

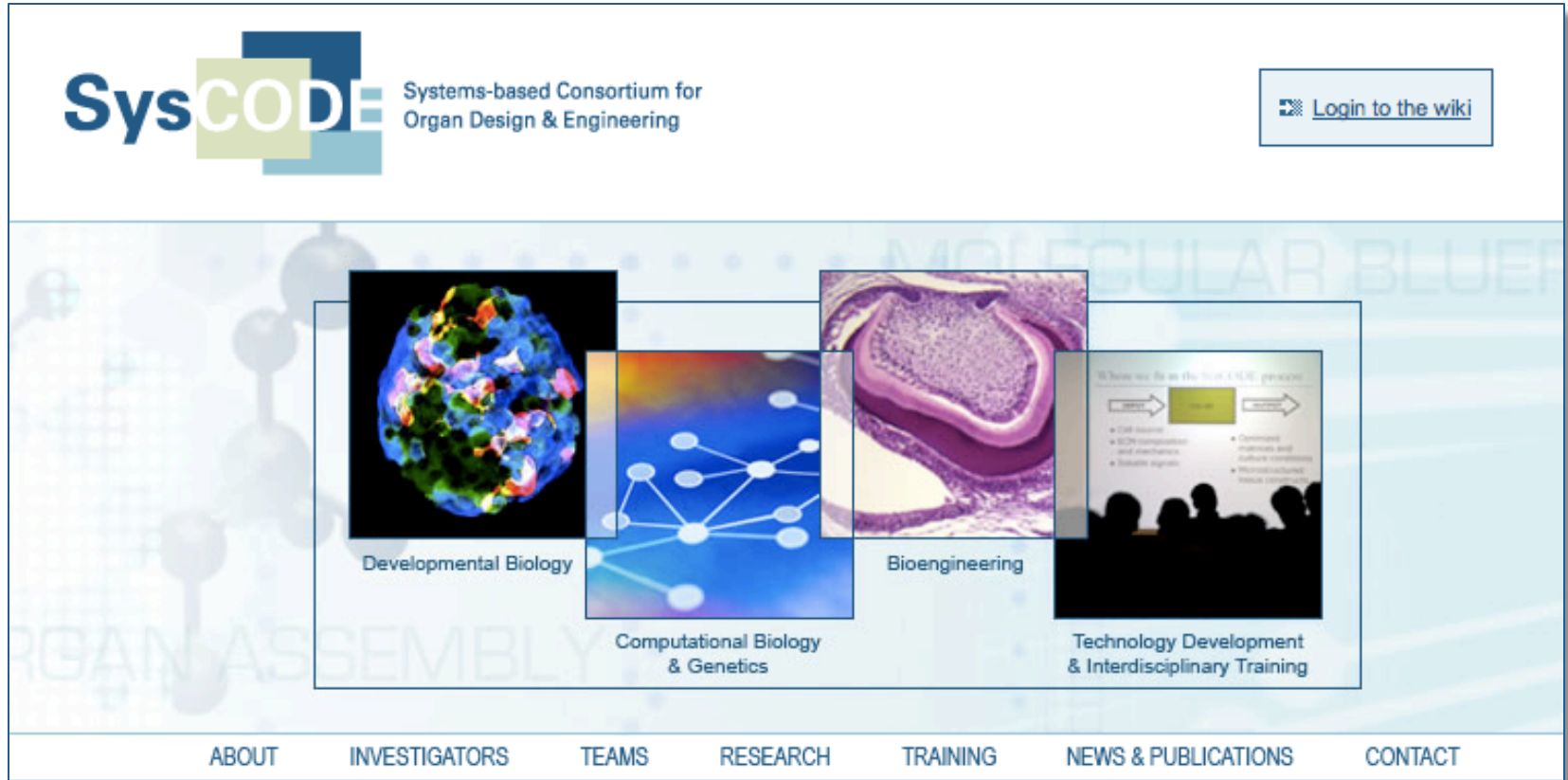
# An Illustration of Social Network Analysis in the Evaluation of Interdisciplinary Team Science

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Multi-paper session presented at Evaluation 2011,  
the Annual Meetings of the American Evaluation Association  
November 02-05, 2011. Anaheim, CA  
Paper # 3

