# TECH CONNECT

ARIZONA'S TECHNOLOGY MAGAZINE

# THE BIO ISSUE

# HOW DO YOU GET TO BE
## THE LEADER OF THE OTHER 49?


## ARIZONA KNOW HOW. RANKED A BEST PLACE FOR BUSINESS.

In Arizona, we kick the future into high gear. So do the top-level talented people moving here for unbeatable lifestyle and opportunities. Arizona is a best state for business. We're 1st in the nation for job growth. We have the country's largest public university graduating the best and brightest in high-demand disciplines. Arizona's undisputed top-line priority is supporting and backing business. Icons Intel, Avnet, Boeing, GoDaddy and more thrive here. Our aggressive pro-business, tax reductions and pro-growth legislation mean record relocations and expansions. Simply put, our state leads the pack. When it comes to success, Arizona is all business.

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AUTHORITY
azcommerce.com

**PUBLISHERS**
Sandra Watson
Steven G. Zylstra

**EDITOR**
Don Rodriguez

**EXECUTIVE EDITORIAL DIRECTOR**
Susan E. Marie

**ART DIRECTOR**
Erin Loukili
Lucky You! Creative
www.luckyyoucreative.com

**DESIGNER**
Jaclyn Threadgill

**CONTRIBUTING WRITERS**
Clara Buchanan
Joseph Caspermeyer
Molly Castelazo
William Harris
Bruce A. Wright
Steve Yozwiak

**E-MAIL**
editor@techconnectmag.com

For queries or customer service call 602-343-8324

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a place to connect and grow

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SUMMER 2015

TECHCONNECT
ARIZONA'S TECHNOLOGY MAGAZINE




## In Every Issue



**ON THE COVER:** Samantha Whitman co-founded the company DemeteRx after graduate school when she realized that she could make a real difference in the biosciences world.
Photo courtesy Tech Parks Arizona

**Guest** Editor

# A Decade of Progress

## BIOSCIENCE ROADMAP STARTED IT ALL

Arizona's bioscience industry has made tremendous strides over the last decade. Since the launch of Arizona's Bioscience Roadmap led by the Flinn Foundation in 2002, Arizona has become one of the nation's fastest-growing bioscience states. This growth has offered improved healthcare outcomes for Arizonans and helped to strengthen and diversify our economy through the creation of higher than average wage jobs.

Incubation programs such as the Center for Entrepreneurial Innovation (CEI) at Gateway Community College are leading the way in growing some of our new leading bioscience companies. CEI has become a hub for medical device startups and provides FDA regulatory-conscientious product development resources to streamline the development and testing of new innovations. Specifically, the Phoenix-based business incubator offers community-accessible 3D printing and prototyping with Phoenix Analysis and Design Technologies, an onsite medical device maker space established in partnership with MediCoventures, and additional in-house commercialization resources and support to help bring these technologies to market.

Statewide organizations are working to support and grow Arizona's entire bioscience industry, including all the individuals, institutions and companies that comprise it into a greater position of national and international leadership and prominence. An example is the Arizona Bioindustry Association (AzBIO), which provides access to key resources, connections and information on the greater bioscience community. This provides the foundation to be able to Connect, Collaborate, Innovate and Succeed, thus supporting the growth of a thriving economic environment for Arizona's bioscience industry today and in the future.

**RUSS YELTON**
*CEO, Pinnacle Transplant Technologies*

Our universities are working harder than ever to move intellectual property out and into new companies, such as NeoLight, an Arizona State University spinout that is treating jaundice in newborn babies. It is estimated that 60 percent of full-term babies and 80 percent of pre-term babies develop jaundice during their first week of life. Although most newborns with jaundice are initially healthy, they need to be monitored because bilirubin is toxic to the central nervous system and can lead to long-term side effects like kernicterus. For this same reason, neonatal jaundice is perhaps the largest unrecognized cause of neonatal morbidity and mortality in the world.

Overall, the bioscience industry in Arizona is growing at a pace not seen before in our state, mainly due to the collaborative work being done by groups such as the Arizona Commerce Authority, the Arizona Technology Council, the Economic Collaborative of Northern Arizona, AzBIO, Flinn Foundation, CEI, the Bioindustry Organization of Southern Arizona and many others. These organizations are combining efforts to promote our entrepreneurs, universities and angel investors in ways that have not previously existed in the state.

The future of the biosciences in Arizona is bright and the current number of efforts underway continues to allow the industry to make great strides. These efforts will continue to move Arizona forward in providing positive health outcomes, creating high wage jobs and strengthening the overall economy.

**RUSS YELTON** is CEO of Phoenix-based Pinnacle Transplant Technologies, chairman of the Arizona Bioindustry Association, board member of the National Business Incubation Association and chair of the Flinn Foundation Bioscience Entrepreneurship Program Review Committee.

# CAPITAL IDEAS

## Report offers suggestions for capturing elusive funding

When it comes to venture capital for Arizona's technology industries, it's a double whammy. First, keen competition for investors doesn't make it easy to secure funding despite how good the product or idea may be. Then there's the chance that those same early-stage firms will get tired of standing in line and waiting so they go elsewhere in their search for equity financing.

Those challenges notwithstanding, Arizona still can get its share with the right coordinated efforts such as those offered in the report "Risk Capital in Arizona: Observations and Recommendations to Make Risk Capital More Accessible." Venture capital program advisory firm Cromwell Schmisseur was retained by the Arizona Bioscience Board (ABB) to develop a risk capital strategy inclusive of the biosciences but also other technology sectors experiencing similar access-to-capital challenges, says Dan Schmisseur, who co-authored the report with Eric Cromwell.

Arizona is not starting from scratch in its quest for capital. It has some strong suits that include corporate and philanthropic engagement, university outreach, state programs such as the Arizona Commerce Authority's Arizona Innovation Challenge, and a very strong angel investing culture led by two of the nation's leading angel investor groups, Desert Angels in Tucson and the Arizona Technology Investor Forum in Phoenix, says Schmisseur.

"The one component for which improvement is most needed—access to early stage venture capital—is a deficiency shared by the majority of states in the U.S.," he says. "But everything else for Arizona is at least 'good' with the potential to be 'great.'"

In its latest draft, the report already has recommendations to offer Arizona tech sectors:

- Honor the angel investors who already have stepped up to show their support.
- Tirelessly promote innovative companies with Bay Area investors.
- Support expansion of commercialization programs.
- Support technology or venture investing conferences and provide "red carpet" experiences for specialized investors.
- Enable equity participation with public funds. Rules or customs discouraging state involvement in programs that stimulate private investment on market standard terms need to be addressed.
- Address "supply side" issues with the goal of creating a self- sustaining venture capital industry. This recommendation will take the most time and capital to achieve but a truly level playing field for Arizona companies requires more than a few bona fide venture capital firms residing in the regional markets.
- Align with a single voice for Arizona's capital formation policy.

