



digital imaging

and anatomic pathology's care delivery model

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Chief Executive Officer
Biolmagene

Executive War College
New Orleans, April 27-29, 2010

1



1 **disruptive innovation**
what differentiates it from sustaining innovation?

2 **digital pathology**
just how disruptive is it? what trends will it trigger?

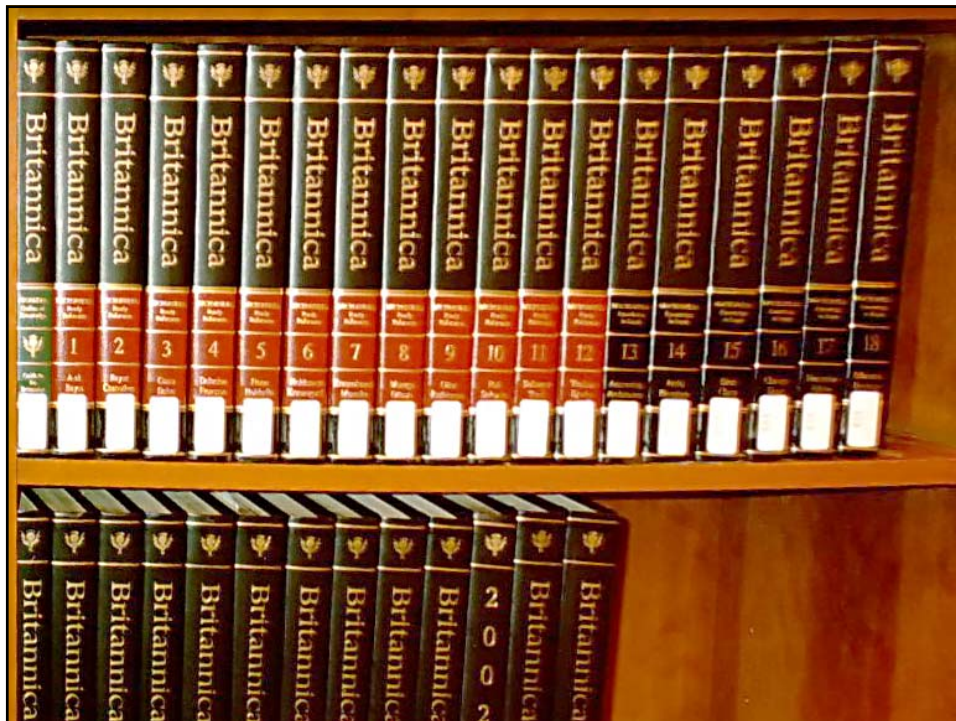
2 **10 trends for 2020**
how will the delivery model change? and why?

2





what is a **disruptive** innovation?





what is
this?

6

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a low-end car?



Building the world's cheapest car

The cheapest car in the world, set to sell for just \$2,500, is being unveiled at the Delhi Auto Expo by the Indian car manufacturer Tata Motors. The "one lakh" – slang for 100,000 rupees – people's car is aimed at the country's 65 million scooter riders currently unable to afford a car.



a high-end
motorcycle?



G

what is
this?

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a low-end
ultrasound?

13



a high-end
stethoscope?

14



G

what is
this?

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another **disruptive** innovation

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These innovations were all **disruptive** for a single reason:

When they were introduced, their performance was initially much lower than that of the existing technologies...

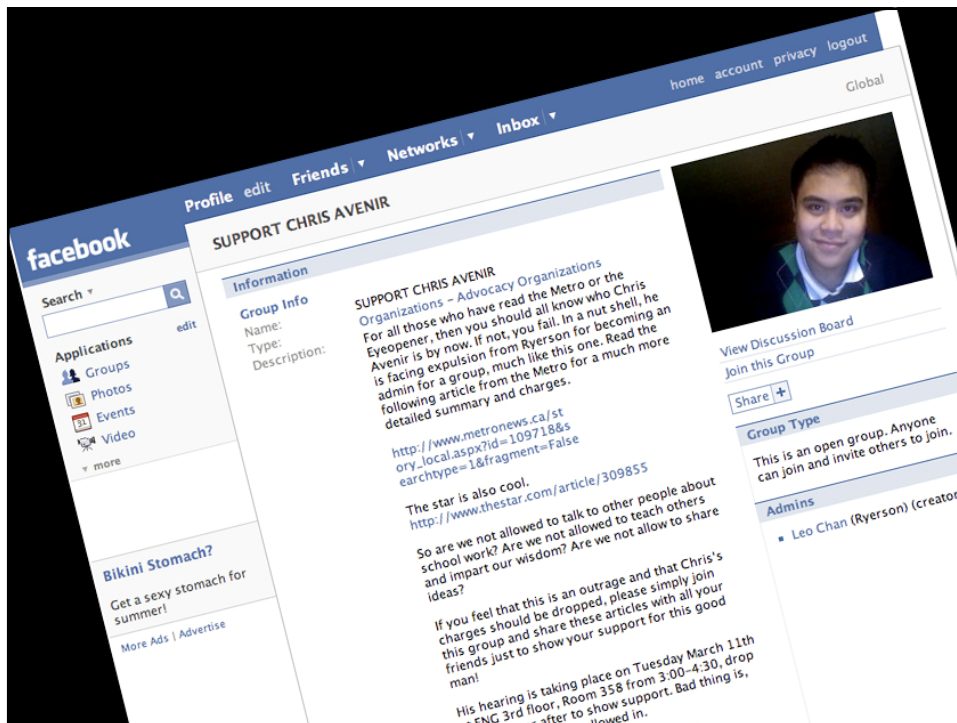
But, they were able to bring the cost down so dramatically that their adoption became inevitable... sometimes in an alternative market segment (to start with)

Eventually, their performance caught on, and led to their mass dissemination.

18




now, another type of **disruptive** innovation



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LIVE



OBAMA'S ECONOMIC TEAM
CHICAGO

facebook

What do you think about what you're watch

Everyone Watching Friends

- Kent Schoen is cold.
about a minute ago via CNN.com Live - Comment
- Michelle Stanek snow!
about a minute ago - Comment
- Monica Koyama wants to throw a SCSWMR part
parker's beach house?
about a minute ago via CNN.com Live - Comment
- Michael Morris is waiting to hear.
4 minutes ago - Comment
- Brendan Holsberry my name is Willie, Willie
Beamennnnnn.
10 minutes ago - 2 Comments
- Sandra Liu Huang is 25 meetings in 3 days. wh
to work?
about a minute ago via CNN.com Live - Comment
- Josh Pritchard is broken glass everywhere.
29 minutes ago - Comment

THE PRESIDENTIAL INAUGURATION
Barack Obama swears in as the 44th president of the United States

NOW PLAYING

- OBAMA'S ECONOMIC TEAM
LIVE: Obama announces his economic team
- UN Security Council
LIVE: UN Security Council on Gaza
- IMMIGRATION
LIVE: 'Gimme My Money Back'

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These innovations were **also disruptive**, but for a different reason:

They were able to “deconstruct” the existing value chain of a business...

They were able to “dis-intermediate” the value chain of a business...

They were able to “re-configure” the value chain with a different set of players.

Their adoption was set off by some “tipping point”

23



all great examples of
disruptive
innovation

24



but, in order to see why,
we had to look
unconventionally

25



*In the **conventional** world of “looking”,
it is easy to see what is going on,*



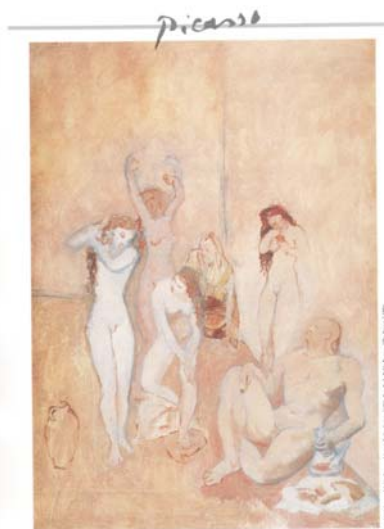
reality is recognizable,



27

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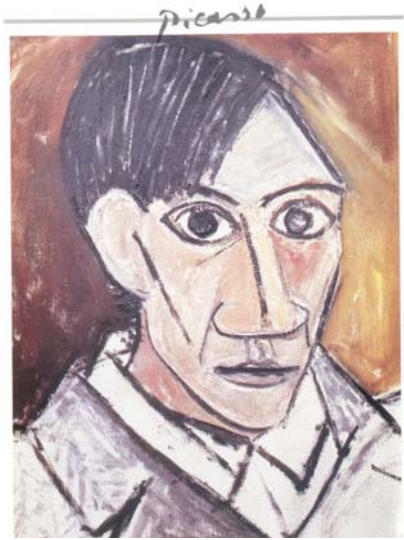
*even though sometimes fuzzy, the picture
is understandable .*



28

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Then things start to look funny ...



