informatics infrastructure was mainly a *research product*.

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TOWARDS PERSONALIZED NUTRITION

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INTRODUCTION

The role of nutrition in health management is known since ancient times, but its relevance was boosted in the last decade by epidemiological studies pointing out diet as a key risk factor for a number of diseases.

Several parallel studies indicated that the traditional approach, focused on caloric and macronutrients intake, fails in capturing essential features of dietary risk factors and specificities associated to the host's unique genetic background[1].

Nutrigenomics, which already demonstrated that genetic polymorphisms influence response to diet, can offer a powerful approach to unravel the effects of diet on health. This emerging field of research and its translation into prevention strategies needs new tools enabling the systematic collection of a variety of data.

METHODS

We developed an integrated platform, called Dietary Monitoring Solution (DMS), to collect phenotypic, genetic and lifestyle information linked to a mHealth application providing personalized dietary indications.

Our DMS was designed according to the indications of clinicians, geneticists and nutritionists and it is composed by:

a) a web-based platform, based on a framework dedicated to CRF management[2];

b) a software, calculating the macro and micronutrients intake from each food/meal;

c) a mHealth application monitoring and guiding the subject in his/her ecological context.

Case Study

The solution was developed to meet the functional requirements defined in the context of a large epidemiological study, conducted during the ATHENA project (7FP, GA 245121), aimed at evaluating genetic and dietary risk factors for cardiovascular diseases in healthy subjects.

The study included:

- Clinical assessment
- Dietary assessment: 24h recall interview (4 times) and Food Frequency Questionnaire
- Genotyping

The DMS was used to collect information from more than 500 volunteers), in three recruitment sites.

RESULTS

The DMS web-based platform combines validated tools for nutrigenomic research.

Fig1: Tools used in DMS web-based platform

The DMS mHealth application provides different functionalities to categories of users identified.

Fig2: Functionalitis provided by the Apps for the patient and the healthcare professional

It can be integrated with a Decision Support System (DSS), that provides indications considering the following information, prioritized as in Fig 3.

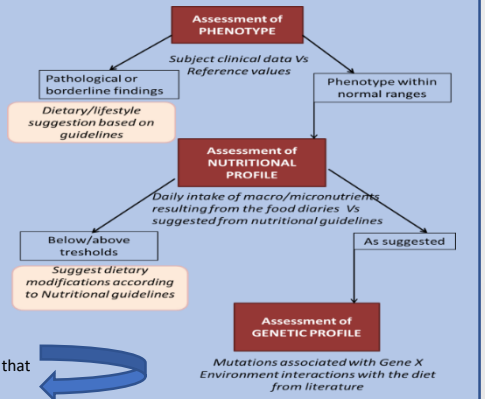

Fig 3: Decision tree used in the DSS

Fig 4: Possibility to supervise DSS suggestions

The suggestions are transmitted to the healthcare professional that needs to validate them, in order to allow the consequent App configuration.

CONCLUSIONS

DMS novelties rely on the possibility for the professional to refine data collection tools, to "supervise" the suggestions proposed by the DSS and to interact with the patients, responding in this way to the concerns raised by healthcare professionals toward the DSS approach.

Future studies are envisaged to evaluate users' compliance and usefulness of the mHealth application suggestions.

ACKNOWLEDGEMENTS

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2. Rossi E, Rosa M, Rossi L, Priori A, Marceglia S. WebBioBank: A new platform for integrating clinical forms and shared neurosignal analyses to support multi-centre studies in Parkinson's Disease, J Biomed Inform. 2014 Sep 7. pii: S1532-0464(14)00195-6.

