

How patients can change the game in (gene-based) nanotechnologies



Serge BRAUN, PharmD, PhD
CSO





Since 1987, a national, festive, and supportive event:

- 30 hr-life TV marathon
- 200,000 volunteers
- 20,000 local events
- 5 million participants
- 1 million donors
on D-Day
- > 70 partners
(private companies, organisations)



Budget :
~ \$135 M



An integrated organisation dedicated to rare diseases

An international network of:

- Hundreds of research teams
- Dozens of partners
- 6000 experts

- > 275 projects fellowships/ y France + abroad
- 6000 projects / 3000 fellowships
- Platforms, strategic programs

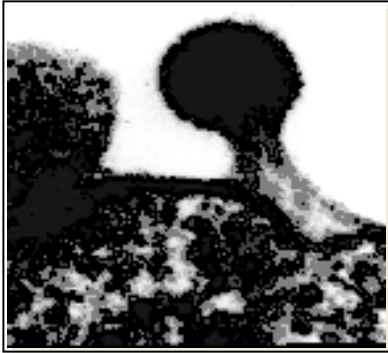
40%

60%



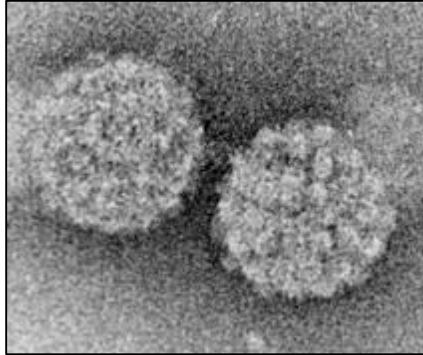
1992: 1st human genome map
Now: gene therapy

Gene therapy



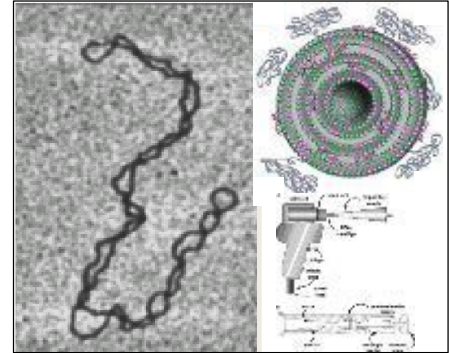
Retrovirus / Lentivirus

- Integrates
- Efficient
- Immunogenic
- Size limitation
- Large scale production



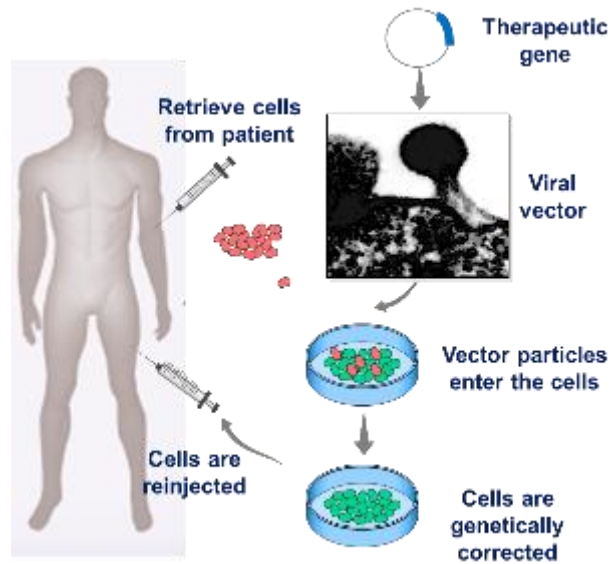
Adeno-associated virus

- Long term (episomal)
- Does not integrate (?)
- Efficient
- Immunogenic
- Size limitation
- Large-scale production



Non-viral

- May be long term
- Does not integrate (?)
- Poorly efficient
- Non-immunogenic
- Large transgenes
- Large-scale production