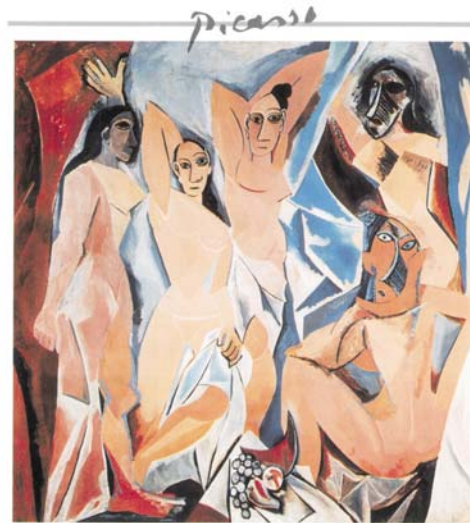
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they become harder to recognize



30

... and disjointed,



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... but you can still tell what is going on.



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However, it gets harder...



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... and harder



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and finally it becomes impossible



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to see what is going on...

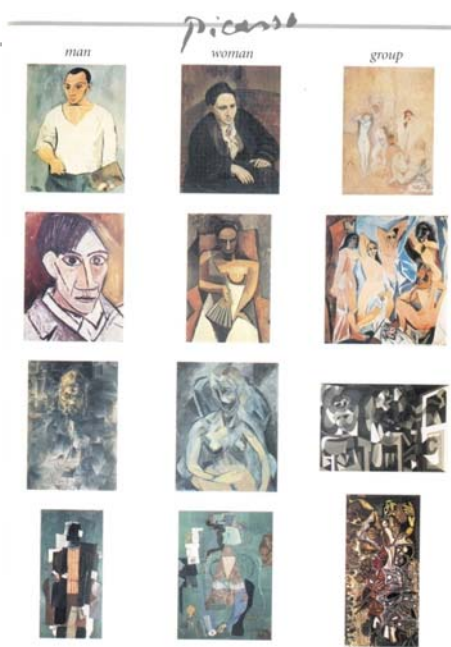


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... by looking at things the *conventional* way.



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our onus is to figure out the pattern

that lies hidden underneath the apparent
chaos on the surface



to see through Picasso's outer shell and uncover...



the Velazquez that lies behind it.



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our onus is to figure out the pattern



42



space :: pattern
time :: trend

43



trends

44



two trends triggered by
disruptive
innovation

45



2 things
you simply could not do at all before

1 things
you can do at a significantly lower cost

46

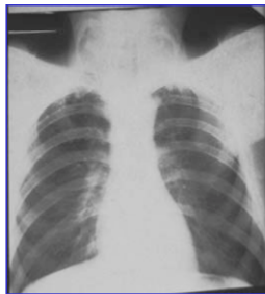


what did digital-ization **transform** in radiology?

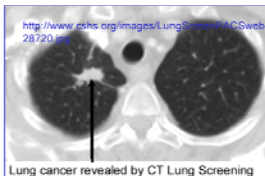
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ca 1900
X- Ray



ca 2000
CT

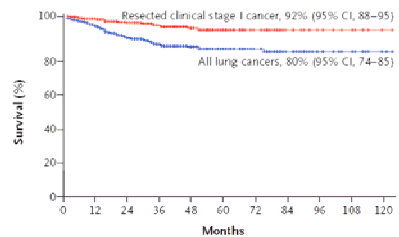


31,567 asymptomatic persons at risk
for lung cancer using low-dose CT
identified 484 with stage I lung cancer

The **NEW ENGLAND**
JOURNAL of *Medicine*

Survival of Patients with Stage I Lung Cancer
Detected on CT Screening

The International Early Lung Cancer Action Program Investigators*



Surgery improved five-year survival

48

15 years of digital radiology



2

New: 3D Visualization
New: Quantitative analysis (Cardiology, Oncology)
New: Fusion – anatomy and physiology
New: Contextual access to anatomy atlas at POC
New: Contextual access to “similar cases” at POC
New: Contextual access to expert opinion at POC

1

Productivity up by 20%
Report turn-around time down from 3 days to 3 hours
Radiology study availability up from 60% to nearly 100%
“Handling errors” down – undocumented

Clinician viewing up by a factor of 2
Comparison with prior studies up by a factor of 5
Screening (breast, lung, colon) up by a factor of 10

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2

things

you simply could not do at all before

1

things

you can do at a significantly lower cost

50

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2 **redefine**
standard of care

1 **automate**
standard of care

51



what did digital-ization
transform
in radiology?

52



what **can** digital-ization **transform** in pathology?

53



Potential Clinical Use Cases... inventoried

quantitative comparison improve report turnaround time
 case sharing and collaboration pathology 2.0
 education archiving and retrieval
 tumor boards remote case review reporting
 improve slide "availability" efficient primary diagnosis
 consultation and second opinions research and clinical trials
 reduce handling errors data mining for decision support
 quantification CME and proficiency testing QA
 remote frozen sections image analysis
 improve slide "availability"
 personalized medicine
 companion algorithms

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Potential Clinical Use Cases... organized



quantitative comparison improve report turnaround time
case sharing and collaboration pathology 2.0
education archiving and retrieval
tumor boards remote case review reporting
improve slide "availability" efficient primary diagnosis
consultation and second opinions research and clinical trials
reduce handling errors data mining for decision support
quantification CME and proficiency testing QA
remote frozen sections image analysis
personalized medicine improve slide "availability"
companion algorithms

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Potential Clinical Use Cases... organized



2

Quantitative comparison
Case sharing and collaboration
Image analysis
Remote frozen sections
Data mining for decision support
Personalized Medicine

1

Improve report turn-around time
Archiving and retrieval
Tumor boards
Remote case review
Efficient primary diagnosis
Reduce handling errors
Improve slide availability
Quantification

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2 things
you simply could not do at all before

1 things
you can do at a significantly lower cost

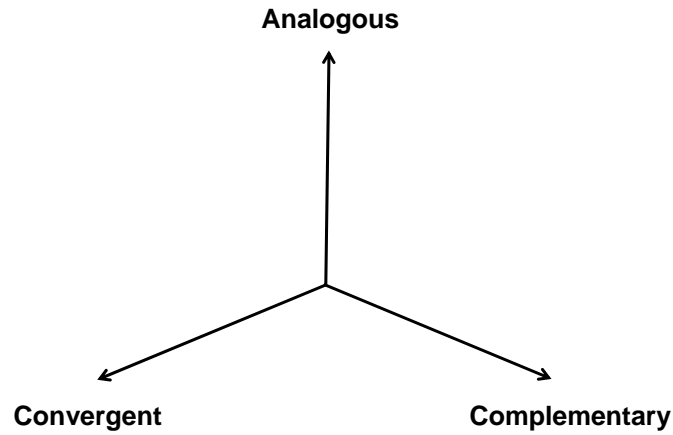
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2 redefine
standard of care

1 automate
standard of care

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how do we
implement
digital pathology?