FUNCTIONS

ePhood™
electronic Phenotypes & Omics On Diet

- Based on the knowledge and expertise developed after ATHENA project conclusion, Sanipedia improved the the informatics infrastructure, in collaboration with an ICT company, mainly active in e-health.
- We then completely re-wrote from scratch a new more powerful “WEB & APP”, which stores and relates clinical, nutritional, life-style environmental and genetics data.
- The Sidra Medical & Research Center di (Doha – Qatar) is using successfully Release 1 in outpatients of the nutrition clinics since Sept. 2015.
- On Oct. 2015 the TM ePhood has been registered:
- The Department of Health Sciences (University of Milan) is using the “WEB & APP” since Sept. 2016.

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- Partnering with others, Sanipedia and KOS funded on Nov. 7th 2016 the "innovative" Start-Up "ePhood S.r.l.".
- Setting up of an *innovative Start-Up* proved indispensable to address the market challenges in a structured way and to have the necessary resources to follow:
  - on one side, the countless changes related to clinical issues, nutrition and genetics
  - on the other, application development, technological and commercial solutions.

Innovative Start-Up is an Italian trade definition that targets a specific category of recently funded SMEs with high investments in R&D and large percentage of highly qualified employees as ePhood.
The inclusion in the category of innovative Start-Up allows substantial tax reduction.
(221/2012 law, Italian Ministry of Economics & Finances)

Working Group

sanipedia

Network of SMEs focused in Health Sciences

www.sanipedia.com

SAN
EFFECTIVE TECH INNOVATORS

SME (ICT), skilled in innovative solutions for integrated management of HC procedures and DSS