These recommendations are just a start. ABB intends for the report to constantly evolve and improve as partners step forward to lead or co-develop components of the recommended strategies, says Schmisseur.

# PLUSES OF PARTNERSHIPS

WRITING BY × DON RODRIGUEZ

*Universities and others set aside competition to make new discoveries*

Beat the competition. That's the driving mantra when it comes to capitalism. But members of the Arizona bioscience community are following an old adage that seems to work better for their way of doing business: If you can't beat 'em, join 'em.

Partnerships have popped up across the state that have set the stage for research that brings together the best minds to do ultimately what's right for health care patients but not necessarily for bottom lines. "Partnering allows us to focus our resources on our best-in-class capabilities and still have access to best-in-class capabilities through our collaborators," says Tess Burleson, chief operating officer of the Translational Genomics Research Institute (TGen). "It's not practical nor is it possible to be best at everything."

When it comes to reaching out to others, Phoenix-based TGen is known for extending a hand throughout the state. It has done some research projects with Arizona State University's College of Health Solutions. TGen North, a pathogen genomics and biodefense research facility in Flagstaff, was developed in partnership with Northern Arizona University. "As a group that focuses on translational medicine, we are constantly working to build off of what is known by exploring the unknown," Burleson says. "Having clinical partnerships allows us to focus on that exploration while our clinical partners can practice the best-known medical practices as well as participate in research with us."

Speaking of universities, Arizona's third school also is exploring the newfound potential that comes with a united front. Last year The University of Arizona and The University of Arizona Health Network entered into an agreement with Banner Health to create a statewide health care organization and a comprehensive new model for academic medicine. UA has Colleges of Medicine in Tucson and Phoenix. "Partnering the state's two medical schools with the state's leading health care provider creates tremendous opportunities to enhance health care statewide by combining medical education and research with top-notch medical care," says Judy Bernas, UA associate vice president, external relations-Phoenix.

Even though the relationship is fairly new, there already is work underway. Research is being done on traumatic brain injury at UA that can help improve care by health care providers, including first responders. "Through data analytics and biomedical informatics, we can translate new knowledge from research directly to patient care," Bernas says. An example is Banner and UA are working together on a new program that would identify patients at risk for drug interactions and prevent medication errors.

## CENTER OF THE ACTION

The College of Medicine in Phoenix is a part of a prime example of how far partnerships have gone. It is at home on the city-owned Phoenix Biomedical Campus, a 30-acre urban medical and bioscience campus in downtown. The campus contains the highest concentration of research scientists and complementary research professionals in the region and provides firms with unprecedented opportunities for growth and collaborative efforts. TGen also is there. Others with a presence on the campus are the International Genomics Consortium (IGC), National Institute of Diabetes and Digestive and Kidney Diseases, The University of Arizona College of Pharmacy, VisionGate and Barrow Neurological Institute.

Away from the campus, IGC has announced formation of a non-profit joint venture with the University of Michigan for the advancement of DNA diagnostics. Barrow Neurological Institute is partnering with Royal Philips to jointly research accelerating the advancement of magnetic resonance imaging technology. And its home base St. Joseph's Hospital and Medical Center has partnered with Creighton University's School of

Medicine to become a medical school campus where third and fourth year medical students receive clinical training in Phoenix.

Across the state, 43 community colleges are developing the next generation of world-class bioscience and health care professionals. More than 27,000 Arizona students are enrolled in postsecondary, health sciences-related CTE programs. At least one unique partnership has evolved in this setting. The Center for Entrepreneurial Innovation (CEI) at Gateway Community College provides office space, consulting, mentorship, laboratory and prototyping support to startups in the bioscience, renewable energy and technology fields. Phoenix Analysis and Design Technologies has partnered with CEI to make state-of-the-art 3D printing systems available to CEI clients and the community.

Beyond Arizona, Banner Alzheimer's Institute is partnering globally on an unprecedented study that will use a promising experimental drug to halt Alzheimer's before it starts. One of the partnering firms is Genentech, a South San Francisco-based biotech company that will test its anti-amyloid drug on patients. The institute also will collaborate with pharmaceutical Swiss company Novartis to test two experimental drugs that aim to prevent Alzheimer's disease in older, high-risk adults. And TGen is working with researchers at the University of California, San Francisco to tackle glioblastoma brain cancers by finding ways to target a tumor's genetic changes with drugs that can cross the blood-brain barrier. The California school is running a trial with 15 patients and their work is guided by TGen's research.

## ARIZONA WINS

So how does Arizona benefit? One way is through better access to precision medicine capabilities through research because local research benefits local people, first, Burleson says. "TGen was founded in 2002 on the belief that understanding the genomic and molecular drivers of disease would allow for better care," she says, "and the rest of the world is beginning to adopt that belief." Arizona has benefitted from medical tourism—people coming here from all over the world for medical treatment—because the clinical community here has a better understanding and better access to precision medicine capabilities than most other communities do.

There are more than just individuals coming here. Teleost Biopharmaceutical is in the process of moving its headquarters to Tucson from Boulder, Colo. The company works with The University of Arizona to use an invention it developed to create products that help protect against and treat skin maladies such as melanoma by enabling people to produce melanin as a prevention mechanism.

Additionally, commercialization activities arising from laboratory discoveries translate to new job creation and economic development, Burleson says. "As a non-profit organization, TGen is organized for the betterment of human health, so everything we do is with that in mind. Once something proves to be useful toward patient care in our research, we actively seek to ensure access to anyone who can benefit from it."

With the tremendous changes in health care, medical students are learning cutting-edge medicine and bringing those skills directly into the hospital, Bernas says. An example is medical students in Phoenix are learning to use programs like Eviti to help determine the best treatments for patients. Those kinds of programs can be put in place in hospitals such as Banner to determine the best evidence-based treatments for patients.

"Our goal is to maintain good health through earlier diagnosis and smarter, targeted treatments," Burleson says. "Everyone will benefit from that."

Contributing to this story was information from the Arizona Commerce Authority's report "Arizona's Bioscience and Health Care Industry (June 2015)."