# Team Science: Mission and Research Goals



- Tooth Germ
- Pancreatic Islet
- Heart Valve

- Developmental and SC Biology
- Computational Sciences
- Tissue Engineering

## 3

# Internal Evaluation of IDR at SysCODE

Subject	Methods & Approaches	Metrics
<b>RESEARCH</b>	Meetings and conferences	Project progress updates, participation rate
	Review and feedback, NIH	Milestones, accomplishments
	Review and feedback, EAB	Research directions approval/adjustment
	Publications	Number of publications, co-authorship, journal ranks
<b>EDUCATION (IDT)</b>	Mentor evaluation form	Feedback, suggestions
	Project progress review	Presentations
	Steering Committee	Recommendations for career development
	NIH interview/survey	Impact on research, career, efficiency
<b>KNOWLEDGE DISSEMINATION</b>	NIH requests for update	Progress reports, scientific advances, publications
	WIKI site	Data entry statistics (present., policies, protocols, etc.)
	WEB site	Public interest in SysCODE research
	SysCODE survey	Demographics, factors that affect IDR, participation rate
	Social Network Analysis	Density, Centrality and Distance of the social network



# Evaluation Tools and Analysis

SysCODE administration used an annual on-line survey as a tool to collect information from the team members about their efforts in primary and secondary disciplines, their participation in collaborative projects, and to solicit their feedback.

Four surveys have been conducted since Consortium inception in 2007, with two major goals:

- To assess the level of interdisciplinary collaborative interactions between groups and individuals
- To identify areas for development and/or expansion

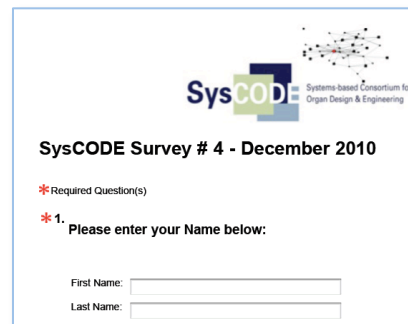
## Survey Demographics

Survey's rate of response has improved with time, with postdoctoral fellows and trainees leading the course

Time Point	All entries	Respond Rate, %	Pls & Collab.	Post Docs	IDT Trainees	Admin
<b>T1</b> Apr'08	44	43	19	18	3	4
<b>T2</b> Dec'08	31	30	12	14	3	2
<b>T3</b> Dec'09	46	51	13	23	9	1
<b>T4</b> Dec'10	54	67	14	28	11	1

## Analysis Approach

- Annual SysCODE survey
- Social Network Analysis
- Analysis of publications for
  - Co-authorship
  - Journal category



**SysCODE** Systems-based Consortium for Organ Design & Engineering

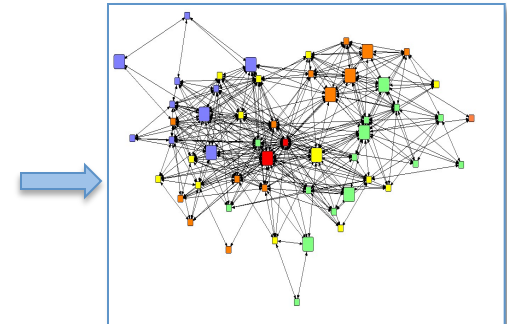
**SysCODE Survey # 4 - December 2010**

\* Required Question(s)

\* 1. Please enter your Name below:

First Name:

Last Name:



# Conducting SysCODE Survey

## Invitation to Participate

**Subject: SysCODE SURVEY # 4**

Having trouble viewing this email? [Click here](#)



Greetings,

To evaluate program synergy and value added outcomes from interdisciplinary research, we collect and analyze your feedback. Please take the [4-th SysCODE survey](#) today.

**Take this survey**

Thank you! We value your time and appreciate your candid response.

Many thanks go to Lindsay Clinton for helping with survey design.

Sincerely,

SysCODE Administration

Thank you for taking the time to complete SysCODE survey !

This survey is similar to the previous three surveys to assure that the data collected is consistent and can be properly analyzed:

- 5 questions about you and your contributions
- 9 sections with questions about your collaborations with SysCODE members (organized by teams)
- 3 questions about your opinion and suggestions

It should take no more than 10 minutes to complete this survey.