www.san.it

Technical Partnership & Scientific Collaborations

POLITECNICO DI TORINO

IBM Watson

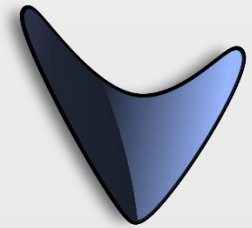
UNIVERSITÀ DEGLI STUDI DI TRIESTE

NuGO

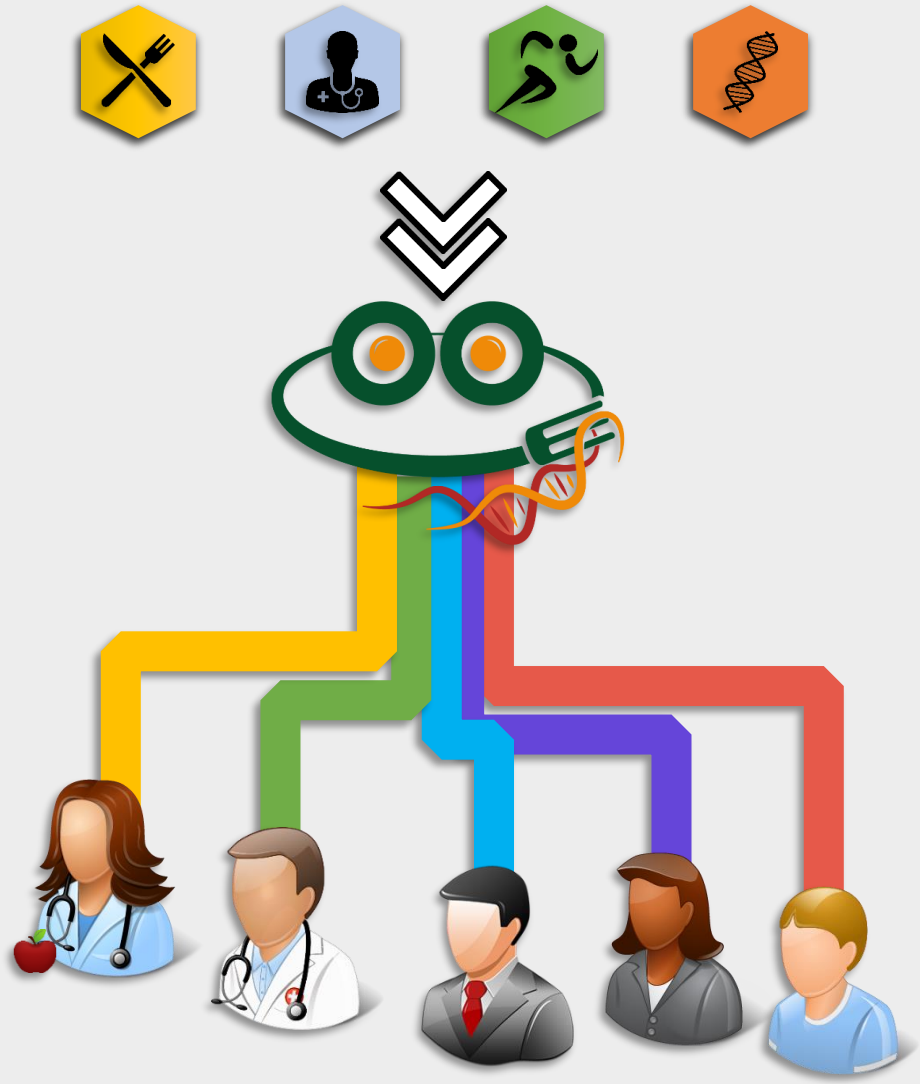
ePhood
Phenotypes & Omics On Diet

The Idea

1. Systematic collection of **user's profile** (nutritional, clinical, lifestyle, genetic)
2. **Macro** and **micro-nutrient** intake tracking
3. **Integration and analysis of collected data** (clinical, nutritional profiles, lifestyles, genetic data) using **correlation algorithms** of scientifically validated data



To promote **healthier eating habit and lifestyle for improving & / or maintaining good quality life**, through **personalized recommendations and advices**

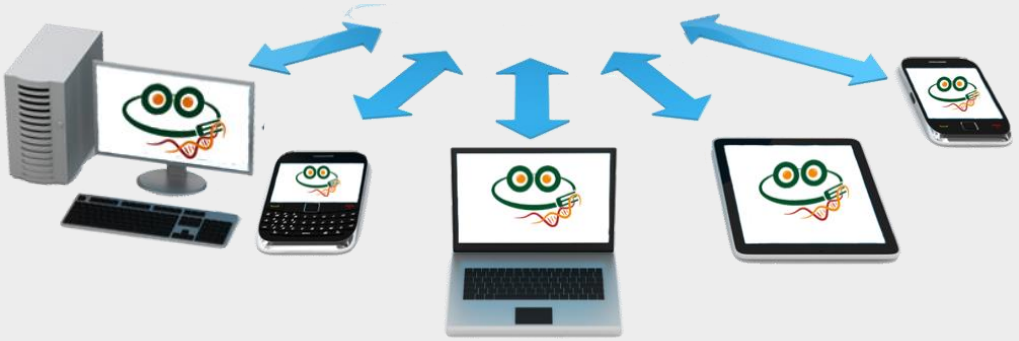


USERS

Note that anyone interacting with ePhood, i.e. any healthy or sick person (patient) using it for personal/medical reasons, a nutritionist, a MD or researcher is a potential user for different reasons from opposite platform sides

Features

1. **Application Architecture:** web-based platform with mobile APPs for iOS and Android
2. **Adaptability:** built to adapt:
   - to different languages, geography and culture as well as to dietary prescriptions and restrictions
   - to research settings, as well as to routine clinical and/or personal needs in nutrition
3. **Scientific validation:** the contents of the platform are kept updated and validated *a priori* by a Scientific Committee
4. **Flexibility:** the platform's structure is Web-based, as such compatible with any browser and available also to any mobile support (e.g. Smartphone, tablet ...)
5. **Customization:** compliant to either research and office/clinical nutrition contexts



ePhood - Already available, stable tools

user's profile

CRF collecting clinical, nutritional and lifestyle, data specific for each individual

food items DB

Tables of food items and portions (containing so far 1750 records for 870 food items)

nutritional profile DB

Tables with more than 40 parameter (micro/macro nutrient) per any food item considered

data export

User-friendly interface for extracting several kinds of information for later analysis

mobile App for end-user

Allows easy *input of daily diet and monitoring dietary statistics by the user himself through a facilitated GUI*

