

# Latin for Biologists

(and everyone else)



Suhas Mahesh | 30 May 2016

# Biologists need to be Linguists too!

## Oncogenic mTOR signalling recruits myeloid-derived suppressor cells to promote tumour initiation

Thomas Welte<sup>1,2,3,4</sup>, Ik Sun Kim<sup>1,2,3,5</sup>, Lin Tian<sup>1,2,3,6</sup>, Xia Gao<sup>1,2,3</sup>, Hai Wang<sup>1,2,3</sup>, June Li<sup>1,2,3</sup>, Xue B. Holdman<sup>2,3</sup>, Jason I. Herschkowitz<sup>1,2,3,11</sup>, Adam Pond<sup>1,2,3</sup>, Guorui Xie<sup>7</sup>, Sarah Kurley<sup>3</sup>, Tuan Nguyen<sup>3</sup>, Lan Liao<sup>3</sup>, Lacey E. Dobrolecki<sup>1,2,3</sup>, Lan Pang<sup>7</sup>, Qianxing Mo<sup>2,8</sup>, Dean P. Edwards<sup>2,3,8</sup>, Shixia Huang<sup>2,3</sup>, Li Xin<sup>2,3</sup>, Jianming Xu<sup>2,3</sup>, Yi Li<sup>1,2,3</sup>, Michael T. Lewis<sup>1,2,3</sup>, Tian Wang<sup>7</sup>, Thomas F. Westbrook<sup>6,9</sup>, Jeffrey M. Rosen<sup>2,3,12</sup> and Xiang H.-F. Zhang<sup>1,2,3,10,12</sup>

Myeloid-derived suppressor cells (MDSCs) play critical roles in primary and metastatic cancer progression. MDSC regulation is widely variable even among patients harbouring the same type of malignancy, and the mechanisms governing such heterogeneity are largely unknown. Here, integrating human tumour genomics and syngeneic mammary tumour models, we demonstrate that mTOR signalling in cancer cells dictates a mammary tumour's ability to stimulate MDSC accumulation through regulating G-CSF. Inhibiting this pathway or its activators (for example, FGFR) impairs tumour progression, which is partially rescued by restoring MDSCs or G-CSF. Tumour-initiating cells (TICs) exhibit elevated G-CSF. MDSCs reciprocally increase TIC frequency through activating Notch in tumour cells, forming a feedforward loop. Analyses of primary breast cancers and patient-derived xenografts corroborate these mechanisms in patients. These findings establish a non-canonical oncogenic role of mTOR signalling in recruiting pro-tumorigenic MDSCs and show how defined cancer subsets may evolve to promote and depend on a distinct immune microenvironment.

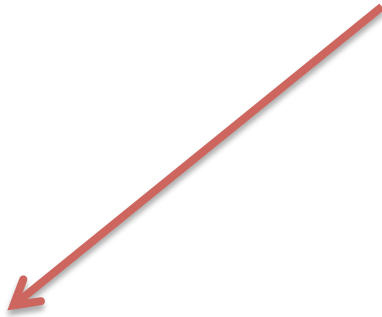
# Seeing through the glasses of Latin and Greek!



- |                 |                    |               |
|-----------------|--------------------|---------------|
| • CHLORO-PHYLL  | • Green-Leaf       | • “Folio”     |
| • ERYTHRO-CYTE  | • Red-Cell         |               |
| • DOLORO-GENIC  | • Sadness-Birthing | • “Dolorous”  |
| • SINISTR-AURAL | • Left-Ear         | • “Sinister”  |
| • HAEMO-FUSCIN  | • Blood-dark       | • “Obfuscate” |
| • GENI-CULATED  | • Knee-like (Bent) | • “जानु”      |
| • NIGRI-TUDE    | • Black-ness       | • “Nigger”    |

# What is Cholecystectomy?

Chole-cyst-ectomy



*Bile*

“Cholera”

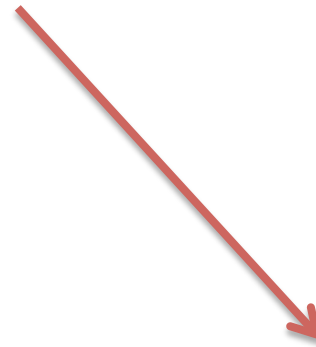
“Cholesterol”