[Continue >](#)



## Survey Main Components

### Part I

- Name and role
- Time spent on SysCODE projects
- Type of contribution
- Primary and secondary disciplines
- Factors that contributed to the program success or hindered it

### Part II

- Interactions with SysCODE members:

- Haven't heard of
- Know the work of
- Plan to collaborate
- **Collaborated**
- **Co-authored a paper**

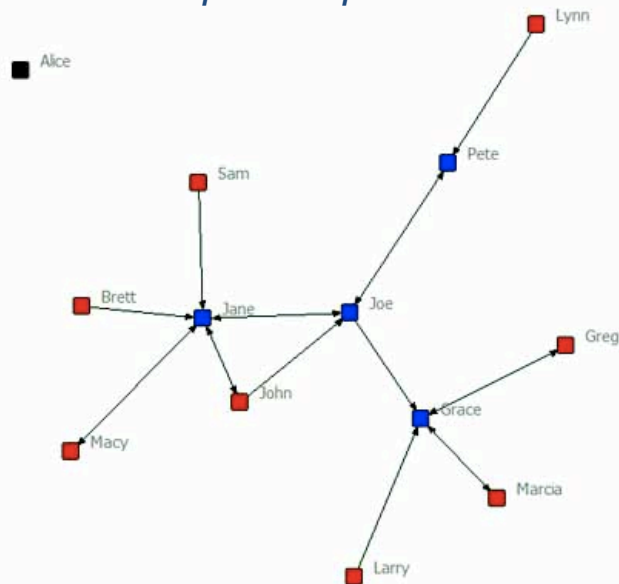
} SNA  
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# Social Network Analysis (SNA)

## NETWORK

- Social network = nodes and ties
- Nodes – individuals
- Ties – relationships between individuals

### Network map example

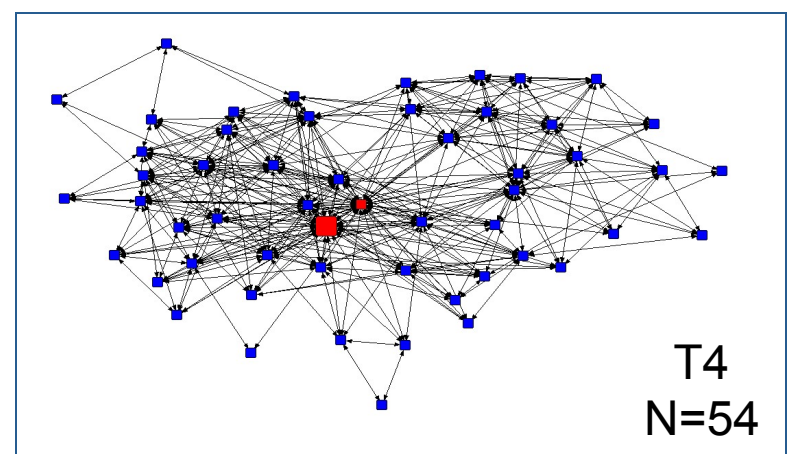
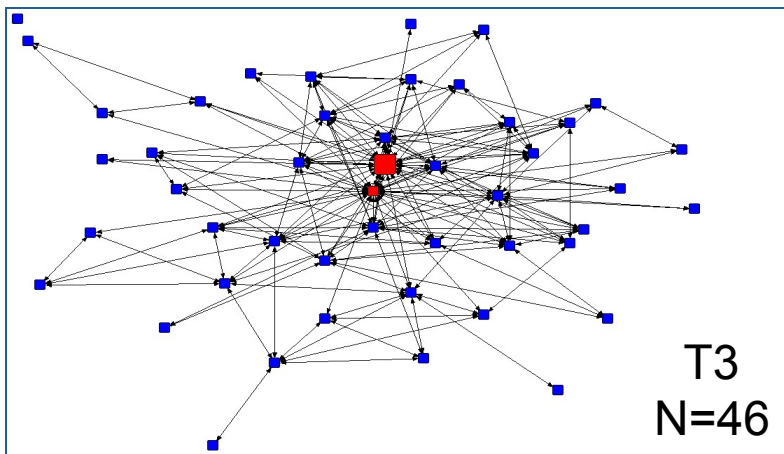
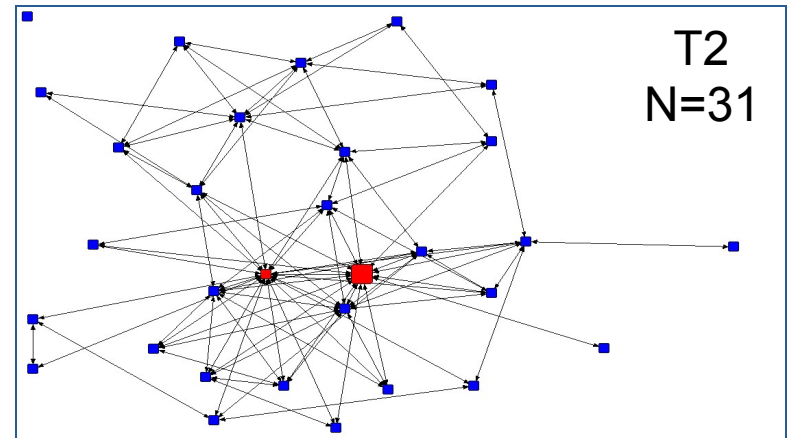
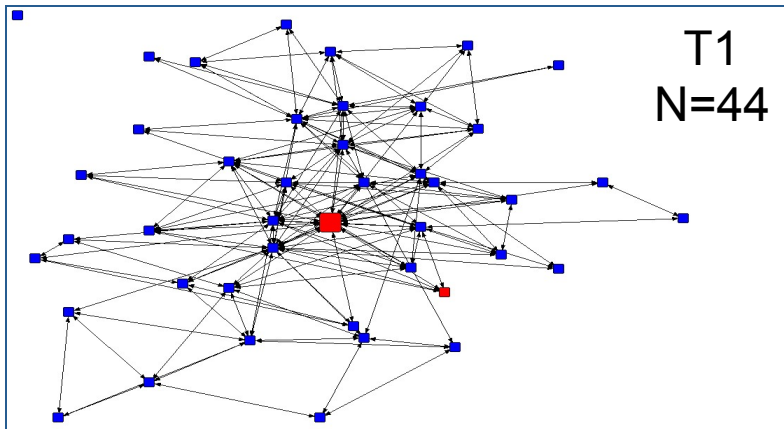