ePhood - User's Specific Data

CRF PROFILES	CRF Modules
PRESENTLY AVAILABLE	
TABLE	Personal data registry
BASE CASE HISTORY	Standard Case History
LIFE STYLE	Index of physical activity & of sedentarity, kind of physical activity
EATING HABITS	Type of diet, habits, amount & number of meals, kind of food eaten
NUTRITIONAL ASSESSMENT INTERVIEW	Daily food intake assessment over several days (e.g. 6 meals)
FUTURE EVOLUTION	
ADVANCED CASE HISTORY	Professional, physiological, family history, in-depth disease records taking
GENETICS	Genetic profiling through DNA analysis (TBD, specific SNPs or GWA arrays)
MEDICAL ASSESSMENT	General assessment + CV system; respiratory system; GI etc.
PHYSICAL ASSESSMENT	Standard biochemistry/urine etc.; Imaging, US+ Doppler, ECG etc.
TREATMENT	Tx past and present
NUTRITIONAL PLANS	Nutritional assessment interview(s), Mediterranean dietary pattern, food atlas.

ePhood - Food items DB

TODAY's DB

DB of **Italian food**

1570

portions

870

food items

40

nutrients

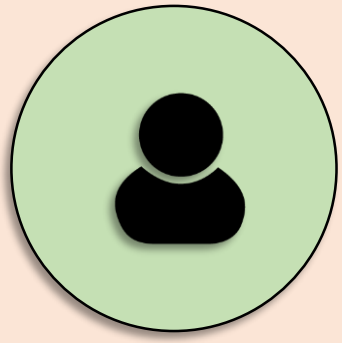
FUTURE EVOLUTION

Pictorial Atlas of Portions

DB of **Arab and Gulf Countries Food**

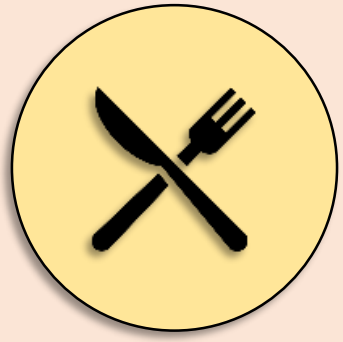
ePhood - Data export (.csv format)

Patients List



one row per record with patients details (observation)

Daily Diets



detail on diets (with comments on quality on data collection)

Nutrients Intake

details available for each meal and each food item.

	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	PatientID	BirthDate	DietDate	Intake	Comments	Time	Kcal	Water_g	Prot tot_g	An Prot_g	Retinol Eq_	Veg Prot_g	Lipids tot_g	An Lip_g	Veg Lip_g
2	LAB1000005	21/12/1986 00:00	08/10/2016 00:00			Breakfast	472.800.000	25.440.000	7.800.000	1.920.000	0.000023	5.880.000	19.800.000	10.800.000	9.000.000
3	LAB1000005	21/12/1986 00:00	08/10/2016 00:00			Dinner	777.750.000	590.182.461	72.873.750	65.400.000	0.000418	7.473.750	32.482.500	29.490.000	2.992.500
4	LAB1000005	21/12/1986 00:00	12/10/2016 00:00	average	Good	Breakfast	190.400.000	8.890.000	13.930.000	0.000000	0.000001	13.930.000	0.350000	0.000000	0.350000
5	LAB1000005	21/12/1986 00:00	12/10/2016 00:00	average	Good	Lunch	427.200.000	14.880.000	12.960.000	0.000000	0.000000	12.960.000	0.360000	0.000000	0.360000
6	LAB1000005	21/12/1986 00:00	12/10/2016 00:00	average	Good	PM Snack	528.000.000	5.160.000	11.400.000	0.000000	0.000000	11.400.000	19.559.999	0.000000	19.559.999
7	LAB1000005	21/12/1986 00:00	12/10/2016 00:00	average	Good	Dinner	1.130.500.000	91.500.000	39.550.000	29.750.000	0.000000	9.800.000	85.375.000	82.775.000	2.600.000