# MINDFUL EFFORT

*Arizona at the forefront of cutting-edge brain disease research*

Arizona's scientists are performing leading research and developing top talent in the brain and neurological disease space. They are targeting advanced therapies whose aim is to prevent Alzheimer's and revolutionize brain-disease and traumatic brain injury treatments.

The focus comes at a time when an estimated 10 million Baby Boomers are retiring daily—and when statistics on brain disease affecting the elderly are sobering: In the U.S., the number of Americans living with Alzheimer's disease will nearly triple to 13.8 million by 2050. Arizona's expertise positions it as a leader in providing solutions for the healthcare needs of an aging U.S. population.

Brain and neurological research companies are part of Arizona's mushrooming bioscience sector, which in 2013—the most recent year measured—attracted about $237 million in direct investment for clinical trials. The sector stretching from Tucson through Phoenix to Flagstaff includes all three state universities, hospitals and the Translational Genomics Research Institute (TGen) as well as other prominent institutions.

> “We have national and global key opinion leaders in Parkinson’s, traumatic brain injury, Alzheimer’s and MS.”

*–Marie Wesselhoft, MSDx, president and co-founder*

The Arizona Commerce Authority (ACA) is tracking at least 35 companies that are either in the late stages of product research or in the early stages of commercialization in the brain and neurological sector, according to Sergio Gazic, ACA’s bioscience portfolio manager. That confluence of resources has helped Arizona become one of the Top 10 states in growth for National Institutes for Health (NIH) funding. A Flinn Foundation report says NIH funding in Arizona grew 31 percent from 2003 to 2013, when it reached $182 million.

Arizona companies doing brain and neurological research also are finding other means of support. MSDx, a Tucson-based company developing blood-testing products for brain diseases, was one of six winners in the spring 2011 round of ACA’s Arizona Innovation Challenge, a biannual business plan competition that awards startups and early stage companies up to $250,000 in grant funding capital to grow their businesses. In 2013, MSDx received grant funding and program services through the Flinn Foundation’s Bioscience Entrepreneurship Program.

The funding is being used to support further development of the company’s technology. Its blood tests give critical data to improve treatment decisions, which can help slow the progression of the diseases. Although the focus is on multiple sclerosis, its technology may be applied in other brain diseases such as Parkinson’s disease and Alzheimer’s disease, and traumatic brain injury.

MSDx was formed by a team in The University of Arizona McGuire Center for Entrepreneurship program that built a business plan to launch a diagnostic company addressing the unmet need of offering simple blood test products for diagnosing and monitoring brain diseases. The plan laid the foundation for the formation of MSDx. The Arizona Center for Innovation, UA’s business incubator, offered wet lab facilities to assist MSDx in getting started and MSDx initiated its first clinical study in multiple sclerosis with Barrow Neurological Institute at St. Joseph’s Hospital and Medical Center in Phoenix. Today it conducts studies on Parkinson’s disease with the UA.

## RIGHT COMBINATION

“The first is neurological expertise,” MSDx President and co-founder Marie Wesselhoft says of factors in Arizona that support a strong brain and neuro ecosystem. “Having institutions such as Mayo, Banner, Barrow Neurological Institute and University of Arizona—with strong medical care and research—creates the right environment. We have national and global key opinion leaders in Parkinson’s, traumatic brain injury, Alzheimer’s and MS. This brings the patients. Then you couple that with the right patient demographics—Arizona’s aging population—to create an environment ripe for early stage drug, device and diagnostic companies.”

Wesselhoft says the support her company received in this sector includes assistance from ACA and the Flinn Foundation as well as angel capital from the Tucson Desert Angels. She also noted that the technical expertise from the UA included interns and research personnel.

Flinn’s grants for companies like MSDx is one of the foundation’s strategies to “build a critical mass

of bioscience firms," Jack Jewett, the foundation's president and CEO says in a statement announcing the grant. In addition to Flinn, Arizona is also home to bioscience funding leaders like the Ben and Catherine Ivy Foundation, which supports brain cancer research.

Another Tucson company focusing on brain and neurological diseases is NuVox, which was one of six winners in the fall 2014 round of the Arizona Innovation Challenge. NuVox's lead product is therapeutic biotechnology to improve oxygen levels in the body, which helps brain and body recovery, and treatment of life-threatening conditions such as radiation-resistant cancers.

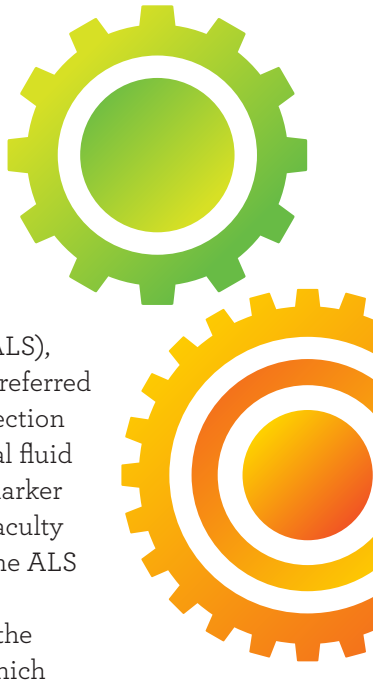
A couple hours north of Tucson is TGen, which is at the heart of the Phoenix Biomedical Campus and is helping lead a revolution in neurogenomic research. Through its Center for Rare Childhood Disorders, TGen uses its world-class expertise in genetic and genomic sequencing that spells out the 3 billion letters of the human DNA to uncover the origins of childhood disease and disorders.

In many cases, children and their families have endured months- and years-long diagnostic odysseys. Their children's disorders often are just a collection of symptoms with no name. TGen has sequenced the genomes of nearly 200 children and their families, and in nearly 40 percent of the cases discovered the genetic cause or likely genetic cause behind the child's disorder. This is extremely valuable information for physicians because it helps guide their medical treatment.

TGen is also plowing new ground in Alzheimer's research with its unique MindCrowd.org crowdsourcing memory study. More than 53,000 people from all 50 states and 150 nations around the world have participated in MindCrowd, already making it one of the largest research studies of its kind.

## GOING GLOBAL

Arizona's brain and neuroscience research in the bioscience sector is at the forefront of efforts to solve some of medicine's most pressing challenges. Iron Horse Diagnostics, a Scottsdale company founded by Dr. Robert Bowser of the Barrow Neurological Institute, is poised to go global with a way to diagnostically detect if a person has amyotrophic lateral sclerosis (ALS), a rapidly progressive disease often referred to as Lou Gehrig's disease. The detection takes form through a blood or spinal fluid test, which serves as a signal or a marker for injury. Bowser, also an adjunct faculty member at TGen, plans to launch the ALS diagnostic test in early 2016.