## NETWORK METRICS

- Distance - shortest path b/w 2 nodes  
optimal connection
- Density - proportion of active ties  
collaborative capital
- Centrality - measure of how well the nodes connect the network  
social power

# Evolution of the SysCODE Network

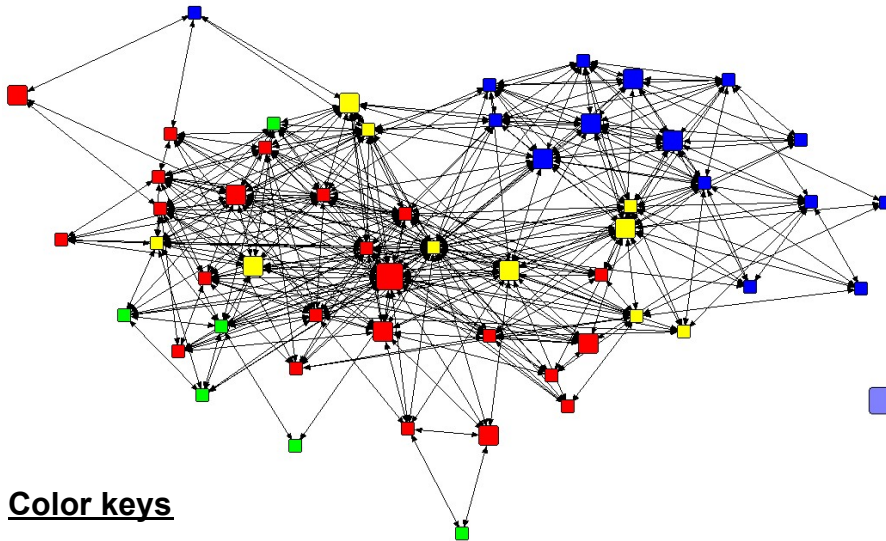
*All entries per survey*



*Red nodes – SysCODE Administration*

# Dissecting Sociograms by Study Subject and Discipline

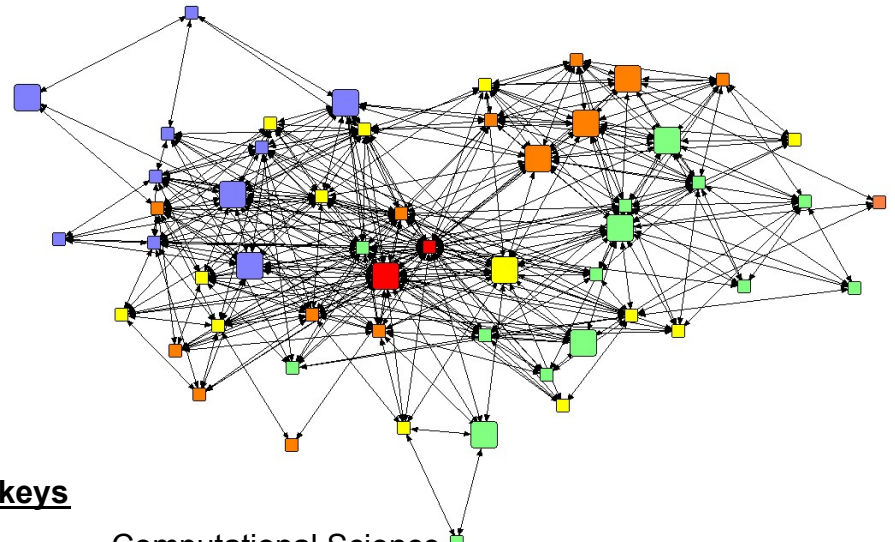