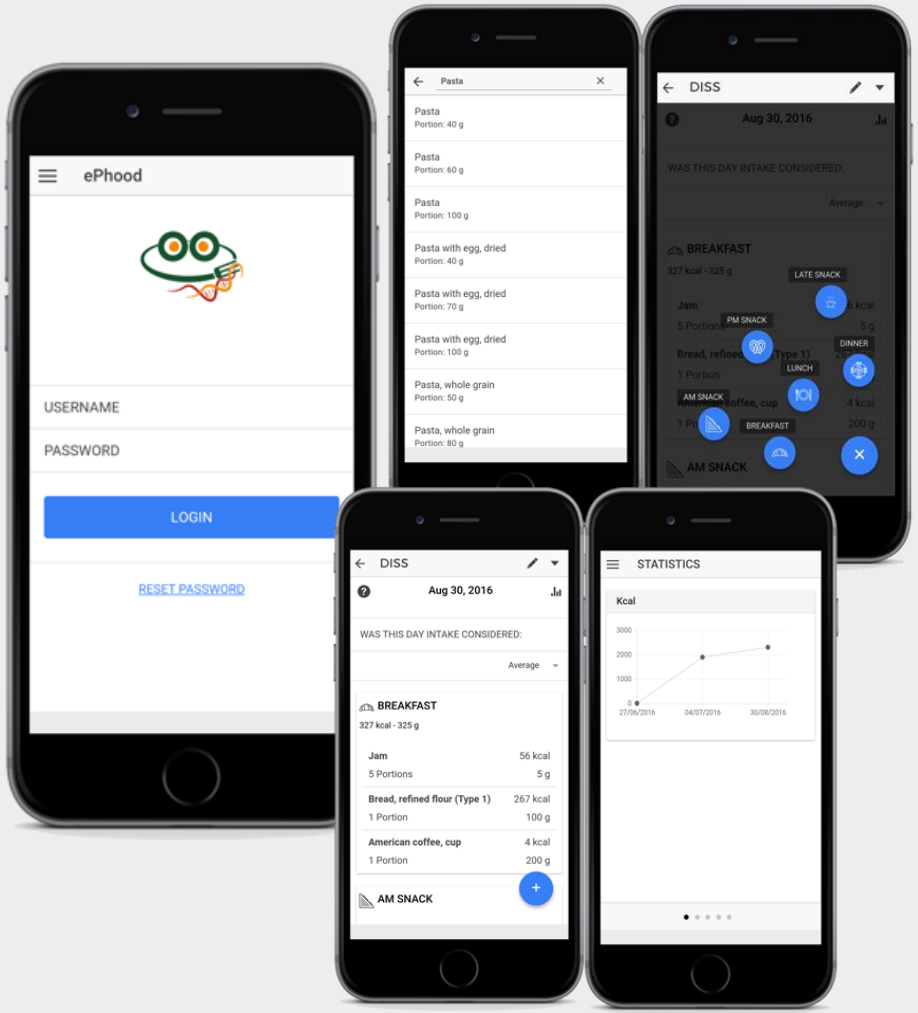
sample export of macro and micro nutrient intake/day in 6 different meals (line 2-7)

ePhood Phenotypes & Omics On Diet

Mobile App

The *base feature* is a support tool that will help the *end user* recording food diaries without interacting with professional staff.

The app (iOS and Android) allows the user interacting with the platform directly through the mobile device using a two-way synchronization with the server.



FEATURES

1. Direct connection with the web platform
2. Access with secure credentials
3. Display of personal and clinical data
4. Possibility to enter the daily diets
5. Possibility to track/recall stats (calories and / or micro-macro nutrient intake)

Future developments

ePhood - Personal Nutrition Tools

Genetics

1. Each individual can be at increased or decreased risk of developing a given clinical condition based on personal genetic profile
2. Specific individual genetic profile may interact with nutritional factors in determining the degree of risk of developing a specific clinical condition

Algorithms

ePhood will define and use algorithms basing on information taken from standards, guidelines and literature. They will constitute a system of rules.