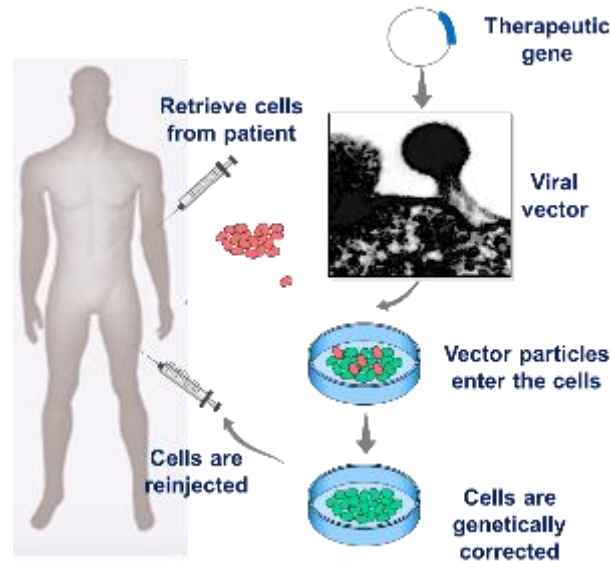


Aleyna, ADA-SCID

« Cured » by gene therapy

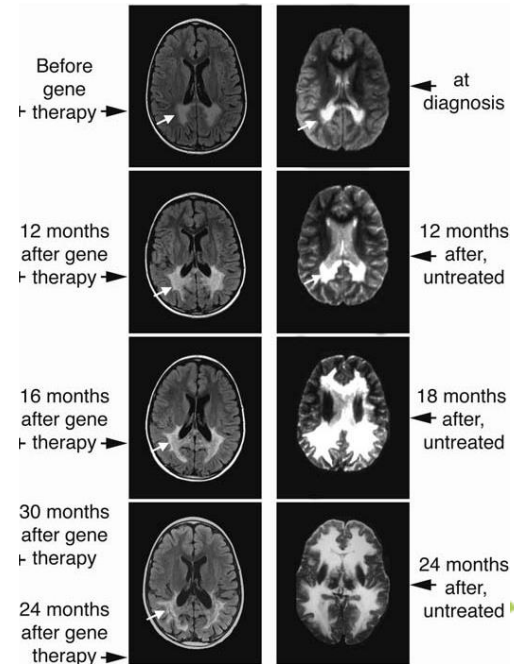
STRIMVELIS[®], GSK (May 27th 2016)



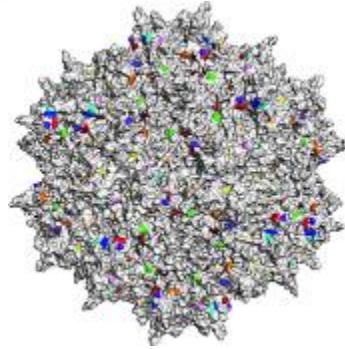


- Immunodeficiencies
- Blood disorders
- Bone diseases
- Adrenoleukodystrophies

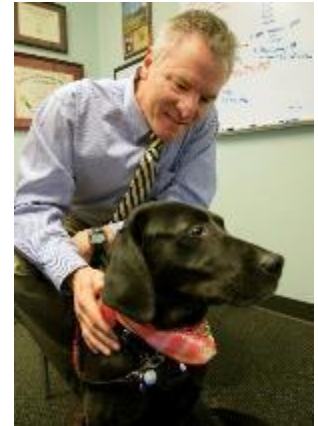