## Color-coded by Organ



### Color keys

- Red – Organ 1
- Blue – Organ 2
- Green – Organ 3
- Yellow – 1+ organ-systems
- Large nodes – PIs

## Color-coded by Discipline



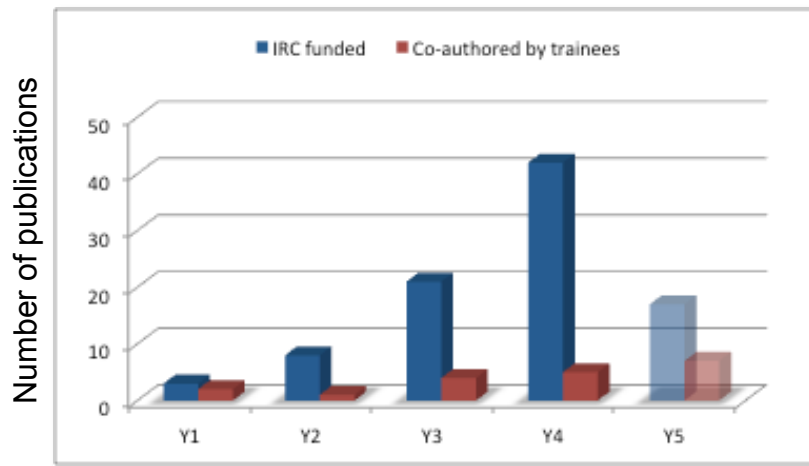
### Color keys

- Blue – Computational Science
- Orange – Developmental and Stem Cell Biology
- Green – Bioengineering
- Yellow – Interdisciplinary Trainees
- Large nodes – PIs

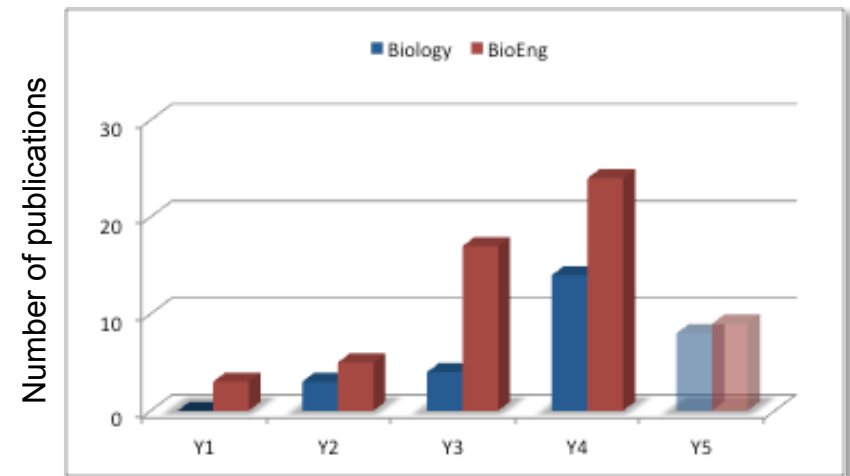
# Publications as a Measure of Scientific Progress