Bowser won a 2013 award from the Arizona Bioindustry Association, which recognizes leaders, innovators and companies that are making Arizona one of the fastest growing bioscience states in the U.S. Iron Horse also has been supported by an NIH grant. Arizona's growing reputation as a leader in brain and neurological research is supported by national recognition beyond the NIH. Barrow's neurosurgical residency program in 2014 was ranked the No. 2 training program in the U.S. by Doximity/U.S. News & World Report.

"From Arizona's economic development perspective, it's about building the economy for the future with high-paying jobs fueled by high levels of education," says ACA President & CEO Sandra Watson. Arizona now claims nearly 320,000 jobs in the bioscience and health care industry. Those jobs command an average annual salary of more than $65,000, according to a June 2015 industry report by ACA.

The innovators, scientists and entrepreneurs working on brain disease research in Arizona are breaking down barriers and creating new scientific pathways of discovery. It's a key cog in the bioscience engine and that's great news for everyone from college-aged students to seniors around the U.S.

# TECH POLICY IN ARIZONA

## A recap of key action in the Legislature's 2015 session

WRITING BY × MOLLY CASTELAZO

The Arizona Technology Council had a number of priorities in the 2015 session of the Arizona Legislature, including create a structure for equity crowdfunding, expand the Refundable Research & Development Tax Credit, recapitalize the Angel Investment Tax Credit and secure additional K-12 education funding. On those priorities and others that affect the state's technology industry, lawmakers delivered some victories as well as some losses. Here's a recap:

### 2015 TECH-RELATED VICTORIES

#### Passage of intrastate equity crowdfunding structure

**Bill title:** HB2591 (securities registration; exemption; website operators)
**Purpose:** This bill created a structure for equity crowdfunding, allowing unaccredited Arizona investors to invest up to $10,000 each in Arizona companies. The businesses can raise up to $1 million without a financial audit and up to $2.5 million if they have an audit completed.
**Sponsors:** Rep. Jeff Weninger, Sen. David Farnsworth
**Status:** Gov. Doug Ducey signed the bill into law on April 1.

#### Passage of ridesharing regulation bill

**Bill title:** HB2135 (transportation network companies)
**Purpose:** The bill provided a regulatory mechanism for transportation network companies such as Uber and Lyft that hire independent contractors or private drivers to operate their own personal vehicles for the purpose of ridesharing. The bill was the product of months of negotiations between ridesharing companies and taxi/livery companies. The bill sought to provide regulations and fix "insurance gaps" that prompted then-Gov. Jan Brewer to veto a similar bill in 2014.
**Sponsor:** Rep. Karen Fann
**Status:** Ducey signed the bill into law on April 9.

#### Defeat of bills to repeal Arizona's College and Career Ready Standards

**Bill titles:** HB2190 (schools; Common Core; replacement), HB2392 (schools; Common Core; prohibition), SB1305 (continuous improvement academic standards committee), SB1458 (schools; academic standards; tests),
**Purpose:** These bills shared a common goal: to repeal and/or replace Arizona's College and Career Ready Standards (formerly called Common Core Standards). Both Ducey and Superintendent of Public Instruction Diane Douglas publicly opposed the standards before

taking office.
**Sponsors:** Rep. Mark Finchem (HB2190), Rep. Jay Lawrence (HB2392), Sen. Kelli Ward (SB1305 and SB1458)
**Status:** HB2190 received the most debate and discussion in both the House and Senate. It failed in a Senate Committee of the Whole vote of 13-16, with Republicans Jeff Dial, Adam Driggs, Steve Pierce and Bob Worsley siding with the Democrats to kill the bill. In addition, none of the other bills made it to the governor's desk.

### Defeat of Interstate Medical Licensure Compact opposition bill

**Bill title:** SCR1003 (interstate medical licensure compact; opposition)
**Purpose:** The bill opposed Arizona's participation in the Interstate Medical Licensure Compact, a new licensing option developed by the Federation of State Medical Boards under which physicians seeking to practice in multiple states would be eligible for expedited licensure in all states participating in the Compact. Advocates believe the Compact would make it easier to attract doctors to Arizona and promote telemedicine opportunities.
**Sponsor:** Sen. Kelli Ward
**Status:** Bill failed to pass in the House.

## 2015 TECH-RELATED LOSSES

### DEEP CUTS TO EDUCATION FUNDING

Legislature and governor ended up agreeing on a budget that cut:

- $113 million (5 percent) from K-12 district schools
- $99 million (13 percent) from Arizona's three public universities
- All state funding for Maricopa and Pima Community Colleges

### Defeat of bill to expand the Refundable Research & Development Tax Credit program

**Bill title:** HB2333 (tax credit; research activities; refund)
**Purpose:** The Refundable R&D Tax Credit program as it currently exists enables the Arizona Commerce Authority to award up to $5 million in income tax refunds to taxpayers for qualified research and development activities. This bill would have increased the total amount that could be awarded from $5 million to $15 million over a four-year period. An economic impact study found the $15 million awarded in the first three years of the program generated $2.3 billion in total economic output. In 2015, demand for the program was so high that the full $5 million was allocated in the first *two days* of the year.
**Sponsor:** Rep. Karen Fann
**Status:** After passing out of committee, House Majority Leader Steve Montenegro blocked the bill from advancing further. Senate President Andy Biggs blocked all efforts in the Senate.

### Defeat of bill to recapitalize the Angel Investment Tax Credit

**Bill title:** HB2011 (tax credit; small business investment)
**Purpose:** In 2014, the Legislature extended the Angel Investment Tax Credit program to 2021 but did not allocate any additional funds. The bill would have allocated to the Arizona Commerce Authority an additional $5 million worth of tax credits to the program. There is currently about $1.1 million left in the fund, which is expected to be depleted this year. In a comprehensive study, economist Elliot Pollack found $18.9 million in tax credits awarded through this program generated $1.4 billion in economic output—and $44 million in tax revenue for the state.
**Sponsor:** Rep. T.J. Shope
**Status:** This bill met the same fate as expansion of the Refundable R&D Tax Credit.

**MOLLY CASTELAZO** is founder of Castelazo Content, which develops thought leadership and lead generation content for technology companies, and co-chair of the Arizona Technology Council's Workforce Development & Education Committee. This article was synthesized from the 2015 Arizona Legislative Wrap-Up prepared by the lobbying firm Public Policy Partners.