**Proofs of concept
that pave the way
for more diseases**



AAV8-MTM gene therapy of myotubular myopathy



Ana Buj-Bello



M.K. Childers
Seattle, WA



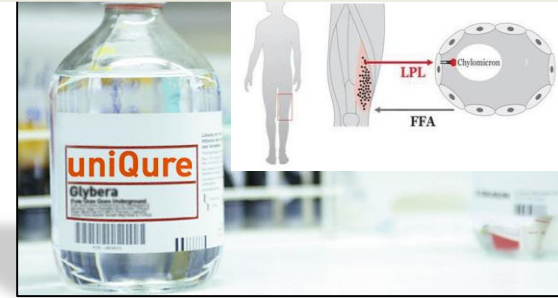
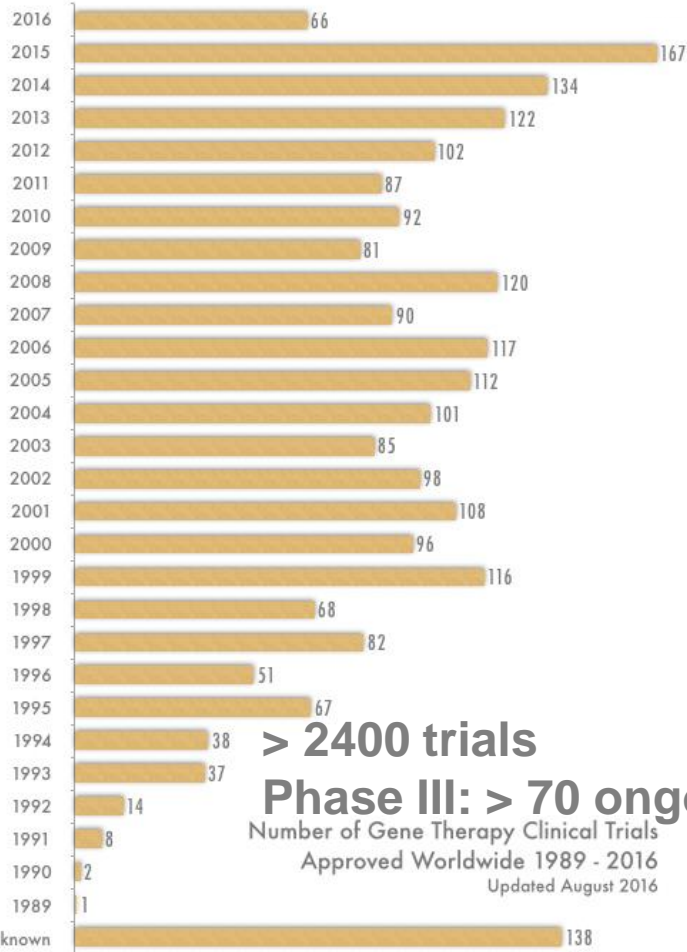
- **X-linked**
- **Death: >50% before 2 y.**
- **Muscle weakness, respiratory failure**
- **No treatment**