“Melancholy”



*Hollow sac of  
some sort*

“Bile-Sac-Removal”

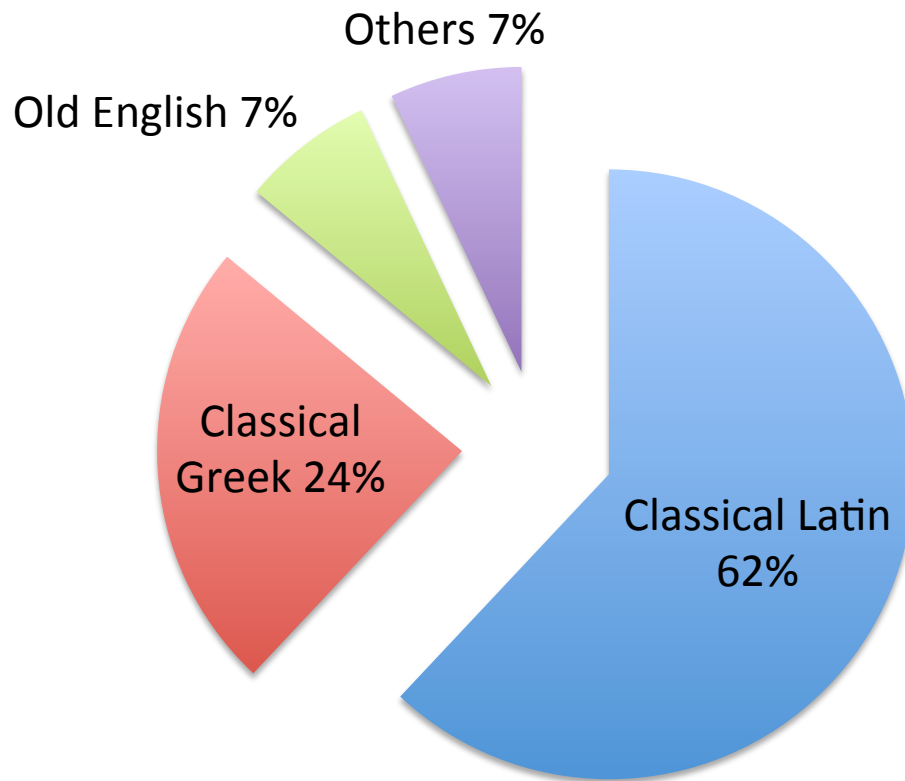


*Removal*

“Vasectomy”

“Appendectomy”

# Why Greek and Latin?



Turmezei (2012)

- Western Medicine descends in an unbroken tradition from Greek medicine.
- Many of Hippocrates' terms are still used: Asthma, Epidermis
- Latin was the dominant language of knowledge production till about 100 years ago.

# How are words generated?

Greek  
compounding

Bucco-pharyng-eal

Latin

*-bucca*

“mouth”

Greek

*-phárunx*

“throat”

Latin

*-alis*

- Greek and Latin are freely mixed.
- Grammar of neither is observed.
- The word inflections are Latin.
- Biology has its own conventions independent of the two languages.

The Greek word for mouth “stoma” has acquired a different meaning.

# PREFIX + ROOT(S) + SUFFIX

ANTI  
Against

PYR  
Fire

ETIC  
Pertaining to

Anti  
pyretic

THERM, DYNAM  
Heat, Power

IC  
Pertaining to

Thermo  
dynamics

Note: O is usually added as a connector between roots.

Eg.

The Latin root *ject* means “throw”  
So *project* mean “to throw forward”



# Prefixes

IN-CLUDE  
EX-CLUDE  
PRE-CLUDE  
SE-CLUDE  
RE-CLUDE  
OB-CLUDE  
CON-CLUDE

Root:  
*cludere*  
“To close”

- Attach at the beginning of words.
- All prefixes do not have well defined meanings.
- They can be Greek or Latin.
- Often they are not logical.
- Sometimes the same prefix gives different meanings to different roots.
- Hundreds of prefixes: but most are familiar!