Total number of SysCODE funded publications in four years of IRC

Overall publications and those co-authored by interdisciplinary trainees



Contribution by disciplines: Category *Biology* includes computational science publications



**Note:** Year 5 data represent publications from July 2011 to October 2011: submitted, in press and published

# Examples of SysCODE IDR Publications

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## ***A Wnt and Bmp feedback circuit controls inter-tissue signaling dynamics in tooth organogenesis***

O'Connell DJ\*, **Ho JW\***, Mammoto T, Turbe-Doan A, O'Connell JT, Haseley PS, Koo S, Kamiya N, **Ingber DE**, **Park PJ**, **Maas RL**. Science Signaling (submitted)

## ***Mechanochemical control of mesenchymal condensation and embryonic tooth organ formation.***

Mammoto T, Mammoto A, Torisawa YS, Tat T, Gibbs A, Derda R, Mannix R, de Bruijn M, Yung CW, Huh D, **Ingber DE**. **Dev Cell**. 2011 Oct 18;21(4):758-69. PMID: 21924961

## ***Networked-based characterization of extracellular matrix proteins from the adult mouse aortic and pulmonary valve proteomes***

**Angel PM\***, **Nusinow D\***, Brown CB, Tompkins K, Violette K, DeLaughter D, **Barnett JV**, Zhang B, **Baldwin HS**, **Caprioli RM**. J Proteome Res. Feb 2011 10(2): 812-23, PMC3139330

## ***Amniocytes can serve a dual function as a source of iPS cells and feeder layers***

**Anchan RM**, Quaas P, **Gerami-Naini B\***, Bartake H, Griffin A, Zhou Y, Day D, Eaton JL, George LL, Naber C, Turbe-Doan A, **Park PJ**, Hornstein MD, **Maas RL**. Hum Mol Genet. Mar 2011; 20(5): 962-74



Developmental Biology



Bioengineering



Genomics and Proteomics



Stem Cell Biology



# IDR Impact Factor



Analyzed publications, PMID

Based on bibliometric analyses, we provisionally conclude that a qualitatively new network of IDR collaborations has emerged in four years of IDR, with more extensive engagement of postdoctoral fellows, faster information dissemination among members, the emergence of stable relationships between IDR investigators, and a stronger network. Overall, our findings support the hypothesis that ***team science stimulates productive research that is focused on new ideas and technological platforms, which in turn facilitates overall biomedical research***

The average number of co-authors has grown **from 5.5 to 7.1** (field ave N=5)

Journal	Impact Factor	5-Year Impact
<b>Year 1</b>		
Science	4.70	4.00
PNAS	2.62	2.75
Dev Biol	1.37	1.45
J Proteome Res	1.05	1.08
<b>Year 2</b>		
Cell	7.98	8.24
Genome Res	5.39	5.50
Nat Methods	4.87	4.12
Nat Biotechnol	3.95	3.31
<b>Year 3</b>		
Genes Dev	5.80	5.48
Cell Stem Cell	3.92	3.92
Nat Chem Biol	3.12	3.15
PNAS	2.62	2.75
<b>Year 4</b>		
Cell	7.98	8.24
Cell Stem Cell	3.92	3.92
Dev Cell	3.68	3.84
J Clin Invest	3.40	3.31

**The impact factor** = average number of times citable publications from 2007-2008 were cited by publications in 2009;

**The 5-year impact** = average number of times citable publications from 2004-2008 were cited by publications in 2009

Dr. G.Weber et al. <http://profiles.catalyst.harvard.edu/?pg=bibliometrics>

# *Selected Findings*

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## Evidence of Interdisciplinarity

- Collaborative capital of the Consortium Team increased
- Connections stabilized and fragmentation decreased
- Centrality of individual node decreased as Team Science strengthened
- SysCODE' s interdisciplinary network is an integrated 3x3 matrix with three organ- systems (left-right) and three disciplines (up-down)

## Evidence of Scientific Progress

- Increased number of IRC publications
- Emergence of IDR publications
- Highly ranked peer-review journals => strong impact

# Acknowledgements



## **National Institutes of Health**

NIDCR, NIDDK, NHLBI, NIBIB, NCRR

## **External Advisory Board**

UPENN, U of Helsinki, U MICH, TUFTS

## **SysCODE PI - Leaders**

BWH, CHB, HU, HMS, VUSM, BU, MIT

# *Selected References*

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