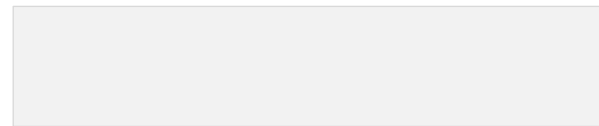
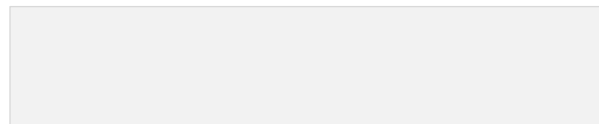
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software applications

scanners

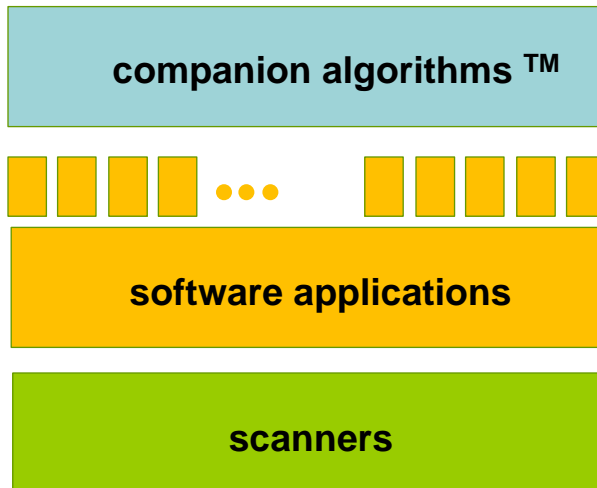
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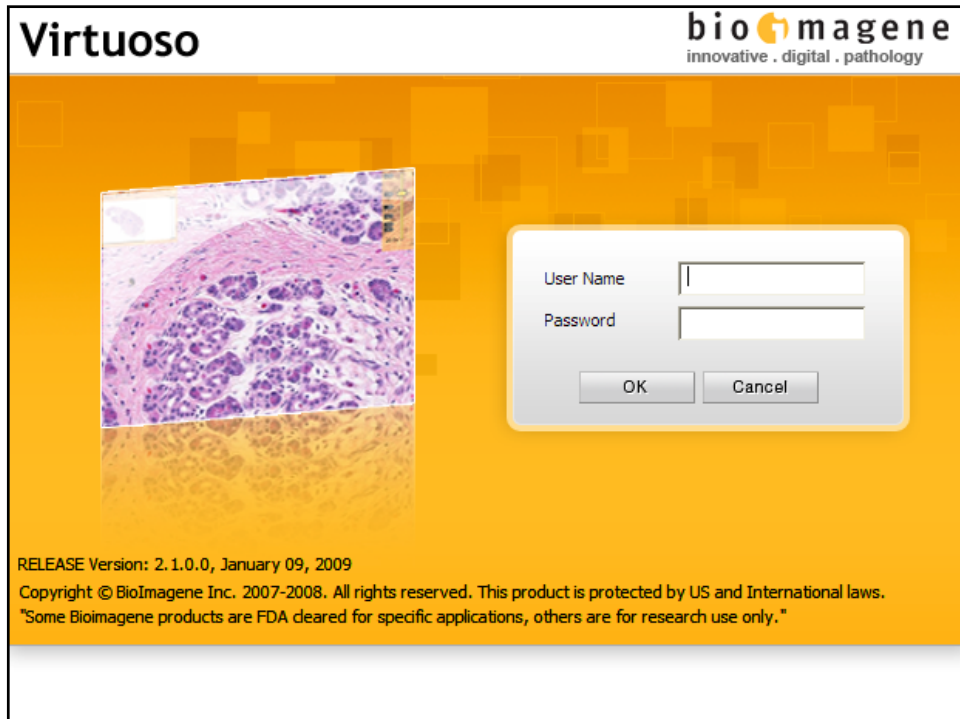
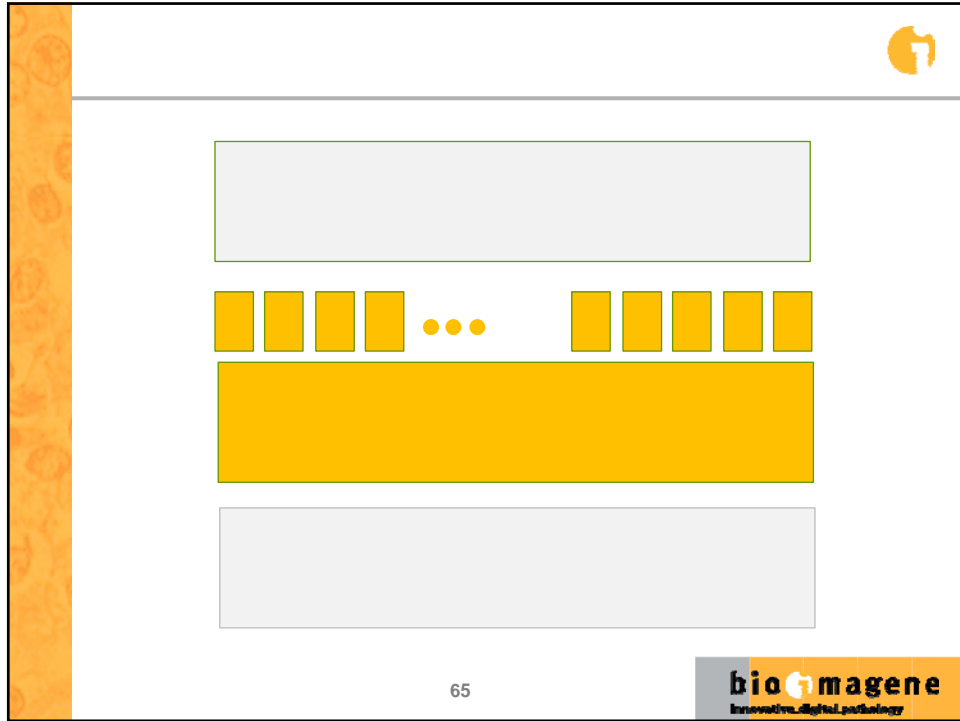
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Virtuoso Name: path path Role: PATHOLOGIST Login Time: Thu, 12 Feb 2009 09:59:38

Home Case List Slides Analysis Search Criterion Search Advanced Search Preferences Help Logout

Navigate To Parameter Set: Set-1 Manual Analyze

Slide Details

Case #: aics001
 Specimen #: aisp001
 Workflow: Integrated View
 Algorithm: IHC_Nuclear

Specimen Slides

H&E Ki-67 HER2 ER

Ki67-4211222

FOVs

1 2 3 4 5 6

Slide Comments

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Navigate To Parameter Set: Set-1 Manual Analyze

Case Info

Case #: S00-11122233
 Specimen #: A
 Patient Name: Jane Doe
 Date of Birth: 1/20/1966
 Patient Gender: F
 Age (years): 43

Clinical Data

Photo data

Save Reset

Biopsy History

No Prior Biopsy History On Record

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Digital Pathology?



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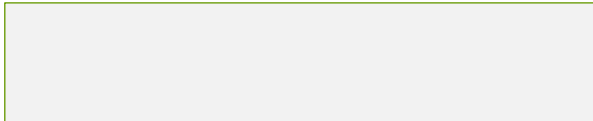
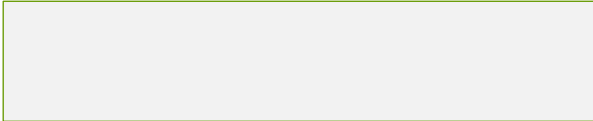


software applications

scanners



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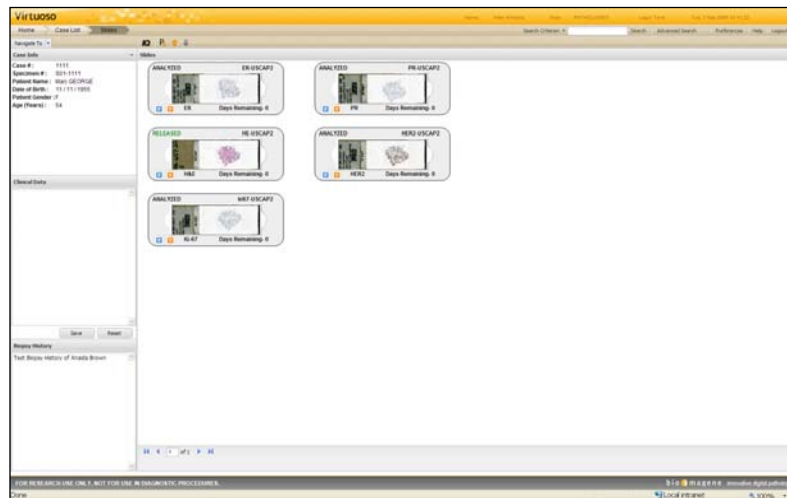
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40x
Digital Zoom
20x
10x
5x
2x
1x
10.0x