Muscular Dystrophy Association
Myotubular Trust
Anderson Family Foundation
Joshua Frase Foundation

AAV8-MTM gene therapy of myotubular myopathy



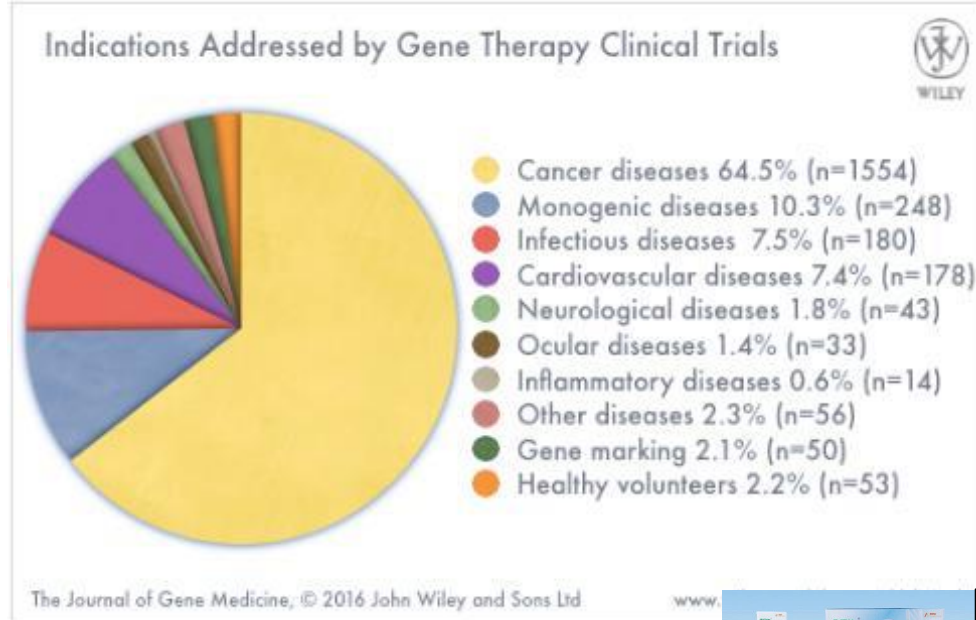
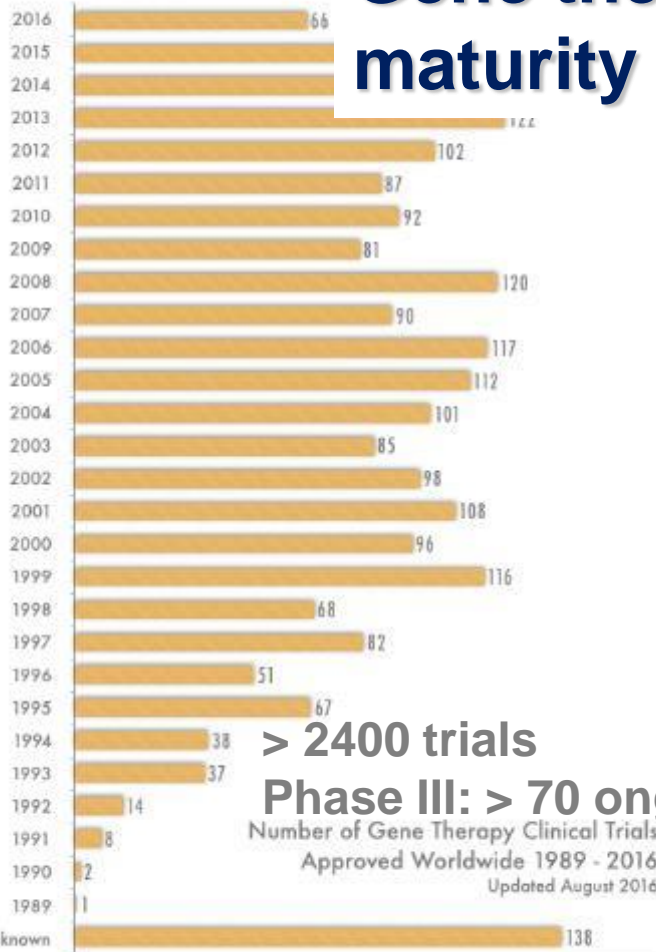
Gene therapy is now reaching the level of maturity that will generate successful products (Ledley et al. Gene Therapy 2013)