GOV. DOUG DUCEY

# Bioscience
## IS BIG BUSINESS IN ARIZONA

Arizona's long-term success will be driven by big ideas and bold leadership. And when it comes to bioscience and health care, we already are thinking big and being bold.

We have a confluence of resources dedicated to developing breathtaking advancements and transformational discoveries that will benefit all Arizonans. I'm proud to acknowledge that our researchers are tackling everything from advanced genomics, early-stage cancer detection, neuroscience exploration, precision medicine and cutting-edge diagnostics.

In short, bioscience and health care in Arizona are thriving.

In 2014, the sectors encompassed nearly 320,000 jobs at an average annual pay of $65,534. These high-demand, high-paying jobs represented nearly $21 billion in total annual earnings. Employment in these industries grew by nearly 27 percent from 2007 to 2014 in Arizona—more than twice the national rate of 11.6 percent.

Additionally, the value of Arizona's clinical research reached $237 million in 2013, resulting in a total economic impact of $618 million. More than 29,000 people participated in 1,311 clinical trials.

This is an Arizona success story worth telling. And it fits right into my "Open for Business" agenda.

Arizona's three universities conduct more than $1 billion in research annually. This creates exciting spinoff companies supported by a combination of university research and private sector know-how. These institutions also are creating the pipeline for a talented workforce that will be needed to fill the best jobs in the future.

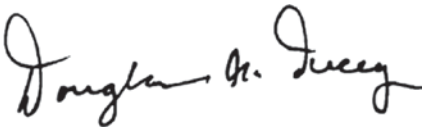
As a governor with years of entrepreneurial experience, I'm energized by the fact that much of the innovation in these sectors is being driven by private industry. Notable employers in the bioscience and health care sectors include companies W.L. Gore, Ventana Medical Systems, Translational Genomics Research Institute (TGen), McKesson, Banner Health, HonorHealth, Mayo Clinic, Medtronic and many, many more.

In Arizona, we have some 50 accelerators and incubators helping biotech companies advance from idea to commercialization. This ecosystem is not only an asset that supports Arizona's overall attraction efforts for global companies but is critical for the state's long-term economic growth and vitality.

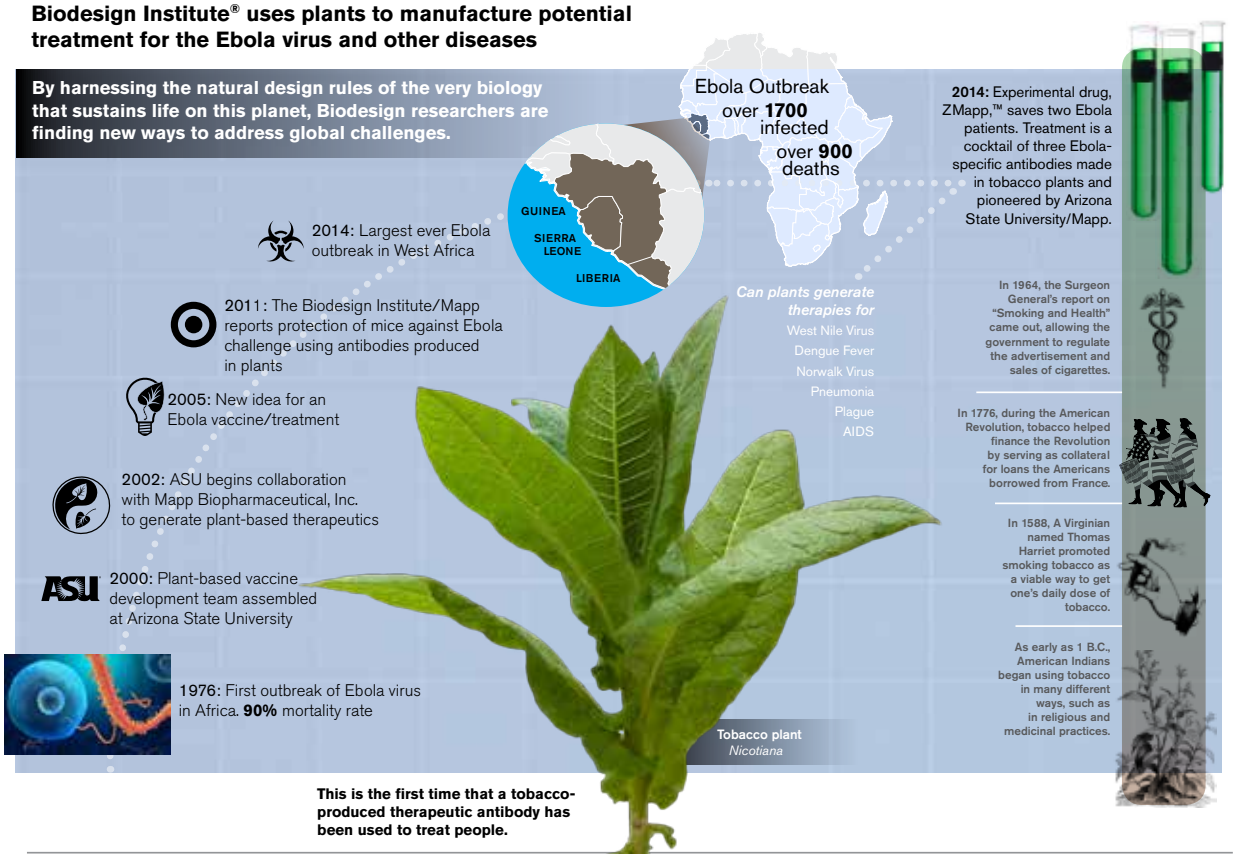
This innovative culture will continue to get a boost by our pro-growth, business friendly environment in Arizona. We've reduced regulations, eliminated bureaucracy and red tape, and will continue to ensure taxes are kept predictable, reasonable and competitive. We've created the ideal environment for bioscience and health care to grow and thrive.

In the following pages of this edition, you'll read about success stories in these sectors. You'll see that we are up to tackling the big challenges: Can we cure cancer? Can we stop diseases like Alzheimer's before they start? Can we revolutionize the diagnosis and treatment of traumatic brain injuries?

If anyone can, it's Arizona. Let's lead the way and show the world how it's done.



**Biodesign Institute® uses plants to manufacture potential treatment for the Ebola virus and other diseases**




ASU BIODESIGN INSTITUTE ARIZONA STATE UNIVERSITY

# MEET MR. CREATIVE

WRITING BY ✕ JOSEPH CASPERMEYER

*Ebola crisis thrusts researcher into Fast Company spotlight*

Charles Arntzen, a researcher at Arizona State University's Biodesign Institute, has been chosen as the No. 1 honoree among Fast Company's annual "100 Most Creative People in Business" for his leadership role in developing ZMapp, a therapeutic produced in tobacco to fight Ebola.