DSS

The data of each individual will be analyzed on the basis of the rules defined system.
The DSS will be used to provide suggestions and personal recommendations to promote health.

Future developments

ePhood - Genetic Data

The system will collect, store and integrate genetic data within the **Decision Support System (DSS)** to link them with the nutritional profile, aiming at building an upper level risk profile.

INDIVIDUAL GENETIC DATA

Standard Heading						SNPs Described in map file				
family ID,	individual ID,	father,	mother,	sex,	affection status,	Genotypes				
GAL_11	GAL_11	0	0	2	0	G G	C C	T T	C C	G G

MPI → Unique subject's identifier

The DSS engine will test if the subject is carrier of mutations conferring increased risk of disease from a pre-defined list of SNPs.

map: *SNPs heading*

The complete string will be saved within ePhood as a text file ".txt". It will be analyzed by Signal Analysis Toolbox, available within the platform

Chr	SNP	cM	pb
1	rs12565286	0	711153
1	rs28659788	0	713170
1	rs11804171	0	713682
1	rs2977670	0	713754
1	rs12138618	0	740098
1	rs3094315	0	742429
1	rs3131972	0	742584
1	rs3131968	0	744055
1	rs1048488	0	750775
1	rs12562034	0	758311
1	rs2905035	0	765522
1	rs12124819	0	766409
1	rs2980319	0	766985

Future developments

ePhood - Algorithms 1/3

A **system of rules** following a **decision tree** will prioritize the following information:

1

FENOTYPE ASSESSMENT

individual clinical data referred to population's standard

2

NUTRITIONAL ASSESSMENT

daily macro/micro nutrient intake (assessed from dietary recall) referred to guideline governed RDAs

3

GENETIC PROFILE ASSESSMENT

disclosure of individual genetic & nutritional profile link with "traditional" clinical risk factors

Future developments (development under test)

ePhood - Algorithms 2/3 - LDL example

PHENOTYPE ASSESSMENT

DATA INPUT

biochemistry & anthropometry:
- serum cholesterol
  1) LDL, HDL, total
- BMI

case history:
- age (integrated in F.)
- physical activity
- risk factors:
  A. smoking (integrated in F.)
  B. recent admission for CVD
  C. diabetes
  D. low HDL (< 40 mg/dl)
  E. pos. family history for CVD
  F. Framingham risk score for CVD

Alternatively: a different flavor of the Framingham risk score for CVD

RULE *

Adults (> 16 years) may have different threshold of acceptable cholesterol level according to concomitant risk factors:
- recent admission for CVD or DM + additional risk as smoke/obesity
  → *LDL <70 mg/dl*
- risk factors ≥2 or DM or Framingham risk score 20%
  → *LDL <100 mg/dl*
- risk factors >2 and Framingham risk between 10-20%
  → *LDL 130 mg/dl*
- only 1 risk factor
  → *LDL 160 mg/dl*

OUTPUT *

if serum LDL estimated unacceptable, the system *directly suggests*:
→ to see the doctor for advice
→ a diet and life style approach as:
- phytosterol rich food: ~ 2g/day
- fiber: 10-25 g/day
- physical exercise: 30 day x 4-6 time/week

**AACE Guidelines for the Management of dyslipidemia and prevention of atherosclerosis*

Future developments (development under test)

ePhood - Algorithms 3/3 - LDL example

GENETIC PROFILE ASSESSMENT: diet x genetic polymorphism interaction

DATA INPUT

- genotype(s) or allele(s) at loci proved interacting with diet (G*E)
- info on diet from dietary recall (min. 2), to compute average daily micro/macro nutrient intake