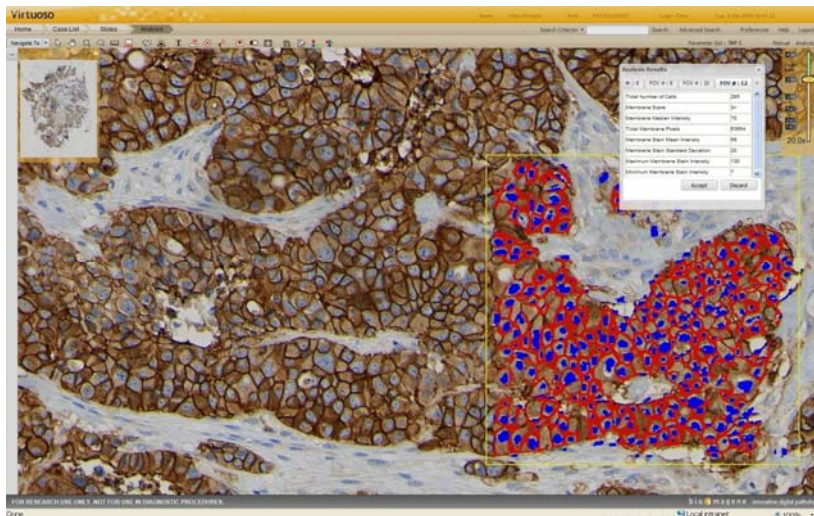
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Breast Panel – Image Analysis for IHC



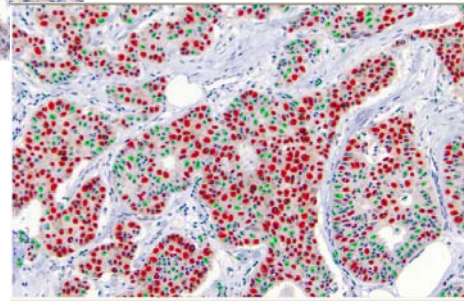
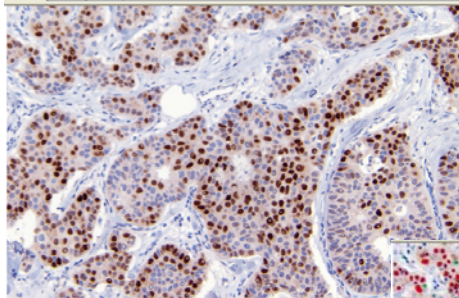
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Her2-neu IHC: Membrane Algorithm



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ER/PR IHC: Nuclear Algorithm

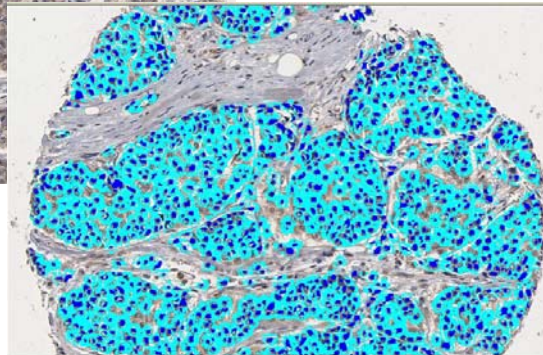
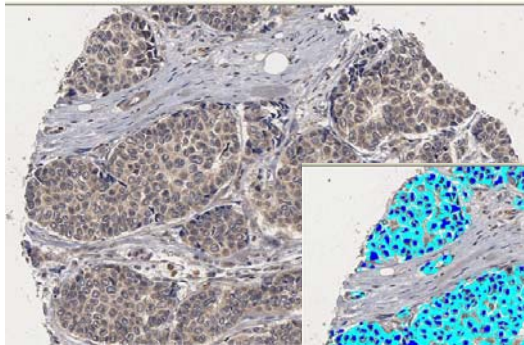


Results	Nuclear
Non Stained Cell Count	95
Stained Cell Count	314
Percent Positivity	77

75

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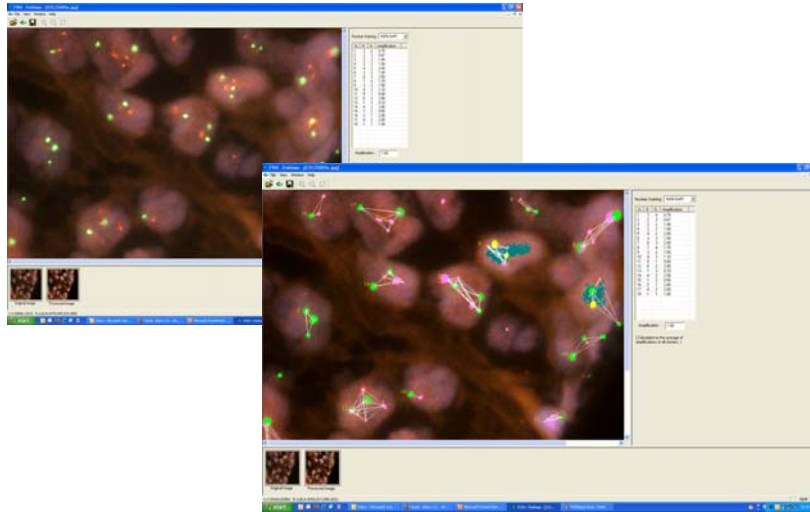
Cytoplasmic Algorithm



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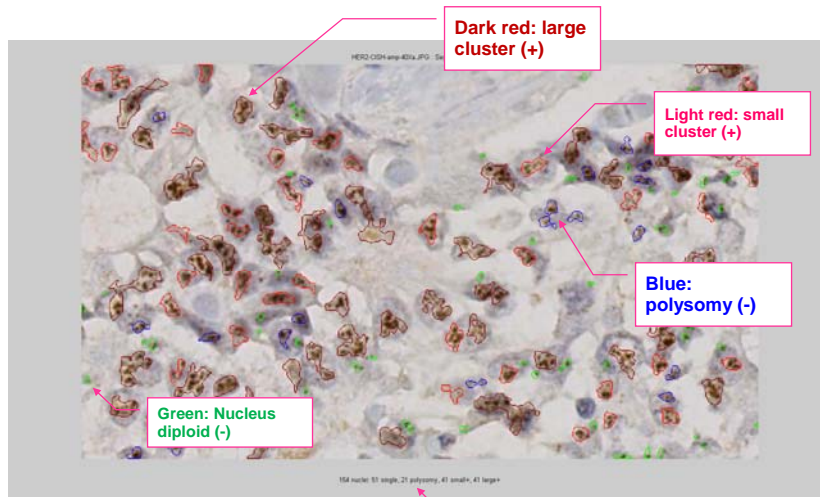
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Digital Scoring of Her2-neu FISH



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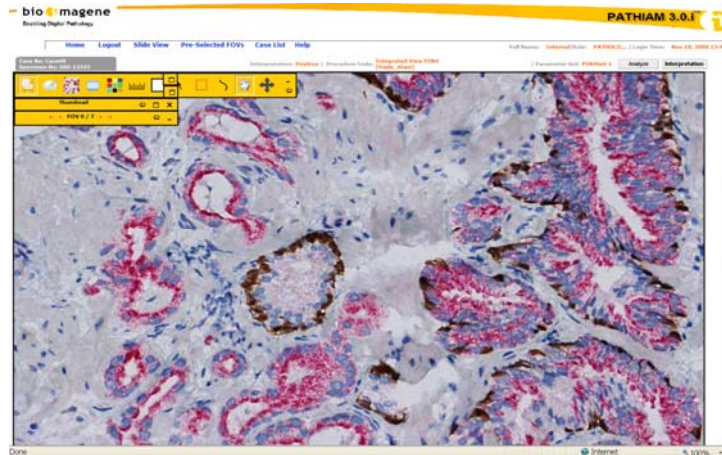
Digital Scoring of Her2-neu CISH