"I never anticipated we would get ZMapp into human testing for another three or four years, and suddenly, the urgency of the situation in West Africa was upon us," says Arntzen, who attended a star-studded Fast Company gala in Hollywood that feted the 2015 honorees, including scientists, actors, musicians, artists and entrepreneurs.

With no known vaccine or cure available, more than 10,000 have now perished throughout West Africa, a humanitarian crisis created by the worst Ebola epidemic in history. During the height of the outbreak, two American missionaries became infected. Physician Kent Brantly and health care worker Nancy Writebol, both near death and desperate for help, became the first people to receive ZMapp, knowing full well that it had never been tested in humans before. Within 24 hours, Brantly was walking again, and both have fully recovered. "It was astonishing how effective this new therapeutic was, and this is snowballing now," says Arntzen, who is convinced ZMapp works. "It's now in human trials in West Africa and has captured all sorts of attention."

Little was known of ZMapp at the time, or how it originally sprung from the minds of creative scientists like Arntzen and his collaborators

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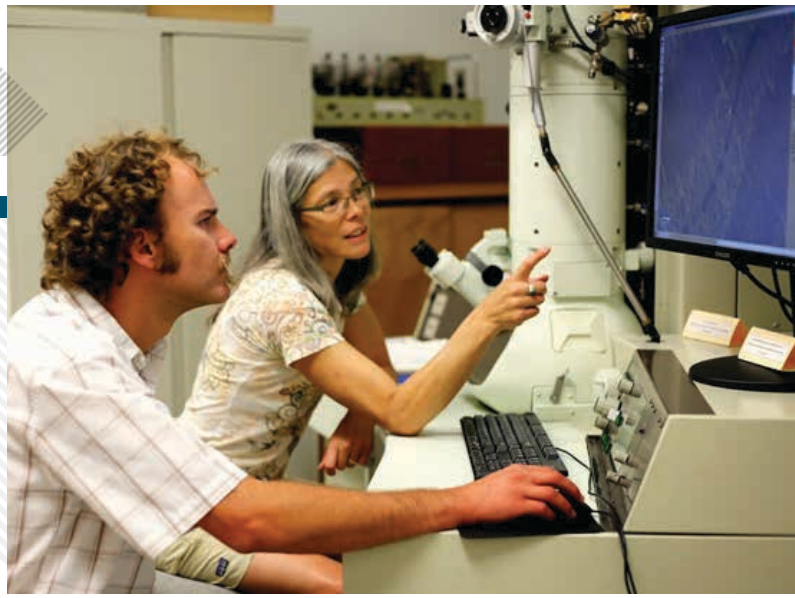


Center Director Kiisa Nishikawa and Associate Professor of Mechanical Engineering Brent Nelson bring biology and engineering expertise to this transdisciplinary team.

# CROSSING PATHS

WRITING BY ✕ CLARA BUCHANAN

*Collaboration spells success for new Center for Bioengineering Innovation*

Regents' Professor Kiisa Nishikawa's $1 million grant from the W.M. Keck Foundation is turning into a significant contribution to the newly established transdisciplinary Center for Bioengineering Innovation (CBI).

Funding from the foundation is highly competitive as it is reserved for "high risk, high reward" research activity with the potential for transformative impact. "In general, the prestige of an award from the W.M Keck Foundation is thought to accelerate innovation," says Nishikawa, whose winding filament hypothesis has been regarded by many as a groundbreaking contribution to understanding muscle contraction. Applications of the theory could have significant implications for rehabilitation engineering, prosthesis design and control, and neuromuscular disease and injury.

According to Nishikawa, the strength of CBI lies in the collaboration of experts from different fields—a main focus of the center will be to develop innovative methods in nanoengineering, applied physics and biochemistry—to test the winding filament hypothesis from every angle imaginable. "We're combining our knowledge and experience to take us to places and produce results beyond anything any of us could do individually," she says. "The center will provide a new model of best practices for inclusive transdisciplinary research at NAU."

Matthew Gage, associate professor of chemistry and biochemistry, was part of the initial collaboration that led to development of the CBI. He agrees that its strength lies in the intersection of specialties. "People with different training look at the same problem differently," he says. "This often leads to ideas and approaches that would not happen when people with the same background look at a problem."

Gage points out that his work with Nishikawa already has led to two other ongoing projects in his lab. He notes that such productivity is common in collaborative research, and has increasingly been a priority for institutions such as the National Science Foundation and the National Institute for Health. "Centers such as this are the new model for research," he says. "I see this as a step into the future for NAU."

Nishikawa—and the W. M. Keck Foundation, which funds her research—believes research that draws from so many different fields is sure to have equally far-reaching impact. "If our idea is right, it could change the way we think and do things in physiology, medicine and robotics," Nishikawa says. "This award gives us the opportunity to really get the ball rolling."

Preliminary research on which the Keck proposal was based was funded by the university's Technology and Research Initiative Fund and the National Science Foundation.

**CLARA BUCHANAN** is an administrative associate in NAU's Office of the Vice President for Research.

# BENCH BY BENCH

WRITING BY × BRUCE A. WRIGHT

*Building bioscience companies at the Arizona Center for Innovation*

Alumni entrepreneurs Dr. Ricardo Hernandez (right) and John Jackson of Grafted Growers are commercializing a novel crop-production strategy that got its start through UA research.

The Arizona Center for Innovation (AzCI) is a critical component of Tucson's entrepreneurial ecosystem and is helping pave the way for budding bioscience ventures. AzCI fosters startups and assists emerging and mature technology companies develop and commercialize ideas, discoveries and products.

Located at the UA Tech Park, AzCI is a component of Tech Parks Arizona. In turn, Tech Parks are part of Tech Launch Arizona, The University of Arizona unit dedicated to creating an ecosystem of invention and commercialization across our region and beyond. AzCI provides resources such as co-working space, full-service offices, professionally managed state-of-the-art laboratories and equipment, an innovative business development curriculum, and connections to business experts and mentors-in-residence.

Alongside such business services, AzCI's laboratory space gives early and mid-stage companies an environment for product development, with a flexible, customizable, supported structure. For example, the "rent-a-bench" program allows companies the flexibility to expand their laboratory space while ramping up their operations to support the company's growth.

AzCI represents a best-practices environment, having adopted Good Laboratory Practice standards for conducting nonclinical research. Companies also have access to laboratory equipment and a lab manager who oversees the safety and functionality of the laboratory, and maintenance of the shared equipment and facilities.