RULE *

Gene	Polym.	Responder	Diet	Effect LDLC	Gender	Ethnicity
ABCG8	rs4148217	A	Plant sterols 2g/d (4wks)	3.9 fold reduction	Both	
ABCG8	rs6544718	C	cholesterol intake was less than 300 mg/d	0.4 mml/L reduction	Female	
ABCG5	rs6720173	C	Low saturated FA	0.5 mml/L reduction	Male	
ADIPOQ	rs1501299	T	<55% energy intake from carbohydrates	0.3 mml/L reduction	Both	

OUTPUT

the system will propose dietary intervention or integration according to the user's profile, e.g.:

- male
- rs6720173 CC homozygous
- diet moderately rich in saturated fat (according to LARN)
  - → *the system will propose* a more balanced saturated fat composition, irrespective on serum lipid level.

**Abdulah et al, 2015 • Nutrigenetics of cholesterol metabolism: observational and dietary intervention studies in the postgenomic era*

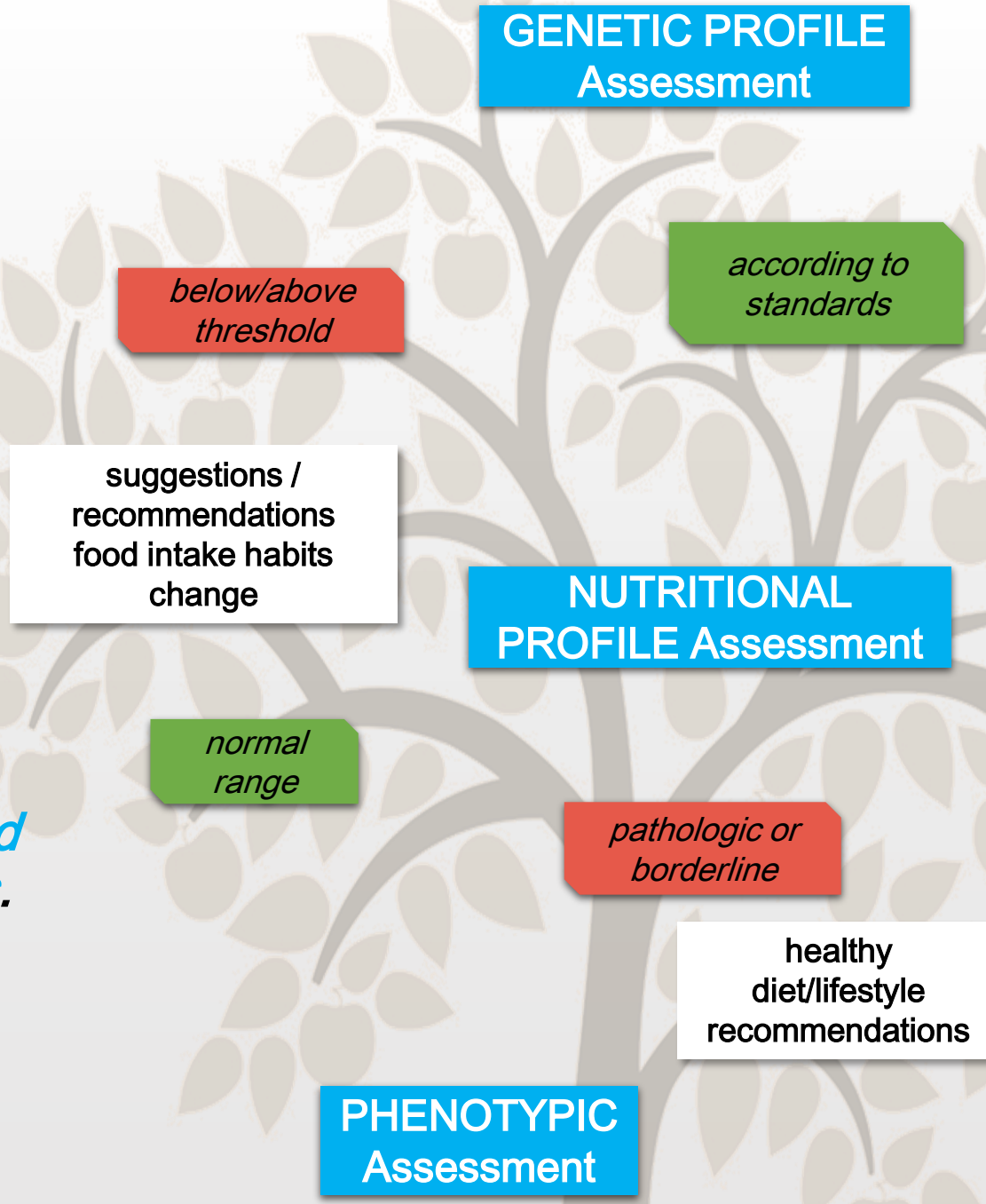
Future developments

ePhood - DSS

Decision Support System

ePhood's DSS will use a batch of predefined internal *algorithms* to analyze user's data.

The DSS will process such information using a *system of rules* (algorithms) to provide *personalized suggestions* and *recommendations*.



Future Developments

ePhood - Decision Support System (DSS)

AUTOMATIC

⚠ HIGH LDL

ePhood directly proposes:

- 10 to 25 gr/day fiber
- 30 min/day x 4-6 time/week
- phytosterol: ~ 2g/day

SEMI-AUTOMATIC

▪ ePhood warns for high LDL and suggests to see a doctor	⚠
▪ the doctor will probably propose:	
▪ 10 to 25 gr/day fiber	✓
▪ 30 min/day x 4-6 time/week	✓
▪ phytosterol: ~ 2g/day	✓ ✗

ePhood - Future developments

- to upgrade the number of food items and portions in the Food Database
- to develop and integrate the Visual Atlas of portions
- to implement and validate algorithms
- to integrate in a "*nutrigenomics module*" all the procedures needed for collecting and analyzing genetic data of users
- to develop and integrate DSS functionality
- to integrate with wearable devices for automatic collection subjects' information
- to evaluate integration of new machine learning technologies for data processing (e.g. Watson Services)

ePhood Folder - ePhood Portal

Business Model: B2B