78

Final: 154 nuclei—51 single, 21 polysomy, 41 small+, 41 large+

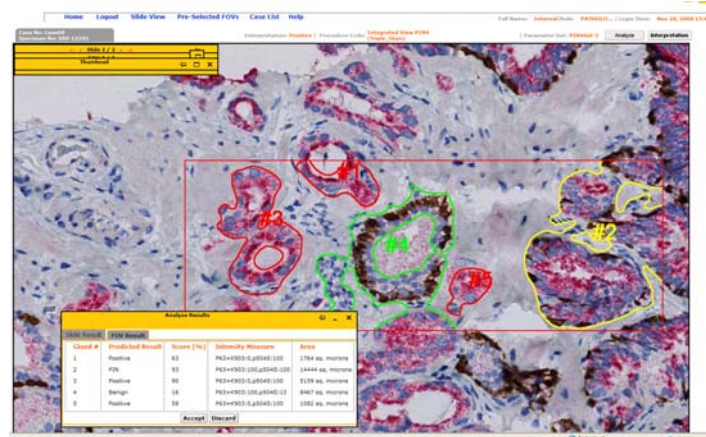
Prostate Panel: IHC triple stain algorithm



P504s (red, cytoplasmic stain)
 K903 (brown, cytoplasmic stain)
 p63 (brown, nuclear stain)₇₉



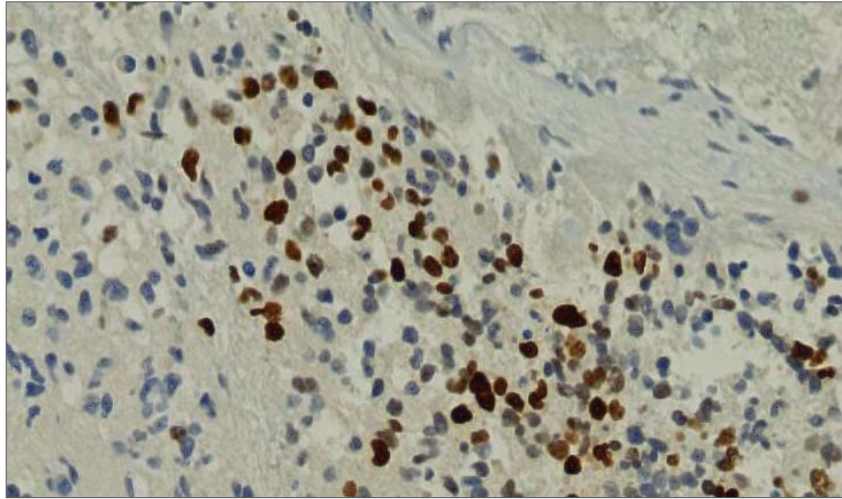
Prostate Panel: IHC triple stain algorithm



Red glands (Red only): Adenocarcinoma
 Green glands (Brown only): Benign
 Yellow glands (Red + Brown): HGPIN



Ki67 Scoring in CNS Glial Tumors



56%

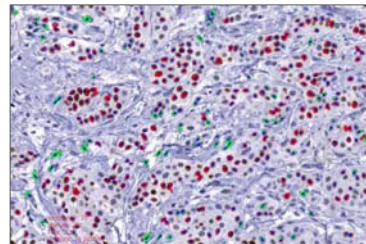
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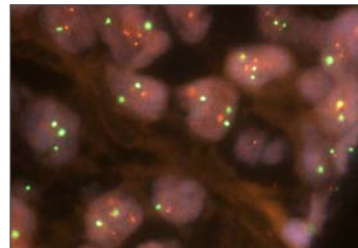
Companion Algorithms: Breast Cancer



**Her2-neu IHC, FISH, and
CISH: selection of
patients for Herceptin®**



**ER/PR scoring selection
of patients for anti-
estrogen therapy**



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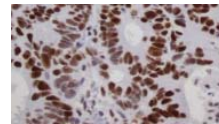
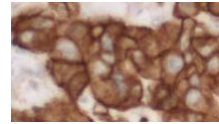
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Companion Algorithms: Colon and Lung



Colon Cancer

- EGFR testing (IHC/FISH) for selection of patients for Erbitux®
- Thymidylate synthase testing for selection of patients for anti-folate based chemotherapy
- MLH/MSH testing for identification of patients with hereditary nonpolyposis colorectal cancer (HNPCC)



Lung cancer

- EGFR testing (IHC/FISH) for selection of patients for Tarceva® and Iressa®
- ERCC1 and RRM1 testing (IHC) for selection of patients suitable for chemotherapy drugs - prediction of response to cisplatin and gemcitabine



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Companion Algorithms: Other Cancers



Prostate Cancer

- Therapy selection - AR IHC for selection of patients for anti-androgen therapy
- Prognostic FISH markers - 21q22 Rearrangements (*TMPRSS2*)

Gastrointestinal Stromal Tumors

- CD117 testing for diagnosis and selection of patients for Gleevec® therapy

Oligodendrogliomas

- FISH testing for deletions at chromosomes 1p and/or 19q for predicting response to chemotherapy



Lymphomas/leukemias – variety of tests (including IHC and FISH) crucial for diagnosis, prognosis, and treatment decisions

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companion algorithms TM
enable companion diagnostics

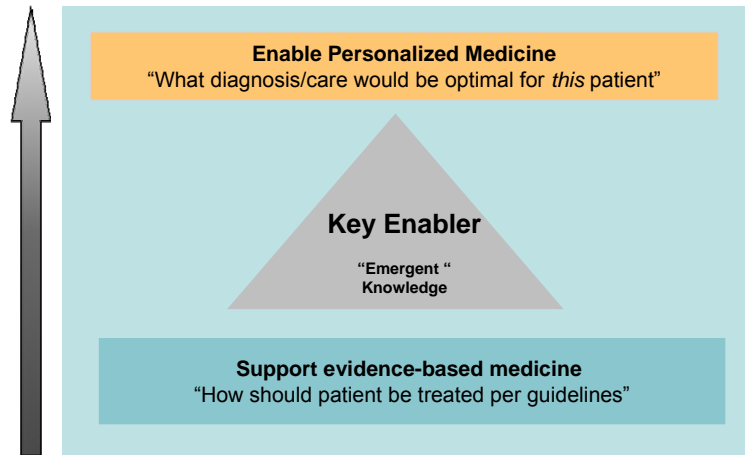
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enable personalized medicine

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Personalized Medicine: What?



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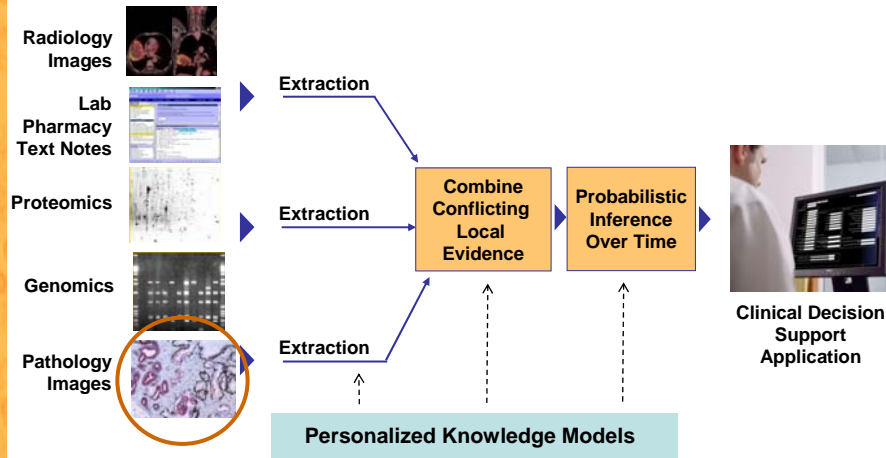
Personalized Medicine: How?



- 1. Collection of large databases of patient data and external medical knowledge**
- 2. Creation of personalized knowledge models**
- 3. Application of personalized knowledge models in clinical workflow**

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Personalized Medicine: How specifically?