- Gendicine®, Oncorine® Ad5-p53
- Strimvelis (GSK) (EU)
- Imlygic® (HSV1-GM-CSF, Amgen) EU/US
- Glybera®, AAV-LDL Familial hyperlipidemia (approved EU Oct.2012; dropped Apr.21, 2017)
- Collategene/AMG0001 (AnGes MG/Vical)
- BC-819 (BioCancell)
- Lenti-D (Bluebird Bio)
- SPK-RPE65 (Spark Therapeutics)
- Invossa/TissueGene-C (TissueGene/Kolon Life Science)

188 companies

Gene therapy is now reaching the level of maturity



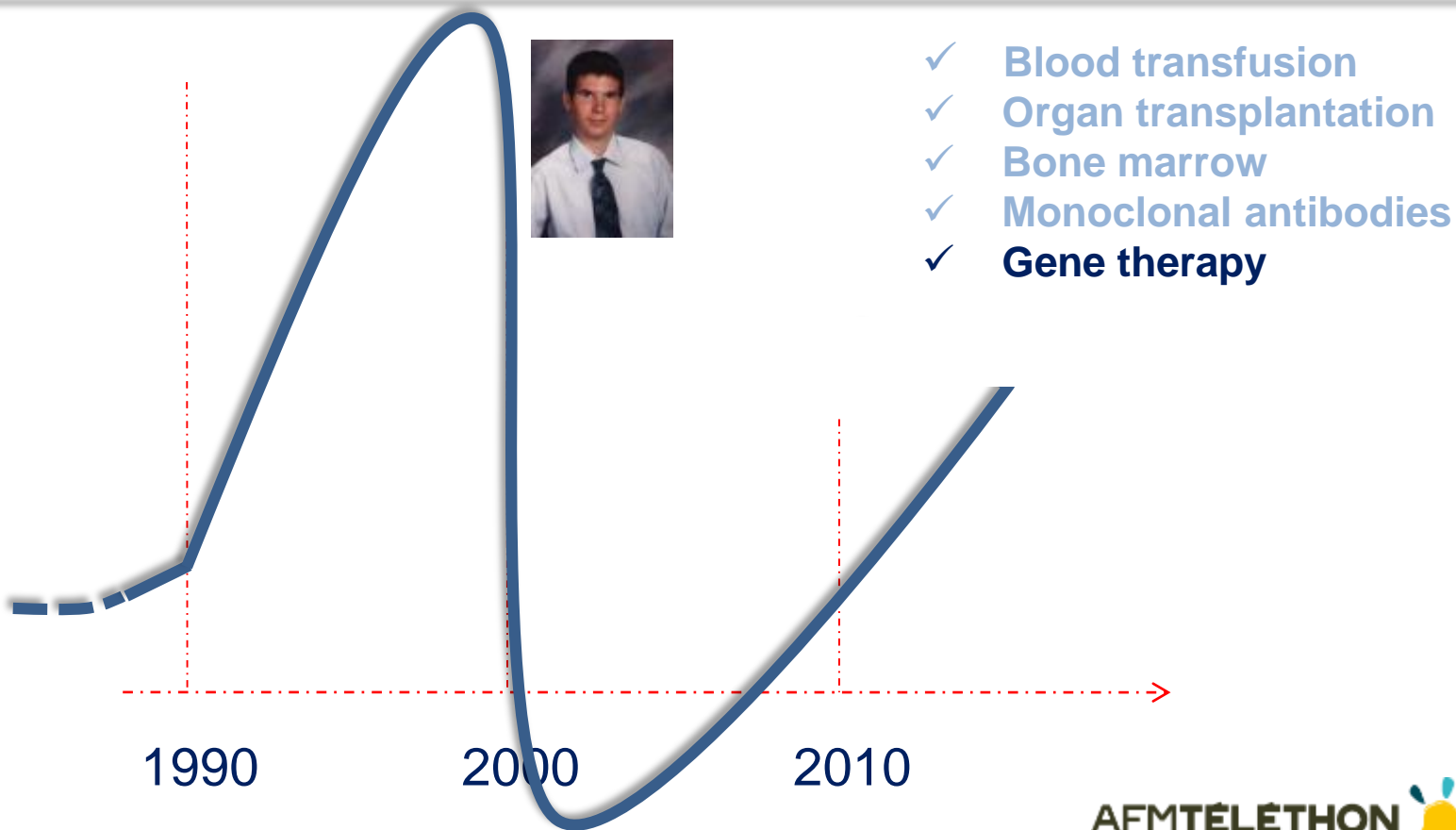
Indications

40
35
12
12
12
7
5
11

- 5 approved products
- 188 companies



The N-shape curve of new medicines



Gene Therapy's Big Comeback

GOING VIRAL

COMPANIES THAT USE VIRUSES TO REPLACE DISEASE GENES HAVE BEEN BOOMING—AT LEAST WHEN IT COMES TO FUND-RAISING. LOOK HOW MUCH THESE FIRMS HAVE RAISED SINCE THE BEGINNING OF 2013.

COMPANY AIMS TO TREAT	RAISED (\$MIL)
GENSIGHT BIOLOGICS GENETIC BLINDNESS	\$41
BLUEBIRD BIO "LORENZO'S OIL" DISEASE	\$116
AUDENTES THERAPEUTICS X-LINKED MYOTUBULAR MYOPATHY	\$30
SPARK THERAPEUTICS GENETIC BLINDNESS	\$50

DIMENSION THERAPEUTICS HEMOPHILIA	>\$10
EDITAS MEDICINE YET TO BE DETERMINED	\$43
JUNO THERAPEUTICS CANCER	\$120
CELLADON ADVANCED HEART FAILURE	\$51
UNIQUE LIPOPROTEIN LIPASE DEFICIENCY	\$92
VOYAGER THERAPEUTICS PARKINSON'S DISEASE	\$45
NIGHTSTARX RETINAL DYSTROPHIES	\$20