The majority of the companies currently incubating at AzCI are working in the field of biosciences. "The flexible lab space AzCI offers has aided in the rapid validation of our business model and the development of specialized indoor production of grafted vegetable transplants plants for commercial grower and hobby grower markets," says John Jackson, co-founder of Grafted Growers.

DemeteRx Pharmaceuticals, another company at AzCI, decided to pivot its business within the first year to biological sample preparation using magnetic particles (Ferradigm). Being affiliated with AzCI and completing the Mentored Launch program made this transition easier and contributed significantly to the successful launch of Ferradigm's first two products within nine months of development.

"DemeteRx was founded by PhDs without business experience. The programs and mentor network the AzCI provided gave us tools to formulate a full business plan and learn to fail fast. This knowledge helped identify a faster route to market in bioseparations (like getting DNA from blood) using magnetic nanoparticles," says co-founder Samantha Whitman. "Our new product brand, Ferradigm, can make a difference in the daily lives of researchers by helping them save time and money."

AzCI also helps companies attract grant funding, investments and new employees as well and offers support for assessing markets, and prototyping and launching new products.

Earlier this year the U.S. Department of

*continued on page 20*

photo courtesy Tech Parks Arizona

# TARGETING TUMORS

WRITING BY ✕ STEVE YOZWIAK

*Joint study provides comprehensive look at brain cancer treatments*

Dr. Sara Byron, research assistant professor in TGen's Center for Translational Innovation and one of the study's co-lead authors

Led by the Translational Genomics Research Institute (TGen) and the University of Calfornia, San Francisco (UCSF), a comprehensive genetic review of treatment strategies for glioblastoma brain tumors was published recently in the Oxford University Press journal Neuro-Oncology.

The study, "Towards Precision Medicine in Glioblastoma: The Promise and The Challenges," covers how these highly invasive and almost always deadly brain cancers may be treated, reviews the continuing challenges faced by researchers and clinicians, and presents the hope for better treatments by harnessing the power of the human genome. The study also describes a pioneering clinical trial—underway for 15 patients at UCSF and guided by TGen research—in which an individual patient's genomic profile is used to offer treatment recommendations to an expert, multidisciplinary panel.

"This study thoroughly explores how we arrived at the current standard-of-care and how, through cutting-edge genomic technologies, we might find better answers for these patients who need our help today," says Dr. Jeffrey Trent, TGen president and research director, and the study's senior author.

Funded by The Ben & Catherine Ivy Foundation, the study is one of several simultaneous and coordinated efforts seeking to uncover the molecular source of this deadly brain cancer with the goal of prolonging survival of glioblastoma patients. "These studies and their associated clinical trials have the potential to lift our knowledge of glioblastoma to an unprecedented new level," says Foundation President Catherine Ivy. "Developing drug compounds that breach the blood-brain barrier and are effective against tumors would fulfill one of the medical community's most critical unmet needs, and boost the hopes of brain tumor patients everywhere."

One of the major difficulties in treating brain tumors is finding drugs that can penetrate the blood-brain barrier, which buffers the brain from the rest of the body's blood-circulatory system. Located along capillaries, the blood-brain barrier protects the brain from rapid changes in the body's metabolic conditions and minimizes exposure to molecules that are toxic to neurons in the brain.

"This study outlines strategies for overcoming past failures, primarily by applying targeted combination therapies that match the tumors' genetic changes with drug compounds that can reach the central nervous system," says Dr. Sara Byron, research assistant professor in TGen's Center for Translational Innovation, one of the study's co-lead authors.

Another major challenge in treating glioblastoma is its intrusive penetration into adjoining tissues, which prevents the complete surgical removal of the tumors from the brain, even with follow-up radiation and chemotherapy. "It is this invasive, infiltrative disease component that is the ultimate cause of recurrence, resistance and death," the study says.

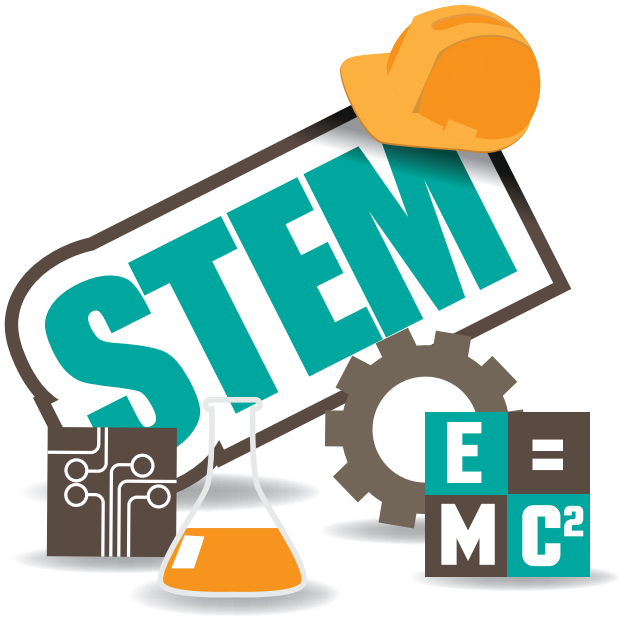
In the clinical trial begun at UCSF, multiple biopsies are performed on each patient at the time of surgery in different regions of the brain tumor. That is followed by extensive genome-wide profiling, leading to a selection of drugs that would target the brain cancer and diffuse regions of the lesion that cannot be removed by surgery.

*continued on page 20*

# EXECUTIVE ACTION

WRITING BY ✕ WILLIAM HARRIS

*Arizona answering nation's STEM commitment challenge*




During last month's White House Science Fair, President Obama revisited the nation's commitment to STEM education, urging action and stressing the importance of diversity. "It's not enough just to talk about STEM," he says. "We want to make sure everybody is involved." In our state, the Arizona STEM Network is employing strategic partnerships between industry and education to increase diversity in STEM fields and position Arizona as a national leader in its advancement.

Backed by multimillion-dollar investments from Arizona's own Freeport-McMoRan and the Helios Education Foundation, the Arizona STEM Network is providing infrastructure, resources and metrics to strengthen the state's next generation economy. Today, the Helios STEM School Pilot program has provided nearly $2 million in impact funding to 19 Arizona schools in seven school districts, with the intention of significantly increasing STEM focus within the K-12 schools.