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digital
pathology...
... is a key “missing piece”



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With discovery of new biomarkers....



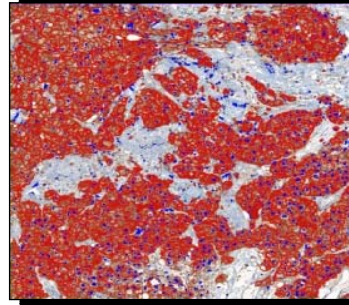
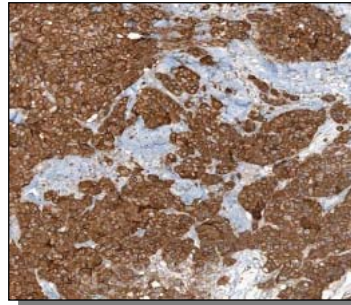
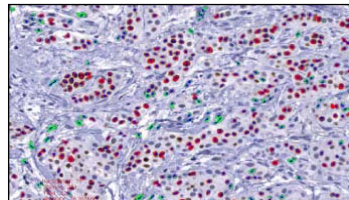
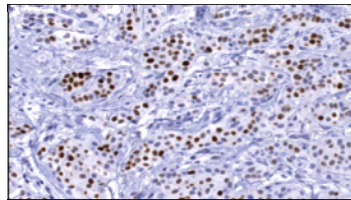
Identification of biomarkers whose expression correlates with:

1. Behavior of disease (for prognosis)
2. Response of disease to specific therapeutic agents

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... the role of quantification will increase



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companion algorithms TM
will redefine standards of care

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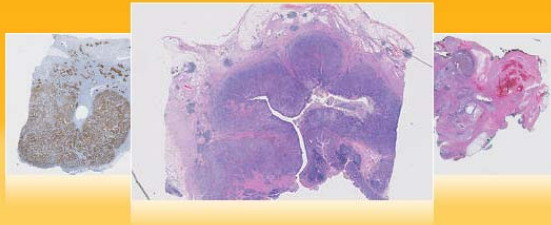


how do we accelerate
adoption?

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Case of the Week

Tumor in the right colon



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Cases of the Week

All Categories

- Blood & Bone Marrow (4)
- Bone (4)
- Breast (19)
- Cardiovascular (5)
- Cytology (8)
- Dermatopathology (195)
- Endocrine (5)
- Gastrointestinal (13)
- Genitourinary (10)
- Gynecological (3)
- Head & Neck (3)
- Immunohistochemistry (0)
- Kidney (3)
- Liver & Pancreas (40)
- Lymphoma (1)
- Neuropathology (5)
- Other (5)
- Pediatric Neoplasms (0)
- Prostate (37)
- Soft Tissue (22)
- Thoracic (8)

Case of the Week

Breast 2
Mahul B. Amin, MD
Tags: Breast

05/27/2009
Cedars Sinai Medical Center
★★★★★

All Categories

Most Recent | Most Discussed | Most Viewed | Highest Rated

Polyoid basal cell carcinoma
Deba P. Sarma, MD
Creighton University Medical Center, Omaha, NE, USA
Tags: Dermatopathology
Man, 70, partly ulcerated exophytic tumor, 2.5 X 2.3 cm, left upper back.
Ref: Love GL, Sarma DP. (1985). Giant polyoid basal cell carcinoma. J Surg Oncol.

Prostate Case #26
Rob Monroe, MD, PhD
Tags: Prostate

01/08/2009
Biotmagene
★★★★★

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Soft Tissue (20) | PathXchange - Mozilla Firefox

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Cases of the Week
All Categories

- Blood & Bone Marrow (1)
- Bone (2)
- Breast (14)
- Cardiovascular (4)
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- Dermatopathology (192)
- Endocrine (5)
- Gastrointestinal (12)
- Genitourinary (10)
- Gynecological (3)
- Head & Neck (2)
- Immunohistochemistry (0)
- Kidney (2)
- Liver & Pancreas (47)
- Lymphoma (0)
- Neuropathology (5)
- Other (3)
- Pediatric Neoplasms (0)
- Prostate (26)
- Soft Tissue (20)
- Thoracic (8)

Soft Tissue (20)

Most Recent Most Discussed Most Viewed Highest Rated

85-y/o female with subcutaneous leg mass 06/02/2009
 pinkoos Christus St. Catherine Hospital
 Tags: Soft Tissue
 The surgeon "shelled out" a 4.5 cm lobulated subcutaneous mass that he thought was a lipoma. ★★★★★

Soft Tissue 1 06/27/2009
 Mahul B. Amin, MD Cedars Sinai Medical Center
 Tags: Soft Tissue ★★★★★

Soft Tissue 2 06/27/2009
 Mahul B. Amin, MD Cedars Sinai Medical Center
 Tags: Soft Tissue ★★★★★

Soft Tissue 3 06/27/2009
 Mahul B. Amin, MD Cedars Sinai Medical Center
 Tags: Soft Tissue ★★★★★

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Tumor in the right colon | PathXchange - Mozilla Firefox

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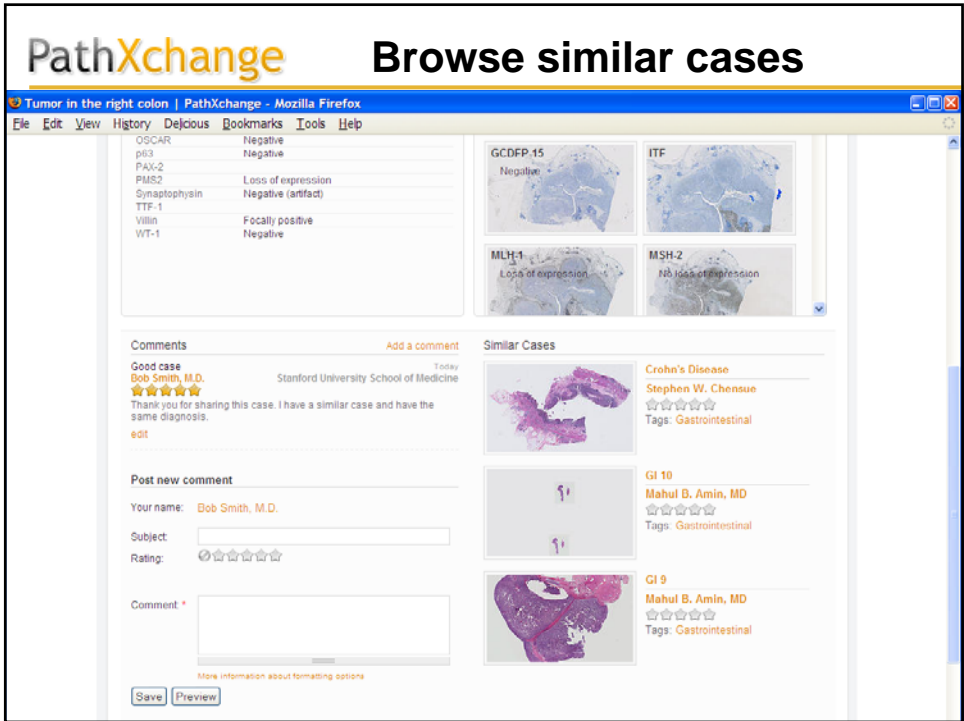
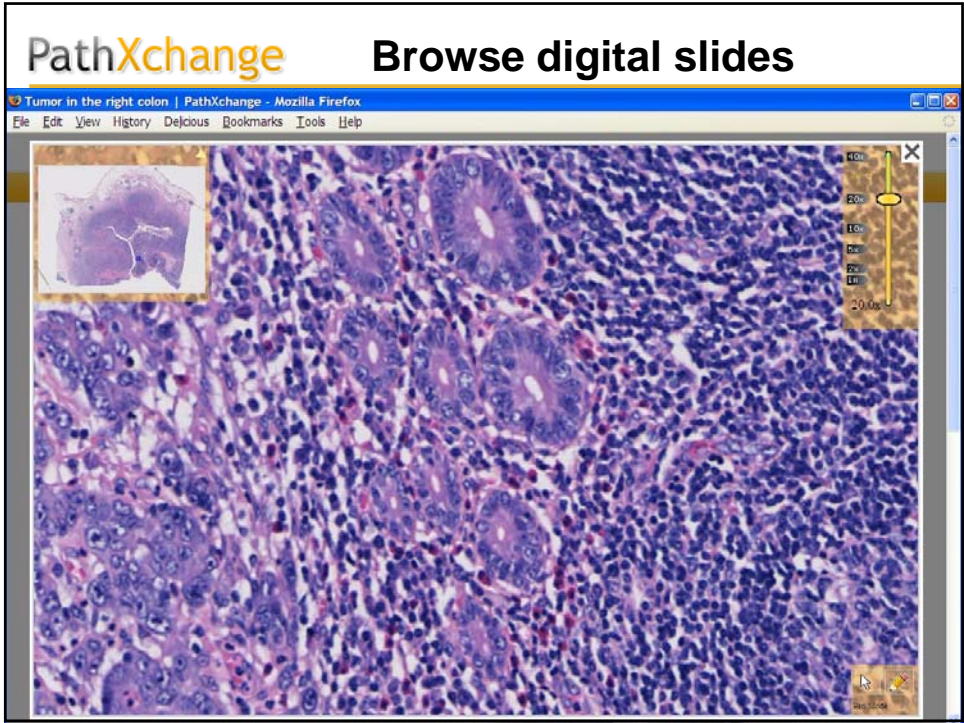
Home » Pathology Categories » Gastrointestinal Search