ISO

META

PRO

PRE

ACRO

ENDO

EX/EXO

HYPO

HYPER

INTER

PERI

APO

SYN

EN

BRADY

MACRO

MICRO

TACHY

ECTO

INFRA

SUPRA

CIRCUM

MESO

EPI

ENDO

# Roots

Word	Meaning
geology	earth-study
telegraph	distance-writing
tricycle	three-wheels
asocial	not-companiable

- A **root** is a set of letters that have meaning.
- Affixes are added to the root to create a new word.
- Roots can appear more than once.
- Roots can be at the beginning, middle or end of the word. In some cases they can be the whole word!

ISO  
CHRON

META  
PHASE

PRO  
PHASE

PRE

ACRO

ENDO

EX/EXO  
DERM

ANA  
PHASE

TELO  
PHASE

INTER

PERI

APO

SYN  
ERG-Y

EN  
ERG-Y

BRADY  
CARDIA

MACRO

MICRO

TACHY  
CARDIA

ECTO  
PLASM/DERM

INFRA

SUPRA

CIRCUM

MESO  
DERM

EPI  
DERMIS

ENDO  
PLASM/DERM

# Suffixes

AN  
ALGIA

TRACHE  
OTOMY

LOBO  
TOME

SARC  
OMA

METALL  
OID

NEUR  
OSIS

TONSIL  
ITIS

APPEND  
ECTOMY

COLO  
OSTOMY

DIA  
RRHEA

ABIO  
GENESIS

THORA  
CENTESIS

ERYTHRO  
BLAST

RETINO  
PEXY

APO  
PTOSIS

# Dealing with two word names



Homo Sapiens  
Raghavendrus Gadagkarus



*A-xantho-som-ella gadagkari*  
*Escherichia coli*  
erector spinae

mycin D had no effect on leukemias in children. Undeterred, Farber unleashed the drug on 275 children with a diverse range of cancers: lymphomas, kidney sarcomas, muscle sarcomas, and neuroblastic tumors. The trial was a pharmacist's nightmare. Actinomycin D was so toxic that it had to be heavily diluted in saline; if even minute amounts leaked out of the veins, then the skin around the leak would necrose and turn black. In children with small veins, the drug was often given through an intravenous line inserted into the scalp.

The one form of cancer that responded in these early trials was Wilms' tumor, a rare variant of kidney cancer. Often detected in very young children, Wilms' tumor was typically treated by surgical removal of the affected kidney. Surgical removal was followed by X-ray radiation to the affected kidney bed. But not all Wilms' cases could be treated using local therapy. In a fraction of cases, by the time the tumor was detected, it had already metastasized, usually to the lungs. Recalcitrant to treatment there, Wilms' tumors were usually bombarded with X-rays and assorted drugs but with little hopes of a sustained response.

Farber found that actinomycin D, administered intravenously, potently inhibited the growth of these lung metastases, often producing remissions that lasted months. Intrigued, he pressed further. If X-rays and actinomycin D could both attack

For non-Biologists:  
Improves  
reading  
experience!

*The Emperor of All Maladies*, pg.  
299, Siddhartha Mukherjee

# Joy of seeing hidden connections!

CARNIVORE

“Flesh-eating”

CARNATION

“Red like flesh”

CARNIVAL

“Flesh-raising”

INCARNATE

“Coming again in flesh”

CARNAL

“Relating to flesh”

CARNAGE

“Flesh cutting”



Pop Quiz: What is

CHOLECYSTENTEROSTOMY?

# Thank you for your attention.

... Nobis parienda sunt imponendaque nova rebus novis nomina. Quod quidem nemo mediocriter doctus mirabitur, cogitans in omni arte cuius usus vulgaris communisque non sit multam novitatem nominum esse cum constituentur earum rerum vocabula quae in quaque arte versentur. (Cicero, *De Finibus* III, 3)

“We are obliged to create a vocabulary and to find names to attach to new discoveries. This will not cause surprise to any moderately well-informed person, when he reflects that in every branch of knowledge lying outside the most elementary ones there must be a large measure of “newness” about its vocabulary. This “newness” grows out of the necessity for each area of knowledge to express the particular concepts with which it deals.”