Initial feedback on the pilot is encouraging. The Arizona Daily Sun recently featured Killips Elementary School in Flagstaff, one of our Helios STEM schools, and its efforts to close the achievement gap and break down socioeconomic barriers to quality STEM instruction. Killips principal Joseph Gutierrez remarked that with a student body where nearly 99 percent of kids qualify for free and reduced lunch, education provides a "way out" for his students. Gutierrez and his staff have built a student-centered approach, "moving the learning forward through their inquiry." Statewide efforts like those at Killips are revolutionizing and diversifying the STEM experience and inspiring others, with at least 12 other states seeking to replicate Arizona's success.

Perhaps the most significant milestone in the state's STEM history, the newly launched Arizona STEM Education Measures is a momentous result of the Helios STEM investment. Science Foundation Arizona and the Arizona STEM Network have launched the Measures, which provide the most current and comprehensive collection of STEM metrics in the state of Arizona. For the first time, policy makers, curriculum builders and other education stakeholders here can access centralized data to measure how Arizona students are doing in comparison to their state and national peers.

Ken Quartermain, Jr., the new Arizona STEM Network director, asserts with these indicators in hand, we can inspire informed discussions regarding where to best target our efforts to improve STEM education in Arizona and better prepare our students for a 21st century workforce.

**WILLIAM HARRIS** is president and CEO of Science Foundation Arizona.

MR. CREATIVE *continued from page 015*

Charles Arntzen

more than a decade ago at ASU's Biodesign Institute. ZMapp is a serum made in a plant with a notorious reputation as a killer, tobacco. The pathway from discovery to treatment began with an idea Arntzen had to produce low-cost vaccines in plants to fight devastating infectious diseases in the developing world.

Then, after 9/11 and the anthrax attack on the U.S. Senate, the government invested heavily in biodefense, including $3.7 million to Arntzen and a small San Diego-based startup led by Larry Zeitlin and Kevin Whaley, Mapp Biopharmaceutical. The goal was to develop plant-based defenses against pathogens, including Ebola, that could be used as potential biological threats. With a dream team of collaborators, they modified the tobacco plants to produce a protective cocktail made of three monoclonal antibodies. This therapeutic cocktail proved to be 100 percent effective in protecting animals against Ebola, even five days after exposure.

"We've been teaming together manufacturing innovation, tobacco engineering innovation, our virus work and antibody discoveries," says Arntzen. "I'm guessing, just in the development of ZMapp, there were about 100 different people with a 100 different skills who came together."

ZMapp is the leading candidate for a drug treatment to fight Ebola but because it was experimental, there were only enough doses to save a few. In response, the government has awarded a $25 million contract to Mapp for the massive scale-up desperately needed to stockpile enough of the drug and safeguard against another possible outbreak. Now, commercial partner Kentucky BioProcessing has produced enough ZMapp for the necessary clinical trials in Liberia to begin.

"For the last decade, a huge part of my role has just been a cheerleader. We've just found we've been able to lower the level of inertia to get over barriers to work together," says Arntzen.

Atntzen's Biodesign colleagues who were a core part of the team, including Qiang "Shawn" Chen, Hugh Mason and Tsafrir Mor, continue to pursue plant-based vaccines and therapeutics to combat West Nile virus, dengue fever, nerve agents and even cancer. Their pursuits are emblematic of the more than 400 creative scientists and students at the Biodesign Institute who have made groundbreaking discoveries, including linking gut microbial composition to autism, identifying diseases like cancer at its earliest stages, generating renewable energy, and making polluted water and soil clean—all with the goal of advancing global health, energy and the environment.

**JOSEPH CASPERMEYER** is managing editor of ASU's Biodesign Institute.

BENCH *continued from page 017*

Agriculture awarded Grafted Growers a $100,000 Phase 1, Small Business Innovation and Research grant. The company has developed a process that combines an accelerated growing environment for vegetable plants with grafted disease-resistant root stocks. The grant will fund the refining of various elements of the company's process.

AzCI was launched in 2003, and its extended history and partnerships enable it to bring proven best practices to the companies and community it serves. It is an active member of the National Business Incubator Association and a founding member of the Arizona Business Incubation Association. "The AzCI programs and facilities have created a dynamic environment that inspires, encourages, and empowers new entrepreneurs, leading to new business growth here in Tucson," says Anita Bell, acting director for the Arizona Center for Innovation.

**BRUCE A. WRIGHT** is the associate vice president for Tech Parks Arizona at The University of Arizona.

TUMORS *continued from page 018*

Drug selection is individualized and multiple FDA-approved agents (up to four) are allowed. "Rules" for drug selection are implemented using the specialized drug pharmacopeia designed for this trial. With the assistance of multi-specialty, multi-institutional molecular tumor board that drafts a report to the treating physician, the drugs are chosen carefully, considered with knowledge about the ability of the drug to reach the brain and the patient's past treatment history and concomitant therapies.

**STEVE YOZWIAK** is the senior science writer for the Translational Genomics Research Institute.

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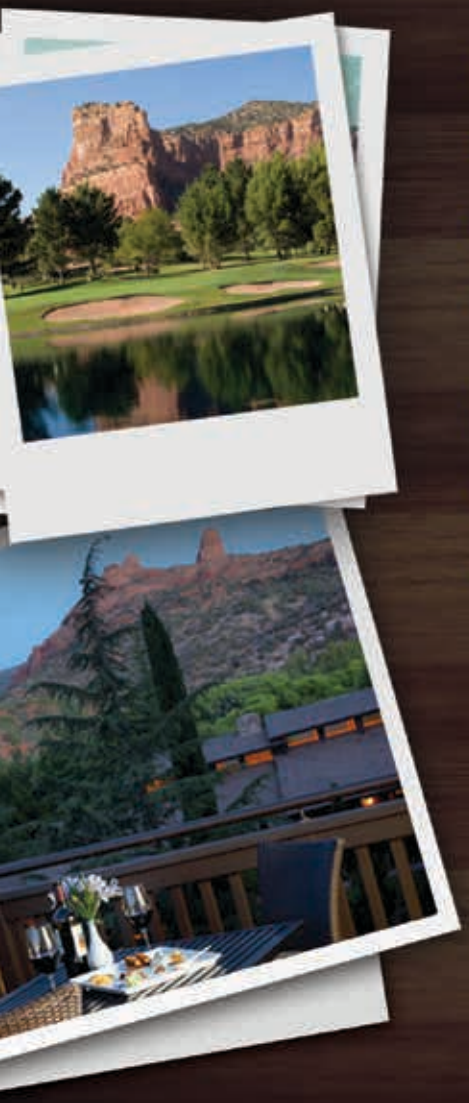

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