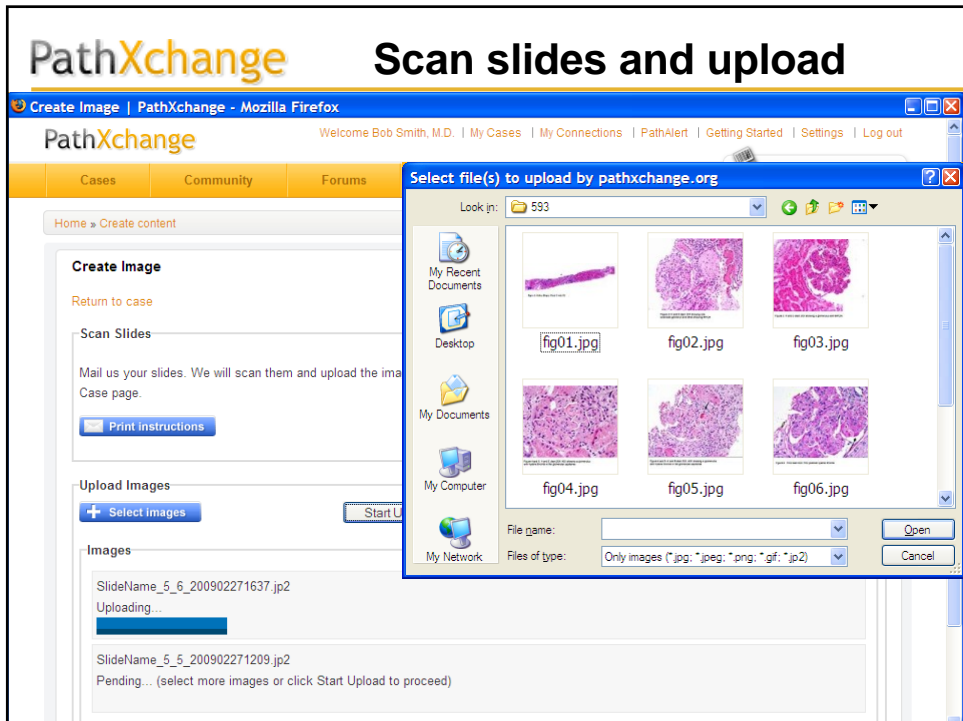
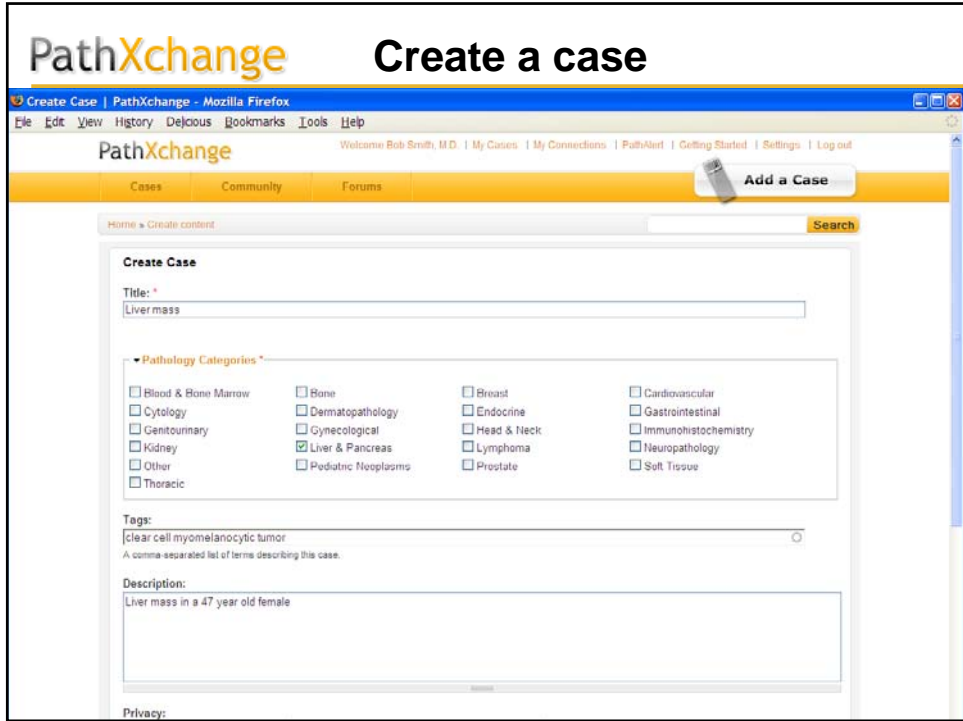
Tumor in the right colon

03/25/2009
 Allen M. Gown, M.D. PhenoPath Laboratories
 Tags: Gastrointestinal ★★★★★
 63 year old female with tumor in the right colon.

Case Overview	Diagnosis
Age:	63
Sex:	Female
Test	Result
H & E	
ER	Negative
CK20	Negative
CK7	Negative
GCDFP-15	Negative
ITF	
MLH-1	Loss of expression
MSH-2	No loss of expression
MSH-6	No loss of expression
No Primary	
OSCAR	Negative
p63	Negative
PAX-2	
PM22	Loss of expression
Synapophysin	Negative (artifact)
TTF-1	
Villin	Focally positive
WT-1	Negative

Slides Image Gallery





PathXchange Create your own case gallery

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Invite a Colleague


Cases of the Week

All Categories

- Blood & Bone Marrow (1)
- Bone (2)
- Breast (14)
- Cardiovascular (4)
- Citology (4)
- Dermatopathology (192)
- Endocrine (5)
- Gastrointestinal (12)
- Genitourinary (10)
- Gynecological (3)
- Head & Neck (2)
- Immunohistochemistry (0)
- Kidney (2)
- Liver & Pancreas (47)
- Lymphoma (0)
- Neuropathology (5)
- Other (3)
- Pediatric Neoplasms (0)
- Prostate (36)
- Soft Tissue (20)
- Thoracic (8)

My Cases

Most Recent | Most Discussed | Most Viewed | Highest Rated




Painless lump in left breast 02/24/2009

Bob Smith, M.D. Stanford University School of Medicine

Tags: Breast ★★★★★

An oriented 7.0 x 5.5 x 3.5 cm. portion of breast tissue was received. On serial sectioning, a 1.8 x 1.5 x 1.5 cm.




Bladder Outlet Obstruction 02/24/2009

Bob Smith, M.D. Stanford University School of Medicine

Tags: Prostate ★★★★★

The patient is an 84-year-old man with history of benign prostatic hyperplasia and bladder outlet obstruction. Transurethral cystoscopic biopsy and transurethral resection of prostate are performed.