ePhood Folder & ePhood Portal

- Personalized Services for nutritional and nutrigenomics studies
  → universities, research centers, hospitals, Specialty Doctors (e.g. Endo, Sports Medicine, etc.), GPs, nutritionists, etc.
- Integration with Health Information Systems and Local Health Systems
  → FSE in Italy; NHS in UK; Health Insurance in USA, etc.
- Customized Services
  → companies involved in food or nutraceutical production or processing, the restaurant industry, pharmacies, gyms, sports centers, SPAs, etc.
- Companies of online advertising

Business Model: B2C

ePhood Portal

- Information for users interested in nutrition related issues
  → patients and/or healthy subjects
- Individual professionals interested in gaining access to the portal in relation to their professional interests
  → journalists/bloggers interested in nutrition issues, etc.
- Access for registered end-users (individuals or professionals) for personal health purposes

ePhood - Progress

Food Items Database and Food Items Atlas are available for the Western Countries (English and Italian language) as well as the version for Arab States of the Gulf Area (foods, recipes and atlas), linked to the running installation at Sidra (Doha, Qatar).

The Mobile App (Android and iOS) has been released on May 2016.

The platform is constantly under developed and improvement, adding new features, new food items to atlases with nutritional related tables as well as additional correlation algorithms.

CURRENT MARKET

The platform is currently used by:

- Department of Translational Medicine, Sidra Medical and Research Center in Doha - Qatar
- Department of Health Sciences (DISS), University of Milano – Italy

In addition there are several active, though preliminary, contacts both in Italy (university departments and research units; integration with the Electronic Health Record, Sports Federations, companies in the catering sector, etc.), and in the Gulf countries. The latter mainly aimed at "Arabization" of the product and to extend the use of the platform also in other research centers and universities.

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