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Gene Therapy's Big Comeback

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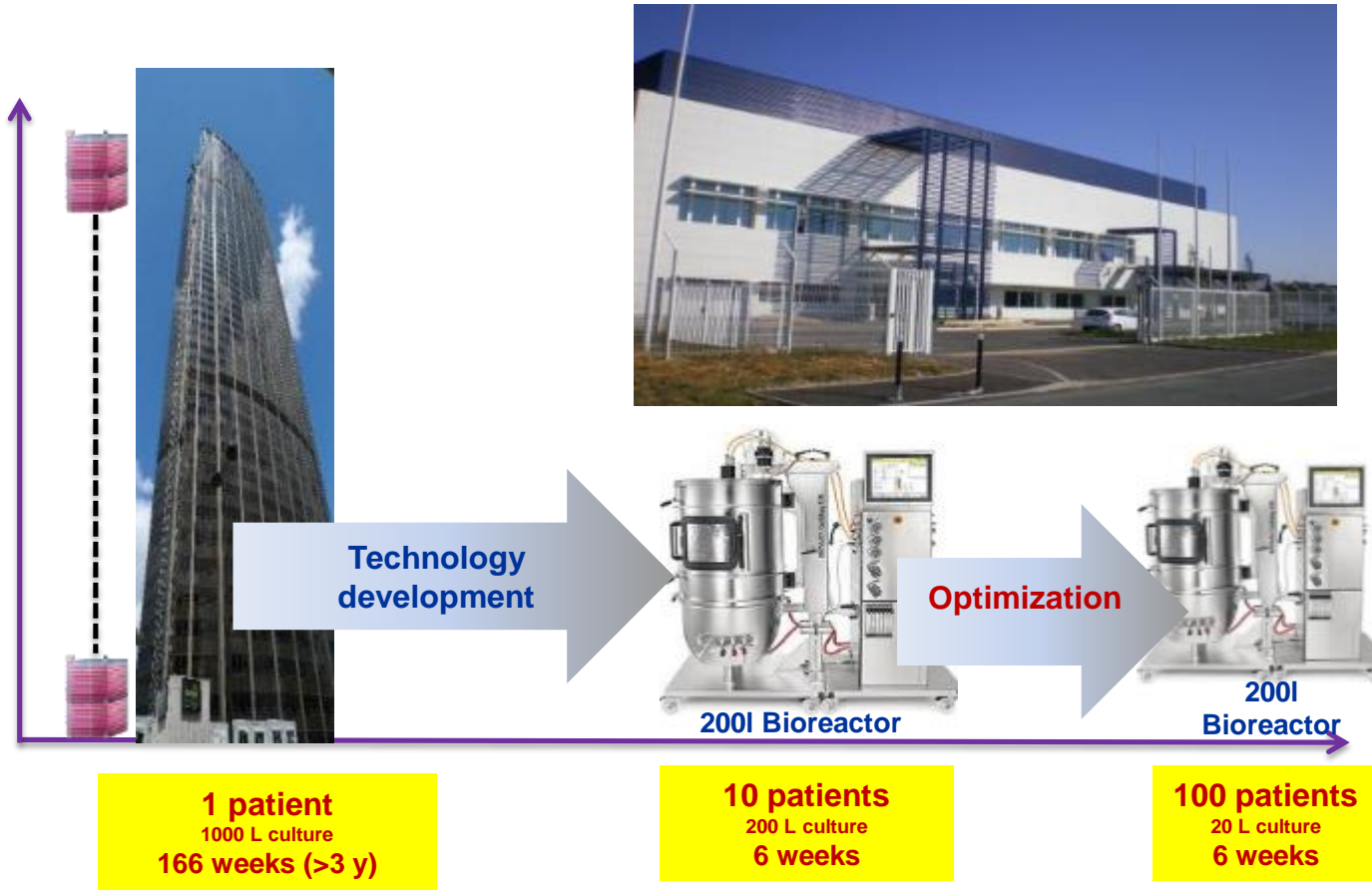
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GMP PRODUCTION



BASIC & APPLIED SCIENCE



ASSISTANCE
PUBLIQUE



HÔPITAUX
DE PARIS



INSTITUT PASTEUR



International



HARVARD
MEDICAL SCHOOL



UNIVERSITÄT
BERN



R & D



GNT Bioprod

GenoSafe

Start-ups

**BASIC &
APPLIED SCIENCE**

R & D

INDUSTRY →



**D
R
U
G**



GNT Bioproducts

GenoSafe



Start-ups



A path to a new industrial nanotechnology sector

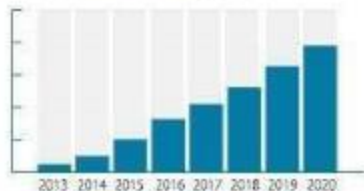


Global RNA Based Therapeutics Market

Size and Forecast (2013 - 2020)

Global RNA Based Therapeutics Market

RNA Therapeutics Market is Expected to Reach \$1.2 Billion, by 2020



Growing at a CAGR of 28.4% (2014-2020)

Global RNA Based Therapeutics Market by End-users

Research



Therapeutics



Diagnosis



For More Details See Table of Contents

Global RNA Based Therapeutics Market By Application



The comprehensive view on the % share of application segment (2013)

Global RNA Based Therapeutics Market by Technologies



The comprehensive view on the % share of technology segment (2013)

Global RNA Based Therapeutics Market by Geography

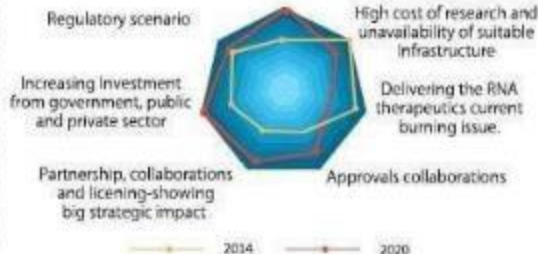
North America, Europe and LAMEA



Fastest Growing Region at a CAGR 29.8% (2014-2020)

Top Impacting Factors

Promising Technologies



700 nucleic acid-based therapeutics (DNA and RNA) in the pipeline
35% oncology

160 companies, 65 academic institutes are developing RNA-based therapeutics

Gousseinov *et al.*, Biopharm Int. 2016

Allied market research report 2014