A man in his 50s with fever, headache, and sore throat 02/24/2009

Bob Smith, M.D. Stanford University School of Medicine

Tags: Prostate fever headache sorethroat ★★★★★

The patient is a Caucasian male in his 50s with a past medical history of hypertension complaining of "fever, headache, and sore throat." The patient stated that his symptoms began with a sore throat.

My case 04/30/2009

Bob Smith, M.D. Stanford University School of Medicine

Tags: Dermatopathology ★★★★★

Privacy: private [edit]

right breast lump

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Search | PathXchange - Mozilla Firefox

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Home » Search Search

Search

Help PathSearch Content Users

Enter your keywords:

prostate

► Advanced search

Search results

Prostate Case #31
 05/30/2009 Prostate Case #31 Biolumigene Rob Monroe ... Tags: Prostate Input from more ...
 Case - Rob Monroe, MD, PhD - 06/02/2009 - 09:40 - 1 comment - 0 attachments - 0 groups

Prostate case
 05/22/2009 Prostate case Bi Biomics (Ultralight Histology) ... Tags: Prostate Artifact free detail makes diagnosis easier ...
 Case - Tom Donndelinger - 05/26/2009 - 09:41 - 0 comments - 0 attachments - 0 groups

Prostate Case #30
 05/30/2009 Prostate Case #30 Biolumigene Rob Monroe ... Tags: Prostate (Prostate) ...
 Case - Rob Monroe, MD, PhD - 06/02/2009 - 09:42 - 0 comments - 0 attachments - 0 groups

Prostate Case #1
 05/29/2009 Prostate Case #1 Biolumigene Rob Monroe ... Tags: Prostate 65 year old male with elevated PSA ...
 Case - Rob Monroe, MD, PhD - 05/30/2009 - 21:53 - 0 comments - 0 attachments - 0 groups

Prostate Case #28
 05/30/2009 Prostate Case #28 Biolumigene Rob Monroe ... Tags: Prostate (Prostate) ...

250 days... since launch
4000 pathologists... online
8000 cases... uploaded
120 countries



what is our
compass?

Our compass for the industry....



1. ... from acquisition thru image analysis, to decision support to report
2. ... from “off-time” to real-time, from single-modality to multi-modality
3. ... from morphology to molecules (...morphology AND molecules)
4. ... from “information” to “diagnostic confidence”
5. ... to personalized medicine, enabled with companion algorithms™

What does that mean?

“from pathologist to diagnostician”

... an INTEGRATOR!

107

what
trends
will this trigger...



108



... for the
delivery
model

109



1

integration
across the value chain

110



2

disintermediation of the value chain

111



3

personalization of therapeutic decisions

112



4

super-specialty based delivery model

113



5

integration of morphology and molecules

114



6

integration

radiology and pathology

115



7

integration

across the medical record

116



8

efficiency
will remain a key driver

117



9

informatics
will emerge as a “practice”

118



10

education
will change dramatically

119



Digital Pathology will....

2 **redefine**
standards of care

1 **automate**
standards of care

120

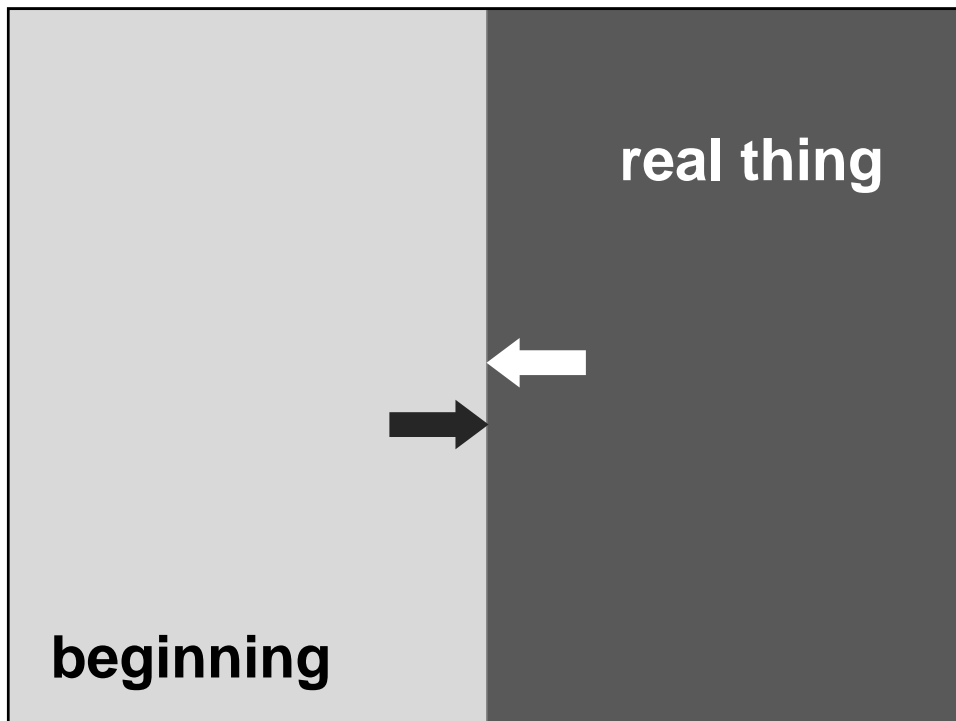
And we are at....

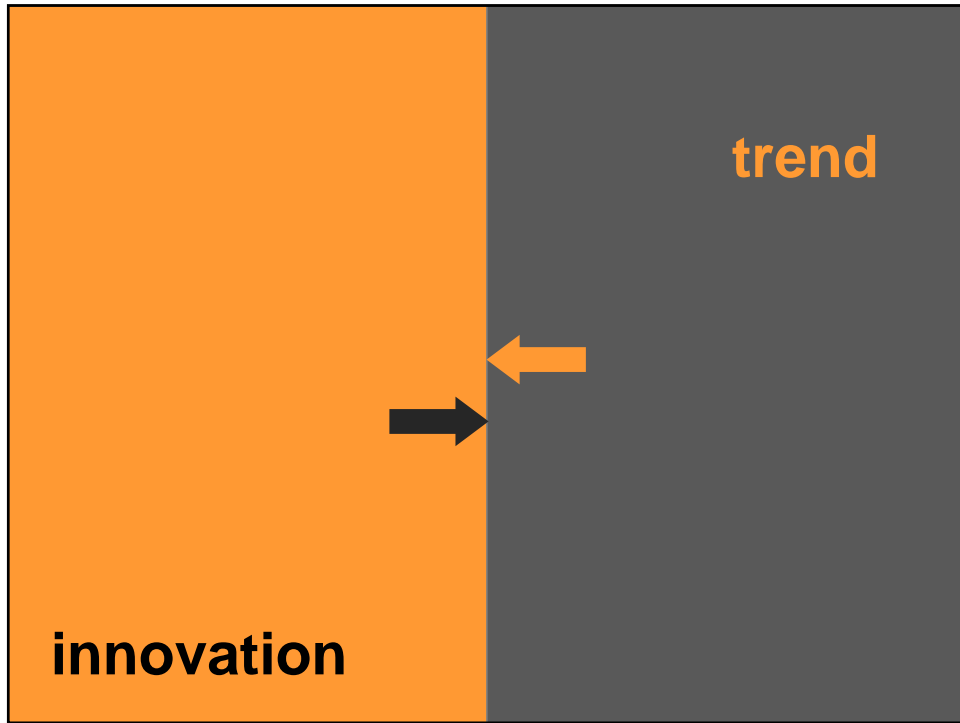


the end of the beginning

121

bio magene
Innovative digital pathology





The slide features a white background with a decorative orange vertical bar on the left side containing a microscopic pattern. A horizontal line is positioned near the top. In the top right corner, there is a small orange circular icon with a white symbol. The main text is centered and reads "digital pathology" in a large, bold, black font, with "an enabler for a disruptive change" in a smaller, orange font below it. At the bottom right, the logo for "bio+magene" is displayed, with "innovative.digital.pathology" written in a smaller font underneath. The page number "124" is located at the bottom center.

digital pathology

the beginning of a trend